z/OS

MVS Planning: Global Resource Serialization

SA22-7600-02

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Note

Before using this information and the product it supports, be sure to read the general information under “Notices” on page 201.

Third Edition, March 2002

This is a major revision of SA22-7600-01.

This edition applies to Version 1 Release 3 of z/OS (5694-A01) and to all subsequent releases and modifications until otherwise indicated in new editions.

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About This Book

This book describes how to plan for a global resource serialization complex. Global resource serialization allows users on multiple systems to serialize access to processing and logical resources, such as data sets on shared DASD volumes.

Who Should Use This Book

This book is to assist you in deciding whether or not to use global resource serialization to serialize access to resources, such as data sets on shared DASD volumes. Once that decision is made, use this book to plan how to make the best use of global resource serialization.

This book applies to those systems that run z/OS, but it also includes information about earlier versions of MVS, through MVS/SP Version 2. Systems should be running data facility storage management subsystem DFSMS/MVS version 1. This book uses "MVS" to apply to all versions of MVS. When it must make distinctions, it uses "MVS/ESA SP Version 5" to "MVS/SP Version 2", or identifies specific releases.

How This Book Is Organized

This book assumes that you are very familiar with MVS and have a thorough knowledge of your installation's data processing goals, problems, and available hardware and software.

The book deals solely with the process of planning — the thinking and decision-making someone at your installation must do before you actually use global resource serialization to serialize access to global resources, such as data sets on shared DASD volumes. It does not describe such details as the complete syntax of the macros, parmlib members, and system commands that you use to actually carry out your plan. These details are described in other books and this book refers to them, when appropriate.

The book has three parts and two appendixes:

- Part one describes the elements of global resource serialization that are common to the **ring** and **star**.
  - **Chapter 1, "Introduction"** presents an overview of what global resource serialization can do for you. It describes the two methods MVS uses to serialize requests for global resources. The information in Chapter 1 can help you to decide which method of global resource serialization to use to solve resource serialization problems that your installation might have.
  - **Chapter 2, "Selecting the Data"** describes how global resource serialization processes requests for resources. The information in Chapter 2 can help you to decide how to handle various resources at your particular installation.
  - **Chapter 3, "ENQ/RESERVE/DEQ Monitor"** describes the global resource serialization monitor tool. The information in Chapter 3 can help you use the monitor tool to assist you in planning the RNLs for global resource serialization implementation.
- Part two describes operations of the star complex:
  - **Chapter 4, "Star Processing"** is a highlevel description of how a global resource serialization star complex works.
  - **Chapter 5, "Planning a Star Complex"** provides information on how to design a global resource serialization star complex.

Chapter 6, “Operating the Star Complex” explains how to build and operate a global resource serialization star complex.

- Part three describes operations of the ring complex:

  Chapter 7, “Ring Processing” is a highlevel description of how a global resource serialization ring complex works.

  Chapter 8, “Designing the Complex” describes the basic principles of designing a global resource serialization ring complex.

  Chapter 9, “Operating the Complex” describes how to build and operate a global resource serialization ring complex. It presents information on the procedures that operators need to run the complex.

  Chapter 10, “Installing and Tuning the Complex” describes step-by-step approaches to installing the global resource serialization ring complex. It identifies installation steps as well as planning tasks and long-term considerations. It also describes the storage requirements for global resource serialization and some actions you can take to tune the performance of the complex.

  Chapter 11, “Diagnosing Global Resource Serialization Problems” describes strategies to aid in the diagnosis and correction of global resource serialization problems in a sysplex environment.
- Appendixes

  Appendix A, “Data Set ENQ Contention Monitor” describes a sample application that determines if contention exists for a particular data set, and sends a message to the TSO/E user who is causing the contention.

  Appendix B, “Accessibility” describes the major accessibility features in z/OS.

How To Use This Book

Once you have decided to build a global resource serialization complex, there are three basic planning tasks:

Select the data to be shared
Design the complex
Provide effective operator procedures

All of these tasks are closely related, and the design and operation of a global resource serialization complex are especially closely related. Therefore, a good way to use this book is to read it quickly all the way through to become familiar with all of the planning you need to do for a global resource serialization complex. Then, use the information and the planning aids in the book to develop your installation’s plan for the use of global resource serialization.

Where to Find More Information

Where necessary, this book references information in other books, using shortened versions of the book title. For complete titles, and order numbers of books for all products that are part of z/OS see *z/OS Information Roadmap*.

Short Title Used in this Book	Title	Order Number
CICS/ESA XRF Guide	*CICS FOR MVS/ESA XRF Guide*	SC33-0661

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Using LookAt to look up message explanations

LookAt is an online facility that allows you to look up explanations for z/OS messages, system abends, and some codes. Using LookAt to find information is faster than a conventional search because in most cases LookAt goes directly to the message explanation.

You can access LookAt from the Internet at:

`http://www.ibm.com/servers/eserver/zseries/zos/bkserv/lookat/lookat.html`

or from anywhere in z/OS where you can access a TSO command line (for example, TSO prompt, ISPF, z/OS UNIX System Services running OMVS).

To find a message explanation on the Internet, go to the LookAt Web site and simply enter the message identifier (for example, `IAT1836` or `IAT*`). You can select a specific release to narrow your search. You can also download code from the *z/OS Collection*, SK3T-4269 and the LookAt Web site so you can access LookAt from a PalmPilot (Palm VIIx suggested).

To use LookAt as a TSO command, you must have LookAt installed on your host system. You can obtain the LookAt code for TSO from a disk on your *z/OS Collection*, SK3T-4269 or from the LookAt Web site. To obtain the code from the LookAt Web site, do the following:

1. Go to http://www.ibm.com/servers/eserver/zseries/zos/bkserv/lookat/lookat.html.
2. Click the **News** button.
3. Scroll to **Download LookAt Code for TSO and VM.**
4. Click the ftp link, which will take you to a list of operating systems. Select the appropriate operating system. Then select the appropriate release.
5. Find the **lookat.me** file and follow its detailed instructions.

To find a message explanation from a TSO command line, simply enter: **lookat** *message-id*. LookAt will display the message explanation for the message requested.

Note: Some messages have information in more than one book. For example, IEC192I has routing and descriptor codes listed in *z/OS MVS Routing and Descriptor Codes*. For such messages, LookAt prompts you to choose which book to open.

Summary of changes

Summary of changes
for SA22-7600-02
z/OS Version 1 Release 3

The book contains information previously presented in *z/OS MVS Planning: Global Resource Serialization*, SA22-7600-01, which supports z/OS Version 1 Release 2.

New information

- An appendix with z/OS product accessibility information has been added.

This book contains terminology, maintenance, and editorial changes. Technical changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

Starting with z/OS V1R2, you may notice changes in the style and structure of some content in this book—for example, headings that use uppercase for the first letter of initial words only, and procedures that have a different look and format. The changes are ongoing improvements to the consistency and retrievability of information in our books.

Summary of changes
for SA22-7600-01
z/OS Version 1 Release 2

The book contains information previously presented in *z/OS MVS Planning: Global Resource Serialization*, SA22-7600-00, which supports z/OS Version 1 Release 1.

New information

- A new TYPE specification, PATTERN, enables matching on a set of characters within a QNAME or RNAME containing wildcard characters.

Deleted information

- Information about the RNL Syntax Checker (ISGRNLCK) is removed. Support has been added to the SYS1.PARMLIB checking tool to accomplish comparable checking.

This book contains terminology, maintenance, and editorial changes, including changes to improve consistency and retrievability.

Summary of changes
for SA22-7600-00
z/OS Version 1 Release 1

This book contains information also presented in *OS/390 MVS Planning: Global Resource Serialization*.

Part 1. Global Resource Serialization

Chapter 1. Introduction

In a multi-tasking, multi-processing environment, resource serialization is the technique used to coordinate access to resources that are used by more than one program. When multiple users share data, a way to control access to that data is needed. Users that update data, for example, need exclusive access to that data; if several users tried to update the same data at the same time, the result would be a data integrity exposure (the possibility of incorrect or damaged data). In contrast, users who only read data can safely access the same data at the same time.

Global resource serialization offers the control needed to ensure the integrity of resources in a multisystem environment. Combining the systems that access shared resources into a global resource serialization complex enables you to serialize resources across multiple systems. Depending on the MVS system operating system level and XCF environment the systems are running in, sysplex or non-sysplex, the complex consists of one or more systems:

- Connected to each other in a **ring** configuration via:

  Global resource serialization managed channel-to-channel (CTCs) adapters

  XCF communication paths (CTCs), or

  Signalling paths through a coupling facility
- Connected to a coupling facility lock structure in a **star** configuration via:
  Signalling paths, or XCF communication paths or both

Global Resource Serialization and the Sysplex: In this book, the term *sysplex* refers to a multisystem sysplex. It is possible, in a ring configuration, to have systems in a global resource serialization complex that are not in the sysplex. For the purposes of global resource serialization, these systems should be treated as if they are not part of a multisystem sysplex. The ring and star systems cannot coexist in a global resource serialization complex. Before looking at the ring and star complexes, you need to see how users serialize global resources (what macros they use) and understand more about global resource serialization in general.

Every system in a sysplex is a member of the same global resource serialization complex. Global resource serialization is required in a sysplex because components and products that use sysplex services need to access a sysplex-wide serialization mechanism. For more information on sysplexes, see *z/OS MVS Setting Up a Sysplex*. You can set up either of the following types of complex for global resource serialization:

- A **star -** In this type of complex, all of the systems in the sysplex must match the systems in the complex.
- A **ring -** In this type of complex, either:
  - The systems in the sysplex are the same as the systems in the complex **(sysplex matches complex)**. In a ring, you derive greater benefits if the sysplex and the complex match.
  - At least one system in the complex is outside of the sysplex **(mixed complex)**. A mixed complex often exists temporarily as your installation migrates one system at a time into a star complex.

Serializing Global Resources in a Multisystem Environment

A user in a multisystem environment can choose either the RESERVE or the ENQ macro to serialize access to a global resource. The following table shows how users can actually serialize access to resources at three levels:

Table 1. Three Levels of Serialization in MVS

To serialize access to a resource:	Use:
Within an address space	The ENQ and DEQ macros with a scope of STEP
Within a single MVS system	The ENQ and DEQ macros with a scope of SYSTEM
Across multiple MVS systems	The ENQ, RESERVE and DEQ macros with a scope of SYSTEMS

- The RESERVE macro obtains access to a resource and the DEQ macro frees the resource. The RESERVE macro, by default, has a scope of SYSTEMS. The corresponding DEQ macro must specify a scope of SYSTEMS. This method serializes access only to data sets that reside on shared DASD volumes. While it protects those resources, it does have drawbacks. See “RESERVE Macro”.
- The ENQ macro with a scope of SYSTEMS obtains access to a resource and the DEQ macro frees the resource when you specify a scope of SYSTEMS. A scope of SYSTEMS indicates that MVS is to protect the resource across multiple systems. Using the ENQ macro with a scope of SYSTEMS requires a multisystem approach to resource serialization. Your installation combines the systems that must serialize access to resources in a global resource serialization complex. See “Global Resource Serialization” on page 5.

Issuing GQSCAN

The GQSCAN macro enables users to obtain information about the status of each resource that is identified to global resource serialization, including information about the tasks that have requested the resource. Information about using ENQ and DEQ appears in *z/OS MVS Programming: Assembler Services Guide*. Additional information about ENQ and DEQ, as well as descriptions of GQSCAN and RESERVE, appears in *z/OS MVS Programming: Authorized Assembler Services Reference ENF-IXG*.

RESERVE Macro

The RESERVE macro serializes access to a resource (a data set on a shared DASD volume) by obtaining control of the volume on which the resource resides to prevent jobs on other systems from using any data set on the entire volume.

Potential Problems When Using RESERVE

Serializing access to data sets on shared DASD volumes by means of a reserve generally protects the resource. However, it creates several critical problems:

- When a task on one system has issued a RESERVE macro to obtain control of a data set, no programs on other systems can access any other data set on that volume. Protecting the integrity of the resource means delay of jobs that need the volume but do not need that specific resource, as well as delay of jobs that need only read access to that specific resource. These jobs must wait until the system that issued the reserve releases the device.

  Because the reserve ties up an entire volume, it greatly increases the chance of an interlock (also called a deadlock) occurring between two tasks on different systems, as well as the chance that the interlock will expand to affect other tasks. (An *interlock* is unresolved contention for use of a resource.)

- A single system can monopolize a shared device when it encounters multiple reserves for the same device because the system does not release the device until DEQ macros are processed for all of those reserves. No other system can use the device until the reserving system releases the device.
- A system reset while a reserve exists terminates the reserve. The loss of the reserve can leave the resource in a damaged state if, for example, a program had only partly updated the resource when the reserve ended. This type of potential damage to a resource is a data integrity exposure.

Solving the RESERVE Problems

Because of these problems, many installations use job scheduling instead of a reserve to protect the integrity of data sets on shared DASD volumes. That is, jobs that need the same data set are assigned to the same job class and run at different times. Protecting resources by job scheduling works, but it complicates operations, might increase job turnaround time, and might reduce the additional workload your installation can handle.

With a global resource serialization complex, however, your installation can override RESERVE macros without changing existing programs. This technique overcomes the drawbacks of the RESERVE macro and can provide a path for installation growth by increasing the availability of the systems and the computing power available for applications.

Note: It is possible to corrupt a DSCB within a VTOC when multiple systems are updating the same data set and no serialization product is installed. This occurs because the access methods do not normally issue a RESERVE when updating a data set. Global Resource Serialization is necessary to prevent data set and VTOC corruption in a shared DASD environment.

Understanding the Synchronous RESERVE Feature

The Synchronous RESERVE feature was added to Global Resource Serialization in OS/390 Release 7. The SYNCHRES option allows an installation to specify whether the system should obtain a hardware RESERVE for a device prior to granting a global resource serialization ENQ. This option might prevent jobs that have a delay between a hardware RESERVE request being issued and the first I/O operation to the device. Prior to the implementation of the SYNCHRES option, the opportunity for a deadlock situation was more likely to occur.

The SYNCHRES option can be activated through either the GRSCNFxx parmlib member or the SETGRS operator command. The GRSDEF statement of GRSCNFxx contains the SYNCHRES (Y or N) parameter. The default value for SYNCHRES is NO. During normal system operation, the operator can modify the setting of SYNCHRES by issuing the SETGRS command. SYNCHRES can be activated by issuing SETGRS SYNCHRES=YES and deactivated by issuing SETGRS SYNCHRES=NO.

Global Resource Serialization

Combining the systems that access shared resources into a global resource serialization complex can solve the problems related to using the RESERVE macro.

In a global resource serialization complex, programs can serialize access to data sets on shared DASD volumes at the data set level rather than at the DASD volume level. A program on one system can access one data set on a shared volume while other programs on any system can access other data sets on the same volume.

Global resource serialization overcomes the major drawbacks of using the RESERVE macro. Because it enables jobs to serialize their use of resources at the data set level, it can reduce contention for these resources and minimize the chance of an interlock occurring between systems. It thus ends the need to protect resources by job scheduling. Because global resource serialization maintains information about global resources in system storage, it does away with the data integrity exposure that occurs when there is a system reset while a reserve exists. A global resource serialization complex also allows serialization of shared logical resources—resources that might not be directly associated with a data set or DASD volumes. An ENQ with a scope of SYSTEMS might be used to synchronize processing in multisystem applications.

How a Global Resource Serialization Complex Works

No matter which configuration you choose, **ring** or **star**, global resource serialization processes (ENQ, DEQ, and RESERVE requests) for resources is the same.

Local and Global Resources

The ENQ, DEQ, and RESERVE macros identify a resource by its symbolic name. The symbolic name has three parts: major name (qname), minor name (rname), and scope (which can be STEP, SYSTEM, or SYSTEMS). For example, on an ENQ or DEQ macro, a resource might have a symbolic name of APPL01,MASTER,SYSTEM. The major name (qname) is APPL01, the minor name (rname) is MASTER, and the scope is SYSTEM. Global resource serialization identifies each resource by its entire symbolic name. For example, a resource that is specified as A,B,SYSTEMS is considered a different resource from A,B,SYSTEM or A,B,STEP because the scope of each resource is different.

When an application uses the ENQ, DEQ, and RESERVE macros to serialize resources, global resource serialization uses resource name lists (RNLs) and the scope on the ENQ, DEQ, or RESERVE macro to determine whether a resource is a local resource or a global resource.

A **local resource** is a resource requested with a scope of STEP or SYSTEM. It is serialized only within the system processing the request for the resource. If a system is not part of a global resource serialization complex, all resources (with the exception of resources serialized with the RESERVE macro), regardless of scope (STEP, SYSTEM, SYSTEMS), are local resources.

A **global resource** is a resource requested with a scope of SYSTEMS. It is serialized among all systems in the complex.

In general, global resource serialization identifies a resource with a scope of STEP or SYSTEM as a local resource, and a resource with a scope of SYSTEMS as a global resource. Because users of some previous versions of MVS could serialize access to resources across multiple systems only through a reserve, whether the user specified SYSTEM or SYSTEMS on the ENQ macro did not affect resource serialization. Thus, your installation might have programs that specify ENQ with a scope of SYSTEM for resources that you would want global resource serialization to identify as global resources. You might also have programs that specify ENQ with a scope of SYSTEMS for resources that you would want global resource serialization to identify as local resources.

To ensure that resources are treated as you want them to be without changes to your applications, global resource serialization provides three resource name lists (RNLs):

- The **SYSTEM inclusion RNL** lists resources requested with a scope of SYSTEM that you want global resource serialization to treat as global resources.
- The **SYSTEMS exclusion RNL** lists resources requested with a scope of SYSTEMS that you want global resource serialization to treat as local resources.
- The **RESERVE conversion RNL** lists resources requested on RESERVE macros for which you want global resource serialization to suppress the reserve.

By placing the name of a resource in the appropriate RNL, you can cause global resource serialization to process it as you want. The RNLs enable you to build a global resource serialization complex without first having to change your existing programs, though you might at some time want to change these programs.

Deciding how to use the RNLs to define your resource processing needs is a major part of the planning for a global resource serialization complex; the process is described in detail in Chapter 2, “Selecting the Data” on page 13. To make most effective use of the RNLs, you also need to understand how a global resource serialization complex processes requests for global resources.

Methods of Serializing Global Resources

The ring is IBM’s original design for serializing global resources and it still has value in today’s sysplex environment. But, the star (with the technological advances made recently in reference to Parallel Sysplex) offers many advantages over the ring complex. “Which Method to Choose” on page 11 offers guidance on which method best suits your present environment and future needs.

The Ring

Prior to OS/390 Release 2, the global resource serialization **ring** was the only method used for serializing requests for global resources. The ring consists of one or more systems connected to each other by communication links. The links are used to pass information about requests for global resources from one system to another in the complex. Requests are made by passing a message or token, called the ring system authority message (RSA-message), between systems in a round-robin or ring fashion. There is one RSA token in a global resource serialization ring complex.

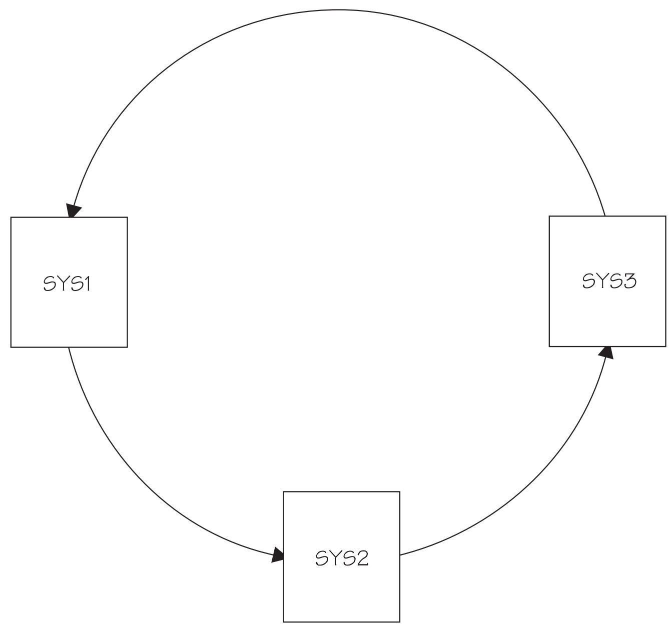


Figure 1. The Conceptual View of the Ring Complex

When a system receives the RSA, it inserts global ENQ and DEQ information, and passes it along to the next system to copy. It also makes a copy of the global ENQ/DEQ information that was inserted by other systems. When the RSA returns to the originating system, it knows that all other systems have seen its request, so the request is removed. The system can now process those requests by adding them to the global resource queues, and can now determine which jobs own resources, and which jobs must wait for resources owned by other jobs. Each system takes this information and updates its own global queues.

For various reasons, such as system or link failure, not all systems in a complex might be actively using global resource serialization. The ring is made up of all systems in a global resource serialization complex that are **actively** using global resource serialization to serialize access to global resources.

Systems participating in a ring are dependent on each other to perform global resource serialization processing. For this reason, the following areas are all adversely affected as the number of systems in a ring increase.

- Storage consumption
- Processing capacity
- Response time
- CPU consumption
- Availability/Recovery time

Figure 2 shows the basic elements of a four-system global resource serialization ring complex. These elements include the systems, the communication links, and any shared resources (such as DASD) specified by the installation.

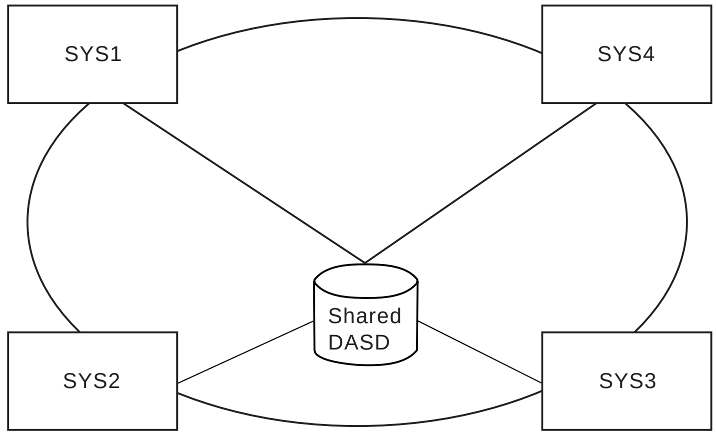


Figure 2. Global Resource Serialization Ring Complex

The systems in the complex can use global resource serialization to serialize access to global resources, such as data sets on shared DASD volumes. Global resource serialization in a ring complex uses the links (either XCF paths or the dedicated communication links) to communicate information about global resources from one system in the complex to another.

- In a ring sysplex, all the links shown are XCF signalling paths. XCF manages the communication links that global resource serialization uses between systems in a sysplex. XCF can use IBM 3088 Multisystem Channel Communication Unit (MCCU) paths, Enterprise Systems Connection (ESCON) channels operating in CTC mode, and list structures in a coupling facility as communication links.
- Links between a system in a sysplex and one outside of the sysplex, as well as between two systems that are both outside of the sysplex, may be 3088 MCCU paths or parallel CTC adapters dedicated to global resource serialization, or an ESCON channel operating in basic mode. Global resource serialization will not use ESCON links which are defined as SCTC.

In this book, “link”, “path”, and “CTC link” can mean an IBM 3088 MCCU data link, a parallel CTC adapter, an ESCON channel operating in CTC or basic mode or, if appropriate, a list structure in a coupling facility.

The Star

OS/390 Release 2 introduces the **star** method of serializing global resources. The star configuration is built around a coupling facility, which is where the global resource serialization lock structure, ISGLOCK, resides. In a star complex, when an ENQ, DEQ, or RESERVE macro is issued for a global resource, MVS uses information in the ISGLOCK structure to coordinate resource allocation across all systems in the sysplex.

Figure 3 shows the basic elements of a global resource serialization star complex. These elements include the systems, the coupling facility, and any shared resources (such as DASD) specified by the installation.

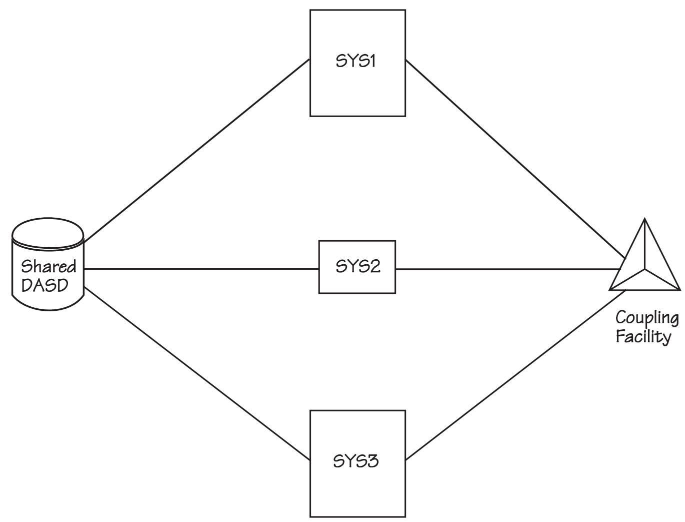


Figure 3. A Conceptual View of the Star Complex

In a star complex, global resource serialization requires the use of the coupling facility. The coupling facility makes data sharing possible by allowing data to be accessed throughout the sysplex by ensuring the data remain consistent among each system in the sysplex. The coupling facility provides the medium in global resource serialization to share information about requests for global resources between systems. Communication links are used to connect the coupling facility with the systems in the global resource serialization star sysplex. For more information on communication links, see *z/OS MVS Setting Up a Sysplex*.

Star Advantages

- Real Storage Consumption:

  Because no system in a star complex maintains a complete queue of all global resource requests for the entire complex, the real storage consumption is decreased. The amount of real storage required by global resource serialization for a system is governed by the number of requests made by that system. There is no longer a relationship between the number of systems in a complex and the amount of real storage required by global ENQ processing.
- Processing Capacity:

  The processing capacity does not diminish as the number of systems in the complex increase. This is because all requests for global resources are handled by the coupling facility; not by passing a token between each system in the complex before a request is satisfied. The requests are processed by the coupling facility as they are received, therefore the processing capacity is improved.
- Response Time:

  Response time is improved in a star as each request for a resource that is not in contention can be completed with only two signals, rather than having to pass the RSA-message to each system in the complex.

  Also, in a star complex, the central processing unit (CPU) overhead required to process an ENQ or DEQ request is limited to the system on which the request originated, the coupling facility, and the system chosen to be the global contention manager by XES (if one is needed). Therefore, the total processing time consumed across a star complex will be less than that consumed by a ring complex.
- Availability and Recovery:

Availability and recovery time is improved for the star because the systems that make up the complex are not dependent on each other, as they are in the ring. The complex does not have to alter processing to adjust to topological changes due to a system joining or leaving the complex. When a system joins or leaves the complex, queue manipulation for resource requests are distributed around the complex, rather than having to be repeated for every request on each system. These changes and adjustments are handled by global resource serialization and XES. Your only requirement is to determine which resource owned by a failing system is in contention and reassign it to a new system.

Which Method to Choose

Your choice of method, ring or star, depends primarily on hardware and software requirements.

- The star complex hardware requirements:
  – Coupling facility
  – Coupling facility links
- The star software requirements:
  – IBM OS/390 Release 2 and higher operating system.
- The ring hardware requirements:
  – Communications links and/or XCF sysplex
- The ring software requirements:
  – Global resource serialization - MVS release 2.2.0 and higher

Another important consideration is the number of systems in the global resource serialization complex, and what performance you are experiencing. IBM recommends that:

- New sysplexes start out using the star method for serializing global resources.
- Complexes that require sharing the MVS systems that are not members of a sysplex require using the ring.
- Existing complexes experiencing performance problems should migrate to the star.
- Existing complexes that are not experiencing performance problems can continue using the ring. For example, if the sysplex consists of two systems, migrating to the star might not noticeably enhance sysplex performance.

Chapter 2. Selecting the Data

The primary reasons for a multisystem global resource serialization complex are:

- It protects resources, especially data sets on shared DASD volumes, as global resources rather than requiring reserves.
- It enables your installation to provide all multisystem applications with a guaranteed serialization mechanism.
- It is required for a sysplex.

If, however, you prefer to use an alternate method of serializing global resources in a sysplex, you can specify GRSRNL=EXCLUDE on the GRSRNL system parameter. When you specify GRSRNL=EXCLUDE:

- Only resources identified as SCOPE=SYSTEMS,RNL=NO on the ENQ macro are still managed by global serialization in the complex.
- A sysplex-wide IPL is required in order to switch to an alternate method of serializing global resources, and
- You cannot specify the SET GRSRNL=xx command.

The rest of this chapter assumes that you have not specified GRSRNL=EXCLUDE.

To ease migration to protecting resources as global resources, global resource serialization provides three resource name lists (RNLs) — the SYSTEM inclusion RNL, the SYSTEMS exclusion RNL, and the RESERVE conversion RNL. The RNLs allow you to change resource scopes and convert reserves. IBM supplies default RNLs, shown in Figure 6 on page 23. You can modify the contents of the RNLs to define the resource serialization requirements of your installation. You can also use the ISGNQXIT installation exit to indicate that global resource serialization is to bypass processing for SYSTEM and SYSTEMS requests. This chapter contains information you can use to select the resource names to place in each RNL.

Planning Aids

This chapter includes worksheets you can use to list the resources you want to include in each RNL. The format of the worksheets enables you to implement your plan easily.

Reference Book

Once you have completed your plan, see *z/OS MVS Initialization and Tuning Reference* for detailed information about how to define your RNLs in the GRSRNLxx parmlib member.

A major reason for carefully planning the contents of the RNLs is that the RNLs installed in all systems in the complex must be exactly the same. During its initialization, global resource serialization checks to make sure that the RNLs on each system are indeed identical. If they are different, global resource serialization does not allow the system to join the complex.

When the sysplex matches the complex, you can change the RNLs dynamically by using the SET GRSRNL command. The procedures for changing RNLs for the ring and star complex are the same. For more information see:

- “Changing the RNLs” on page 22 or “Changing the RNLs for a Ring” on page 148 for the ring complex, or
- “Changing RNLs for a Star Complex” on page 101 for the star complex.

Naming resources in the appropriate RNL enables you to build a global resource serialization complex without modifying any existing programs. Thus, your decisions about resources will probably focus on two questions:

1. What are my installation’s short-term goals for the global resource serialization complex? Or, what must we do with the RNLs to get benefits from the complex as quickly as possible?
2. What are my installation’s long-term goals for the global resource serialization complex? Or, what changes might we make to existing programs and procedures to make resource serialization more efficient?

Answering the first question requires you to analyze your use of data sets on shared DASD volumes to select the resources that are causing contention problems. As you do this analysis, focus on resources that are known to cause problems, such as resources that are frequently involved in interlocks. Consider whether a shared DASD volume accessed by the complex must also be accessed by systems outside the complex. Answering the second question might require you to analyze the data set naming conventions at your installation.

You must also understand how global resource serialization uses the resource names in the RNLs and what suggestions and recommendations exist for various situations.

Data Set Naming Conventions

Using global resource serialization effectively requires an established installation-wide convention for naming data sets, especially those on shared DASD volumes. If your installation does not have a standard convention for naming data sets, you should probably define and implement a standard before trying to use a global resource serialization complex to serialize access to global resources.

Some data set naming conventions, such as one that relies heavily on system-dependent information like virtual storage addresses, do not work well with global resource serialization. If your installation has such a standard, you might want to redefine it as part of your long-term planning. A data set naming convention that works well with global resource serialization can avoid both very long RNLs and frequent changes to the RNLs.

In general, a data set naming convention that works well is one where the high-level qualifier or qualifiers have a meaning that proceeds from the general to the specific. For example, assume that an application named ACCOUNTS has three data sets: MASTER, TRANS, and ERRORS. If the data set names are ACCOUNTS.MASTER, ACCOUNTS.TRANS, and ACCOUNTS.ERRORS, you can use the high-level qualifier (ACCOUNTS) to cause all of the ACCOUNTS data sets to be either local resources or global resources.

Data set names that proceed from the general to the specific tend to work well with global resource serialization. Such names make it easy to identify and, if necessary, subdivide large groups of resources with a minimum number of entries in the RNLs. If your installation uses TSO/E, the format of the TSO/E userid is also important because it affects the names of user data sets.

RNL Processing

To evaluate how well your installation's data set naming conventions will work with global resource serialization, and to make decisions about specific resources, you need to understand how global resource serialization processes entries in the RNLs to determine if a specific resource is a local resource or a global resource.

Scanning the RNLs

Whenever global resource serialization encounters a request for a resource with a scope of SYSTEM or SYSTEMS, global resource serialization invokes a search routine (ISGNQXIT) to scan the appropriate RNL. (Your installation can replace the IBM-supplied search routine.) Global resource serialization will not scan the RNL in the following instances:

- The request specifies RNL=NO.
- You have specified GRSRNL=EXCLUDE.
- An ISGNQXIT exit routine indicates to bypass RNL processing.

To scan an RNL, global resource serialization compares the input search argument — the resource name — to the resource name entries in the RNL.

Entries in an RNL can be specific or generic, or can be specified through the use of wildcard characters. A **specific resource name entry** matches a search argument only when they are exactly the same. A **generic resource name entry** is a portion of a resource name. A match occurs whenever the specified portion of the generic resource name entry matches the same portion of an input search argument. A pattern resource name entry, containing **wildcard characters**, extends the matching specification. The wildcard characters (*,?) can be used within both parts of the resource name.

- * — Allows matching for a substring of any characters for any length, including zero.
- ? — Allows matching for any single character.

Each RNL entry indicates whether the name is specific (SPECIFIC), generic (GENERIC), or contains wildcard characters (PATTERN).

The exit search routine finds a match when:

- A specific resource name entry in the RNL matches the specific resource name in the search argument.

  For example, the specific entry APPL01,MASTER in the RNL matches APPL01,MASTER as a search argument, but does not match a search argument of APPL01,MASTER2.

  The length of the specific rname is important; for example, a specific rname of 'ABC' does not match a resource named 'ABC   '.
- A generic qname entry in the RNL matches the qname of the search argument.

  For example, a generic qname entry of APPL01 in the RNL matches any search argument with a qname of APPL01, such as APPL01,MASTER or APPL01,TRANS.
- A generic qname,rname entry in the RNL matches the corresponding portion of the resource name in the search argument.

  For example, a generic qname,rname entry of APPL01,MASTER in the RNL matches any search argument that begins with APPL01,MASTER, such as APPL01,MASTER or APPL01,MASTER2.

Effective use of generic entries and entries containing wildcard characters simplifies the management of the RNLs by reducing the number of entries and the complexity of the entries.

Note: All of the specific entries in a RNL are searched before scanning the generic and pattern RNL entries for a match. If no specific entry matches, the first generic or pattern entry that matches is used.

Global resource serialization scans the RNL to determine if there is a match. The actions it takes, however, are different for each RNL.

SYSTEM Inclusion RNL

When global resource serialization encounters an ENQ or DEQ request for a resource with a scope of SYSTEM, it scans the SYSTEM inclusion RNL. If there is no match, global resource serialization processes the resource as a local resource.

If there is a match, global resource serialization changes the scope of the request from SYSTEM to SYSTEMS and processes the resource as a global resource. For example, if the resource a task requests is A,B,SYSTEM, and there is a match in the SYSTEM inclusion RNL, global resource serialization changes the resource name to A,B,SYSTEMS and processes A,B,SYSTEMS as a global resource. That is, global resource serialization then scans the SYSTEMS exclusion RNL for the resource name. See Figure 4 on page 19.

Thus, you can specify a generic name in the SYSTEM inclusion RNL, changing the scope of all resources with that generic name to SYSTEMS. You can then place specific resource names with that generic name in the SYSTEMS exclusion RNL, making those specific resources local resources. (The default RNLs use this technique to make certain system data sets local resources. See Figure 6 on page 23.)

SYSTEMS Exclusion RNL

When global resource serialization encounters a request for a resource with a scope of SYSTEMS, it scans the SYSTEMS exclusion RNL. Thus, it scans the SYSTEMS exclusion RNL when:

1. A task issues a RESERVE macro (which has a default scope of SYSTEMS) or specifies a scope of SYSTEMS on the ENQ or DEQ macro.
2. The resource name matched an entry in the SYSTEM inclusion RNL, which caused global resource serialization to change the scope to SYSTEMS.

If there is a match, global resource serialization changes the scope of the request from SYSTEMS to SYSTEM and processes the resource as a local resource. For example, if the resource name a program requests is A,B,SYSTEMS, and there is a match in the SYSTEMS exclusion RNL, global resource serialization changes the resource name to A,B,SYSTEM and processes A,B,SYSTEM as a local resource.

If there is a match and the task issued the RESERVE macro to request the resource, global resource serialization processes the resource as a local resource and does not scan the RESERVE conversion RNL; the system issues the reserve.

If there is no match, global resource serialization processes the request as a global resource. If the task issued the RESERVE macro to request the resource, global resource serialization then scans the RESERVE conversion RNL to determine if the system is to issue the reserve.

RESERVE Conversion RNL

Only when a task issues a RESERVE macro to request a resource and the resource name is not in the SYSTEMS exclusion RNL does global resource serialization scan the RESERVE conversion RNL.

If there is a match, global resource serialization suppresses the reserve for the global resource. It issues an ENQ with a scope of SYSTEMS to serialize access to the resource.

If there is no match, global resource serialization allows the system to issue the reserve. Thus, the RESERVE conversion RNL does not affect the scope of the resource but does determine whether or not the system is to issue the reserve.

Choosing the reserves to be converted is a critical planning task; see “RESERVE Conversion” on page 20 for a full explanation of the considerations involved.

Excluding Requests from RNL Processing

An ENQ or DEQ request can be excluded from RNL processing by specifying RNL=NO on the request. IBM recommends that the default of RNL=YES be used. When RNL=NO is specified the ENQ request will be ignored by alternative serialization products, and this will impact protection of the resource to systems outside of the current global resource serialization environment using alternative serialization products. Use RNL=NO only after understanding and considering the impacts of its specification to the control of the resource by an installation-specified RNL.

Consistent usage of the RNL= and resource scope specifications is important. If RNL=NO is specified for a resource on the ENQ request, it must also be specified on the DEQ request. Do not mix ENQ RNL=NO and RNL=YES requests that use the same Qname and Rname. Do not mix ENQ scope SYSTEM and SYSTEMS requests that use the same Qname and Rname. Not following these rules can result in abends, incorrectly obtaining serialization, failure to obtain serialization, or failure to release serialization.

When to Use RNL=NO

For scope SYSTEM requests where the scope is always limited to a single system.

Example – AN ENQ issued by an application that communicates exclusively within a sysplex, using XCF and XES services, to serialize a resource that is only relevant to the systems within that sysplex due to the use of the sysplex services. Because only systems within the sysplex are fully aware of the state of the resource it is appropriate to specify RNL=NO to avoid having the request be processed by alternative serialization products.

Note: The RNL=NO specification should not be used just to prevent scope SYSTEMS requests from being changed to scope SYSTEM during RNL processing as this will also prevent processing by alternative serialization products at the request of the installation when it may be appropriate to do so.

When to Use RNL=YES

For scope SYSTEM requests that serialize a resource shared across multiple systems, but which can not be changed to scope SYSTEMS due to compatibility with other requestors.

Example – An ENQ that is used to serialize a data set on shared DASD. Because multiple systems can access the data set, the ENQ really should be scope SYSTEMS. However, the request scope can not be changed because other requestors outside of your control are using scope SYSTEM and therefore all requests must be made using scope SYSTEM. By specifying RNL=YES or allowing it to default, RNL processing can treat all requests the same and allow them to be converted to scope SYSTEMS.

For scope SYSTEMS requests that serialize a resource shared across multiple systems which may exceed the serialization scope of the global resource serialization ring or star.

Example –An ENQ that is used to serialize a data set on shared DASD where either the data set is shared for read only access or exclusive serialization is always held while updated data set information is in the owning processor’s storage. The data set may be safely shared by multiple sysplexes or with systems outside of the global resource serialization complex using alternate serialization products, but only when RNL=YES is specified or allowed to default.

RNL Processing Sequence

Unless an ENQ or DEQ is coded with RNL=NO, global resource serialization searches the RNLs. When RNL=NO, global resource serialization bypasses the RNL search. The default, however, is RNL=YES. Figure 4 on page 19 summarizes the processing done for a resource requested by an ENQ or DEQ macro. The figure shows how global resource serialization uses the scope of the request and the RNLs to determine if the resource is a local or global resource. It also shows when global resource serialization internally changes the scope of the resource.

For an ENQ or DEQ request with a scope of SYSTEM, global resource serialization first scans the SYSTEM inclusion RNL. If it finds a match, it changes the scope to SYSTEMS and then scans the SYSTEMS exclusion RNL.

For an ENQ or DEQ request with a scope of SYSTEMS, global resource serialization scans only the SYSTEMS exclusion RNL.

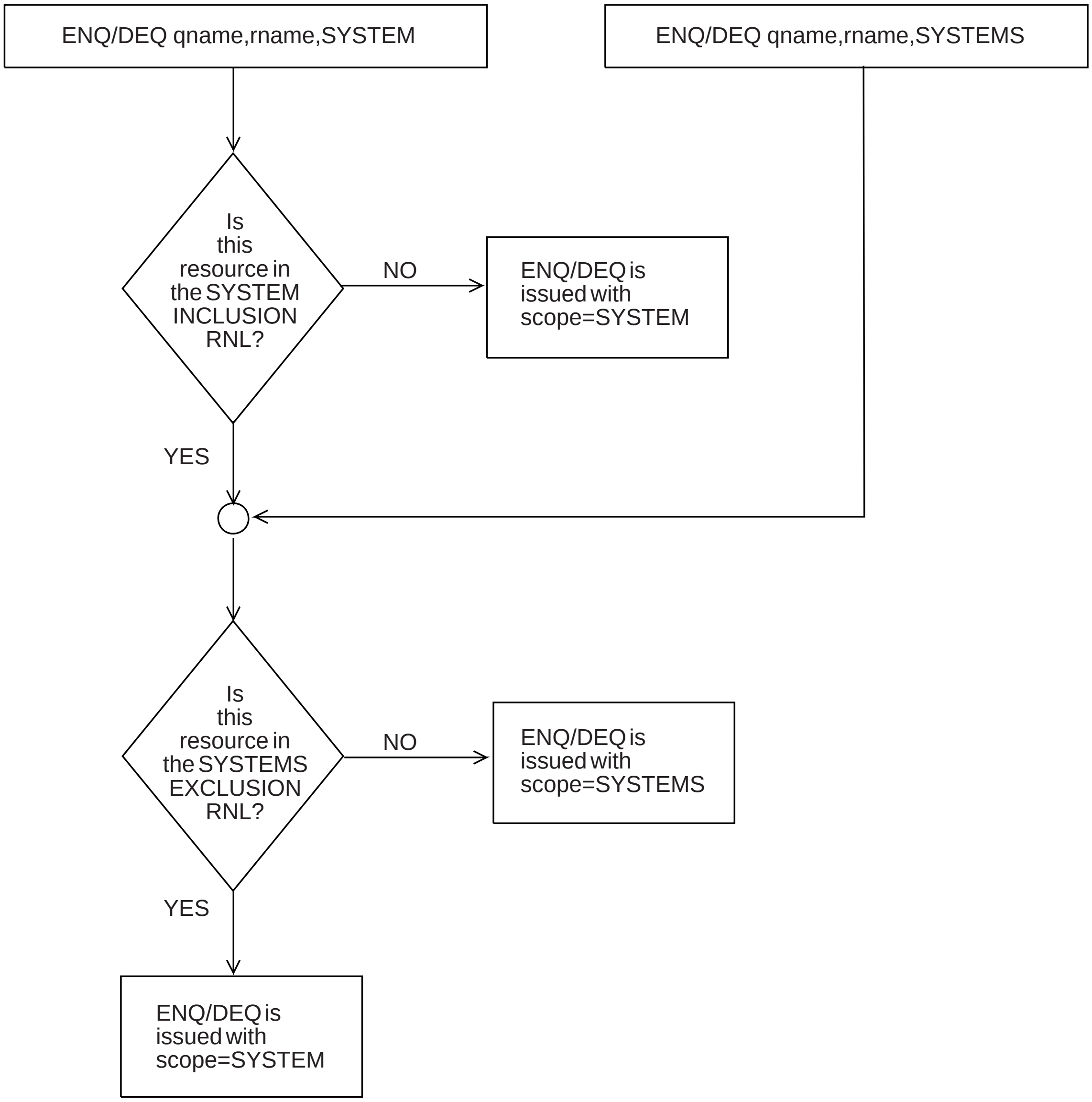


Figure 4. ENQ and DEQ Processing Summary

For a RESERVE request, global resource serialization first scans the SYSTEMS exclusion RNL to see if it should treat the resource as a local resource or as a global resource. If the resource is not named in the RNL and is thus a global resource, then global resource serialization scans the RESERVE conversion RNL to see if the global resource requires a reserve. If the resource is named in the SYSTEMS exclusion RNL, global resource serialization does not search the RESERVE conversion RNL; it treats the resource as a local resource and allows the system to issue the reserve.

Figure 5 summarizes the processing done for a resource requested by a RESERVE macro. The figure shows that global resource serialization first scans the SYSTEMS exclusion RNL to determine whether or not the resource is global. If there is no match, it scans the RESERVE conversion RNL to determine whether or not the system is to issue a reserve. Figure 5 also shows when global resource serialization internally changes the scope of a resource requested by a RESERVE macro.

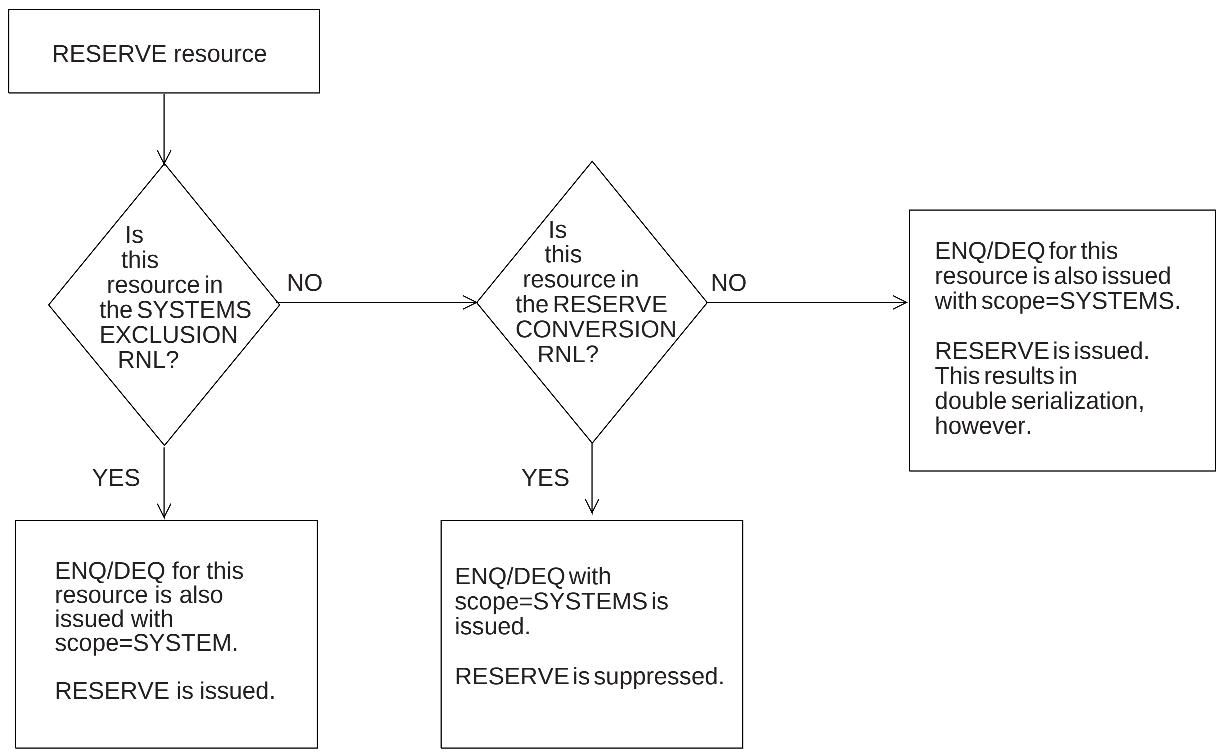


Figure 5. RESERVE Processing Summary

RESERVE Conversion

One major purpose of global resource serialization is to eliminate the need to protect data sets on shared DASD volumes by issuing a RESERVE macro that causes a reserve of the entire volume. In general, you want to convert reserves to minimize problems your current methods of resource protection cause. These problems are:

- Interlocks
- Contention between jobs for the same volume
- The possibility that one system might monopolize a shared device
- The data integrity exposure that occurs as a result of a system reset while a reserve is in effect

By converting reserves, you make the systems and the resources more available. Not all reserves, however, should be converted. Thus, global resource serialization provides the following RESERVE conversion choices. You can:

1. Convert the RESERVE for a resource. Place the resource name in the RESERVE conversion RNL and do not place its name in the SYSTEMS exclusion RNL. Global resource serialization suppresses the RESERVE and treats the requested resource as a global resource.
2. Issue the RESERVE for the resource. Place the resource name in the SYSTEMS exclusion RNL. The system issues the reserve, and global resource serialization treats the requested resource as a local resource. It internally converts the scope of the request to SYSTEM to serialize access to the resource within the originating system. Global resource serialization then does not search the RESERVE conversion RNL, so the system issues the reserve to serialize access to the resource among multiple systems.

   This choice is a good way to handle a reserve that must be issued.

3. Do nothing. Do not place the resource name in either the RESERVE conversion RNL or the SYSTEMS exclusion RNL. The system issues the reserve, and global resource serialization treats the resource as a global resource.

   Because it causes both a reserve and a SYSTEMS ENQ, this choice effectively causes duplicate serialization. Doing nothing can also lead to an interlock if jobs on different systems contend for multiple resources on the same shared DASD volume, as shown in the following example:

   ```
   1.  Job A on system SYS1 issues a RESERVE macro for resource
       (A,B) on the DASD volume.

   2.  Job B on system SYS2 issues a RESERVE macro for resource
       (C,D) on the DASD volume.

   3.  Job A on system SYS1 issues a RESERVE macro for resource
       (C,D) on the DASD volume.
   ```

   Job B on system SYS2 owns the SYSTEMS ENQ portion of resource (C,D), but it is unable to reserve the DASD volume. Job A on system SYS1 holds the hardware reserve on the volume from its RESERVE of (A,B), but it is waiting for the SYSTEMS ENQ for (C,D). If resources (A,B) and (C,D) had been in either the SYSTEMS exclusion RNL or the RESERVE conversion RNL, this interlock would not have occurred.

In deciding which reserves your installation should convert, concentrate on reserves that are causing known problems. In addition, there are two general restrictions:

1. Do not convert a reserve for a resource on a volume if any system in your complex shares the volume with a system that is not part of the complex (or is part of another complex). In this case, you require the reserve to protect the data sets on the shared volume.
2. Do not convert the reserves for a resource when different systems in the complex use different names for the resource. This inconsistency can occur when the resource name includes system-dependent information, such as a control block address. Global resource serialization assumes that the different names represent different resources, and it cannot protect a single resource known by different names. If you modify existing programs to use the same name for the resource, you can then, of course, convert the reserves.

If an application issues a single reserve to serialize access to multiple resources on the same volume, you cannot convert the reserve unless you change the application.

Another general consideration is the use of the resource. You cannot convert some reserves because the application that uses the resource cannot tolerate the ring delay time required to process a request for a global resource. Your installation might have applications where dependencies on quick access to a resource outweigh the additional availability resulting from converting the reserve.

Converting All RESERVEs to Global ENQs

In a Parallel Sysplex environment, for improved performance, availability, and serviceability, IBM recommends that all sysplex-wide RESERVEs be converted to global resource serialization global ENQs. Use the PATTERN specification to implement this conversion and include the following statement as the only Reserve Conversion entry in the GRSRNLxx member of parmlib.

```
RNLDEF RNL(CON) TYPE(PATTERN) QNAME(*)
```

Note that this sysplex-wide conversion is recommended only for installations that are implementing a global resource serialization Star complex.

Changing the RNLs

In certain circumstances, you might need to change the scope of one or more resources. If the sysplex matches the complex, you can use the SET GRSRNL command to make the change dynamically; no system needs to reIPL. If, however, your ring complex includes any systems that are not a part of the sysplex, you must purge those non-sysplex systems from the global resource serialization complex before initiating the change. After the change completes, you can then reIPL the non-sysplex systems back into the global resource serialization complex. Plan your use of the RNLs carefully when operating a mixed complex to avoid unnecessary IPLs.

Changing the RNLs dynamically would be useful in the following examples:

- Add new applications that introduce new resources.
- Tune a complex by suppressing reserves, especially against such resources as catalogs.
- Reverse an RNL change that may be degrading the performance of your complex.
- Change your shared resources (changing local resources into global resources, or changing global resources into local resources).
- Run a job (such as DFDSS DEFRAG programs) that performs better with different RNLs than the ones used for your installation's normal operations.

After the operator issues the SET GRSRNL command, global resource serialization suspends any job that requests any *affected resource* (a resource that is not the same in the current RNLs as in the new ones) until the change completes or until the operator cancels the change. If a job currently holds one or more of the affected resources, the change is delayed until that job frees any affected resources. For more details see:

- "Changing the RNLs for a Ring" on page 148 for the ring complex, and
- "Use of the Sysplex Couple Data Set" on page 89 and "Changing RNLs for a Star Complex" on page 101 for the star complex.

Some restrictions apply while global resource serialization is processing an RNL change.

- Global resource serialization can process only one change command at a time.
- The total amount of new RNLs that can be processed during any single change request cannot be greater than 61 Kbytes.
- A new system cannot join the complex until after the change completes or is cancelled; however, a system can be removed from the sysplex during an RNL change. If the removed system is the system on which the change command was issued, the change is cancelled.

Notes:

1. After a change has been completed, you must be sure to update the GRSRNL system parameter (in IEASYSXX) on every system in the sysplex to preserve the changes beyond the next reIPL.
2. A global resource serialization ring complex cannot be migrated to a star complex during an RNL change.

RNL changes are permanently recorded in SMF records, and RNL change events can be traced using the TRACE CT command with COMP=SYSGRS.

RNL Considerations

Because the resources to include in each RNL depend on the needs of your installation, it is not possible to supply default RNLs that will work well in every environment. IBM does supply a default for each RNL; Figure 6 shows these defaults.

The generic qname entry for SYSDSN in the SYSTEM inclusion RNL indicates that all data sets that go through MVS allocation (except for VIO and subsystem data sets, such as SYSIN, SYSOUT, and SUBSYS data sets) are to be global resources. The entries in the SYSTEMS exclusion RNL identify the system data sets with a qname of SYSDSN that specifically cannot be global resources.

SYSTEM Inclusion RNL:
SYSDSN

SYSTEMS Exclusion RNL:
SYSDSN PASSWORD
SYSDSN SYS1.BRODCAST
SYSDSN SYS1.DAE (applies only to MVS/XA and MVS/ESA systems)
SYSDSN SYS1.DCMLIB
SYSDSN SYS1.DUMP (generic — all dump data sets)
SYSDSN SYS1.LOGREC
SYSDSN SYS1.MAN (generic — all SMF data sets)
SYSDSN SYS1.NUCLEUS
SYSDSN SYS1.PAGE (generic — all page data sets)
SYSDSN SYS1.STGINDEX
SYSDSN SYS1.SVCLIB
SYSDSN SYS1.UADS

RESERVE Conversion RNL:
The RESERVE conversion list is empty.

Figure 6. Contents of the Default Resource Name Lists (RNLs)

If all the systems in your ring complex are running MVS/SP version 2 release 2 or later (all the systems in a star complex must be at OS/390 release 2), you can IPL the systems and build a ring using the default RNLs. An IPL with the default RNLs, however, might not reflect all the goals your installation has for the global resource serialization complex. For example, you might want to change the contents of the default RNLs to emphasize RESERVE conversion and avoid potential interlocks. The DISPLAY GRS,CONTENTION command provides information about resources that are causing contention, and RMF reports can also help. The most useful RMF reports are:

- Monitor I enqueue activity report
- Monitor II system enqueue contention (SENQ) and system enqueue reserve (SENQR) reports
- Monitor III (workload delay monitor) reports on resource-oriented enqueue delays and resource-oriented device delays

IBM recommends using the ENQ/RESERVE/DEQ monitor for helping plan RNLs. See Chapter 3, “ENQ/RESERVE/DEQ Monitor”.

Because a global resource serialization complex can consist multiple levels of MVS systems, and because each system control program usually works with multiple levels of other products, it is not possible to compile a complete and exhaustive list of recommended treatment for resources in all possible situations. There are, however, some general recommendations as well as some specific suggestions on known resources that are good candidates for the SYSTEM inclusion RNL, the SYSTEMS exclusion RNL, and the RESERVE conversion RNL. These recommendations and suggestions cover the following topics:

- CICS
- CVOLs
- DAE
- DB2
- DFHSM
- DFSMS/MVS
- IMS
- ISPF or ISPF/PDF
- JES2
- JES3
- System logger
- RACF
- Temporary data sets
- TSO/E
- VIO journaling data set
- VSAM

The information is meant to give you an idea of the kind of decisions you might need to make, and it does not deal with the specifics of every level of every product.

Note: If you need more information about the macros mentioned in the explanation, see *z/OS MVS Programming: Authorized Assembler Services Guide* or *z/OS MVS Programming: Authorized Assembler Services Reference ENF-IXG*.

CICS

If you are using CICS/XRF in a multi-MVS environment with DB2, you should use global resource serialization to ensure the integrity of DB2. In the case of an alternate CICS system taking over from an active CICS system, the original DB2 region that the failed CICS was using must be completely terminated before a new DB2 can be restarted with the newly active CICS. Global resource serialization can reduce the risk of data integrity problems caused by concurrent execution of DB2 on both MVS systems. One recommendation is to set up global resource serialization to control key DB2 data sets so that only one DB2 region is allowed to update them at the same time.

See *CICS/ESA XRF Guide* for additional information.

CVOLs

CVOLs (non-VSAM user catalogs) are protected by a reserve that includes the UCB address.

If you use CVOLs, you cannot convert the reserve because the UCB address is system-dependent.

DAE

Dump analysis and elimination (DAE) allows an installation to suppress SVC dumps and SYSMDUMP ABEND dumps that are not needed because they duplicate previously written dumps. To identify the cause of previous and requested dumps, DAE uses symptom strings, which contain data that describes a problem. DAE stores these symptom strings in a DAE data set that you provide.

You can use the DAE data set in a single system environment, or the systems in a sysplex can share a single DAE data set. The way you use the DAE data set determines how you specify the data set to global resource serialization to avoid contention for that data set.

Using DAE in a Single System Environment

The default DAE data set, SYS1.DAE, is already defined in the default RNLs as a local resource. IBM recommends that you name the DAE data set SYS1.DAE in a single system because you do not need to change the data set definition for global resource serialization.

For a single system, the default RNLs contain the generic qname entry SYSDSN in the SYSTEM inclusion RNL and a specific rname entry for SYS1.DAE in the SYSTEMS exclusion RNL.

Note: If you intend to use a DAE data set name other than SYS1.DAE in a single system environment, you must add that DAE data set name as a specific rname entry in the SYSTEMS exclusion RNL to avoid contention when more than one system uses the same DAE data set name for different physical data sets.

Using DAE in a Sysplex

The shared DAE data set, if it is not named SYS1.DAE, is already set up as a global resource. IBM recommends that you provide a name other than SYS1.DAE for the DAE data set to be shared in the sysplex because then you do not need to change the data set definition for global resource serialization.

For a sysplex, the default RNL contains the generic qname entry SYSDSN in the SYSTEM inclusion RNL. An entry is not needed in the SYSTEMS exclusion RNL for a global resource.

Note: If you intend to use SYS1.DAE as the shared DAE data set for a sysplex, you must remove the specific rname entry for the SYS1.DAE data set from the default SYSTEMS exclusion RNL.

DB2

If you are using DB2 in a shared DASD environment, review *DB2 System Planning Administration Guide* for recommendations about tuning global resource serialization for DB2.

DFSMShsm

If you are using Data Facility Storage Manager (DFSMShsm) on all systems in the complex that run DFSMShsm, no action is necessary for user data set serialization, as long as SYSDSN is named in the SYSTEM inclusion RNL.

Note: When using SMS-managed DASD volumes with DFSMShsm and USERDATASETSERIALIZATION active, DFSMShsm Version 2.6 tries to delete temporary data sets during automatic primary space management. If no global serialization exists, or if global serialization is not performed for temporary data sets, you can delete an in-use temporary data set. You can also convert some of the reserves that DFHSM issues, such as ARCBACV and ARCMIGV. See *Data Facility Storage Manager Installation and Customization Guide* for information about DFSMShsm reserves and how to decide whether or not to convert them.

DFSMS/MVS

You should place resource name IGDCDSXS in the RESERVE conversion RNL as a generic entry. This will minimize delays due to contention for resources and prevent deadlocks associated with the VARY SMS command. See *z/OS DFSMS Migration*.

Note: If there are multiple SMS complexes within a global resource serialization complex, be sure to use unique COMMDS and ACDS data set names to prevent false contention. For information on allocating COMMDS and ACDS data set names, see *DFSMS/MVS Implementing System-Managed Storage*.

IMS

A generic entry for DSPURI01 should be placed in the SYSTEMS exclusion RNL.

ISPF or ISPF/PDF

To serialize access to resources with concurrent batch or TSO/E use of the resources, ISPF relies on MVS allocation (qname of SYSDSN).

To ensure the integrity of shared data, batch or TSO/E users who are updating a data set must allocate it with DISP=OLD.

Because MVS allocation does not satisfy an exclusive request and a shared request for the same resource at the same time, data set integrity is maintained between ISPF users and batch or TSO/E users.

To serialize access to partitioned data sets among multiple ISPF users, ISPF also issues its own ENQ, DEQ, and RESERVE macros.

To allow users to update a data set that has a record format of ″U″, ISPF serializes with the linkage editor to protect the entire partitioned data set.

Notes:

1. If both ISPF and SPF (meaning a pre-ISPF product, such as 5668-009 or 5740-XT8) are installed on the same system, there is a danger of destroying partitioned data sets that are being updated. This problem can occur when ISPF and SPF update the same data set at the same time.
2. A partitioned data set extended (PDSE) is a data set that, like a PDS, allows you to partition data into members. Users can access PDSE members more easily and quickly than they can PDS members. For information about PDSE data sharing, see *z/OS DFSMS: Using Data Sets*.

If you use ISPF on more than one system in the complex and do not use SPF on any system in the complex:

1. Place entries in the SYSTEMS exclusion RNL for the SPFEDIT data sets that cannot be global resources. For example, create SPFEDIT entries for the system data sets that cannot be shared. These data sets have the same rnames as those specified for SYSDSN in the default SYSTEMS exclusion RNL (shown earlier in Figure 6 on page 23).
2. Place entries in the RESERVE conversion RNL to convert the SPFEDIT reserves ISPF issues for data sets that you want global resource serialization to protect as global resources.

   Note: If your complex includes both a system running ISPF and a system running SPF, you cannot use global resource serialization to serialize access to global resources among ISPF and SPF users. You must not include entries for either SPFEDIT or SPFDSN in the RESERVE conversion RNL.
3. Resources that ISPF users on more than one system might share with batch users or TSO/E users must be global resources defined with both a qname of SYSDSN and a qname of SPFEDIT. That is, you must define, either explicitly or by default, an entry in the SYSTEM inclusion RNL for SYSDSN,dsname.

JES2

Global resource serialization can work well in a JES2 environment because it can replace job scheduling as a method of preserving the integrity of the data on shared DASD volumes. All of the considerations on temporary data sets and TSO/E, however, apply to a JES2 environment, and there is an additional consideration.

Handling the reserve for the checkpoint data set in a JES2 multi-access spool configuration is a particularly critical decision. It is generally not a good idea to convert the reserve for the checkpoint data set. JES2 cannot tolerate the processing delay required to protect the data set as a global resource rather than with a reserve. Also, if a failure disrupts ring processing, JES2 cannot access its checkpoint data set, and it comes to a complete stop.

The location of the checkpoint data set, however, is another factor that affects your decision. There are two basic situations:
1. The checkpoint data set is the only data set on a volume or resides on a volume that contains no data sets that are ever serialized by reserves. In this case, do not convert the reserve; include the name of the checkpoint data set in the SYSTEMS exclusion RNL.
2. The checkpoint data set resides on a volume that contains other data sets that are serialized by reserves. Such use of a volume contradicts recommendations for placement of the JES2 checkpoint data set. If your installation requires such use, then you must convert the reserves for all resources on the volume, including the checkpoint data set. In this case, include the names of all data sets in the RESERVE conversion RNL.

Note: If your installation also uses an alternate checkpoint data set, the reserve JES2 issues for the primary checkpoint data set also provides serialization for the alternate. Checkpoint duplexing thus does not require additional action.

JES3

The major advantage of global resource serialization in a JES3 environment lies in the conversion of reserves to avoid interlocks and reduce contention for data sets on shared DASD volumes. Global resource serialization also provides the only way to serialize access across multiple systems to new nonspecific DASD data sets that the Storage Management Subsystem (SMS) does not manage.

JES3 cannot tolerate the processing delay required to protect its checkpoint data set as a global resource rather than with a reserve. The possible actions are the same as those described under “JES2” on page 27.

System Logger

If you are using System Logger in a sysplex environment, no further action is necessary for logger data set serialization, as long as SYSDSN is named in the SYSTEM inclusion RNL.

An alternative to the above method is to add the following RNLDEF statements in the system inclusion RNL. This statement covers all log streams data sets allocated on behalf of log streams that are defined with the default high level qualifier:

```
RNLDEF RNL(INCL) TYPE(GENERIC) QNAME(SYSDSN) RNAME(IXGLOGR)
```

IBM recommends that you add other RNLDEF statements in the system inclusion RNL to cover log streams that are defined with a high level qualifier other than IXGLOGR:

```
RNLDEF RNL(INCL) TYPE(GENERIC) QNAME(SYSDSN) RNAME(hlq)
RNLDEF RNL(INCL) TYPE(GENERIC) QNAME(SYSDSN) RNAME(hlq.lsname)
```

hlq specifies a high-level qualifier associated with a log stream or a staging data set. IBM supplies two log streams for customer use, the logrec log stream and the operations log (OPERLOG) log stream. You can create your own log streams and your own staging data sets. Each DASD data set that represents a log stream or staging data set begins with the specified high-level qualifier. The high-level qualifier can be specified when you define a log stream or staging data set to the LOGR policy.

lsname specifies the portion of the log stream name that limits the scope of the RNLDEF statement to the System Logger-created data sets.

Using the Logrec Recording Medium

The logrec recording medium can be either a logrec data set or a logrec log stream. The logrec recording medium contains data about machine failures, as well as records for program error recording, missing-interrupt information, dynamic device reconfiguration (DDR) routines, and other related data.

If you are using a logrec log stream, follow the instructions above for specifying RNLDEF statements with the high-level qualifier.

If you are using a logrec data set, the default logrec data set name, SYS1.LOGREC, is defined in the default SYSTEMS exclusion RNL as a local resource.

For a single system, if you name the logrec data set SYS1.LOGREC, you do not need to change the data set definition for global resource serialization. If you name the data set something other than SYS1.LOGREC, then there is no need to add the name to the SYSTEMS exclusion RNL.

In a global resource serialization complex environment, IBM recommends that you define a unique name for the logrec data set on each system. And, if you do, IBM also recommends that you *not* put this name in the SYSTEMS exclusion RNL.

RACF

If you are experiencing contention problems related to the RACF data base, you may consider converting the reserves, as long as all systems that access the RACF data base are MVS systems that are part of the complex. If a VM system, for example, is sharing access to the RACF data base, you cannot convert the reserves.

To convert the reserves, place a generic entry for SYSZRACF in the reserve conversion RNL. In a mixed complex (meaning at least one system in the global resource serialization complex is outside of the multisystem sysplex), when you convert the SYSZRACF reserves you **must** reply to any global resource serialization messages related to ring disruptions or restarts from an MCS console. Failure to reply or replying to the message after issuing an operator command might result in a system hang condition.

In any case, do not put an entry that begins with ’SYSZRACF’ or ’SYSZRAC2’ in the SYSTEM inclusion RNL.

Tape Volumes

If tape drives are being used across multiple MVS images and volume serial numbers are unique, add a generic entry for SYSZVOLS to the SYSTEM inclusion RNL to insure that a tape volume is used by only one job at a time. If you are using automatic tape switching, add a generic entry for SYSZVOLS to the SYSTEM inclusion RNL to prevent a system from holding a tape device while it waits for a mount of a volume that is being used by another system.

If tape drives are not being used by multiple MVS images, no RNL entry is required.

Temporary Data Sets

If you take no action, global resource serialization treats non-VIO temporary data sets as global resources. One reason for letting temporary data sets be global resources is that your installation can then run scratch functions (such as SCRATCH VTOC,SYS) safely at any time against shared volumes.

If your installation, however, wants global resource serialization to treat temporary data sets as local resources, the data set names must appear in the SYSTEMS exclusion RNL. The format of a temporary data set name, however, is not compatible with the format of an RNL entry. There is no way to create a generic entry that will work all the time in every installation. The format of a temporary data set name is one of the following:

SYSyyddd.Thhmmss.RA000.jobname.R0000nnn
SYSyyddd.Thhmmss.RA000.jobname.ddname

TSO/E

When one or more of the systems in your global resource serialization complex runs TSO/E, you must decide whether or not to treat SYS1.UADS and SYS1.BRODCAST as global resources and how to handle user data sets. If your installation uses the RACF data base in place of SYS1.UADS, see “RACF”.

If your installation runs ISPF, see the considerations identified under “ISPF or ISPF/PDF” on page 26. How you handle user data sets is especially critical in a JES2 environment.

SYS1.UADS and SYS1.BRODCAST

The default SYSTEMS exclusion RNL includes entries for SYS1.UADS and SYS1.BRODCAST, causing them to be local resources while you decide whether your installation wants them to be global resources. To make this decision, your installation must investigate and measure:

- Resource requirements (that is, the resources required to merge multiple versions of the two data sets into a single version of each and test the new versions)
- Performance implications (that is, the performance of one version of each data set accessed by all users in contrast to multiple versions of the same data sets each accessed by a subset of those users)

There are, however, significant advantages to treating SYS1.UADS and SYS1.BRODCAST as global resources:

- Your installation has only two data sets to maintain, rather than two data sets for each TSO/E system in the complex.
- A user can logon from any system in the complex, allowing a better workload balance.
- For foreground-initiated background jobs, a user who specifies NOTIFY will always receive the job-ended message regardless of which system in the complex processed the job.

To cause global resource serialization to treat SYS1.UADS and SYS1.BRODCAST as global resources, you must:

1. Merge all existing versions of SYS1.UADS and SYS1.BRODCAST into a single version of each data set.
2. Modify the default RNLs:
   a. Delete the entries for SYS1.UADS and SYS1.BRODCAST from the SYSTEMS exclusion RNL.
   b. Add SYSIKJUA as a generic qname entry in the SYSTEM inclusion RNL to make SYS1.UADS a global resource.
   c. Add SYSIKJBC as a generic qname entry in the SYSTEM inclusion RNL to make SYS1.BRODCAST a global resource.

Related information appears in *z/OS TSO/E Customization*. Some of the information is repeated here for your convenience.

TSO/E User Data Sets

The data sets that are used only by TSO/E users include:

- Private user data sets that are not shared by other users or by batch jobs
- Temporary user-related data sets, such as ISPF, log, or recovery data sets
- Shared data sets, such as program libraries

If you use the default RNLs, the SYSDSN entry in the SYSTEM inclusion RNL defines all of these data sets as global resources.

If your installation wants all of them or some of them to be local resources, you must exclude them from global serialization. You can, if the structure of your userid allows, place a generic entry in the SYSTEMS exclusion RNL to define all TSO/E user data sets as local resources. If, however, a user might logon to different systems at different times, that user's data sets must be global resources. Place a generic entry for the userid in the SYSTEM inclusion RNL, and do not place an entry for the user in the SYSTEMS exclusion RNL.

If the structure of your userid does not allow you to create a generic entry to define all TSO/E user data sets as local resources, you can place a generic entry in the SYSTEMS exclusion RNL for the userid of each user whose TSO/E data sets are to be local resources. Omit the entry for a user whose TSO/E data sets are to be global resources. This method, however, might cause a very long RNL that you would have to change frequently. If the problem is significant at your installation, you might want to modify the exit search routine (ISGGREX0) to recognize the TSO/E user data sets that are to be local resources and exclude them from global serialization. See *z/OS MVS Installation Exits*.

VIO Journaling Data Set

The VIO journaling data set is an optional VSAM data set that contains auxiliary storage management records for virtual I/O (VIO) data sets that the system saves across job steps and between IPLs. The default journaling data set name, SYS1.STGINDEX, is defined in the default SYSTEMS exclusion RNL as a local resource.

VIO Journaling Data Set in a Single System Environment

For a single system, if you name the journaling data set SYS1.STGINDEX, you do not need to change the data set definition for global resource serialization. If you name the data set something other than SYS1.STGINDEX, there is no need to add the name to the SYSTEMS exclusion RNL. If your installation does not use the journaling data set, then no action is required in the SYSTEMS exclusion RNL.

VIO Journaling Data Set in a Multisystem Environment

In a global resource serialization complex environment, IBM recommends that you define a unique name for the journaling data set on each system. And, if you do, IBM also recommends that you *not* put this name in the SYSTEMS exclusion RNL.

VSAM

Whether or not you can serialize access to VSAM data sets and VSAM and ICF catalogs as global resources depends on the level of VSAM installed on all systems in the complex. Only the current level of VSAM is compatible with global resource serialization. The current level of VSAM is available in MVS/370 DFP Release 1.1 or later, in MVS/DFP release 2.1 or later, and in MVS/DFP version 3. (If you need more information about VSAM, see the VSAM information at your installation.)

Thus, the major consideration related to VSAM is that you must not treat VSAM data sets as global resources or convert any reserves for VSAM and ICF catalogs unless all systems that might access the resources under any possible conditions include the current level of VSAM. Additional specific considerations for VSAM data sets and for VSAM and ICF catalogs follow.

VSAM Data Sets

If you take no action, SYSVSAM data set serialization is global.

Do not place an entry for SYSVSAM in the SYSTEM inclusion RNL. Every SYSVSAM request that needs the SYSTEMS attribute already has it. (Placing an entry for SYSVSAM in the SYSTEM inclusion RNL can degrade performance.

VSAM and ICF Catalogs

VSAM and ICF catalogs are VSAM data sets, but VSAM recognizes catalogs and manages access to them in a special way. If catalog reserve contention is a concern at your installation, replacing VSAM catalogs with ICF catalogs can help. Converting catalog reserves can also reduce contention caused by catalog activity. Depending on your system configuration, you need to do the following to convert catalog reserves:

1. To avoid a data integrity exposure, verify that all systems using an ICF catalog are part of the complex.
2. Place a generic entry for SYSIGGV2 in the RESERVE conversion RNL.
3. If you have VSAM catalogs used by any systems that are not part of the complex, you must place specific SYSIGGV2 entries for these catalogs in the SYSTEMS exclusion RNL.

   Note: For example, specify:

```
RNLDEF  RNL(EXCL)  TYPE(SPECIFIC)
          QNAME(SYSIGGV2)  RNAME(ucat)
```

Do not place an entry for SYSIGGV2 in the SYSTEM inclusion RNL. Every SYSIGGV2 request that needs the SYSTEMS attribute already has it. (Placing an entry for SYSIGGV2 in the SYSTEM inclusion RNL can degrade performance).

RNL Candidates

Based on these general recommendations, there are certain resources that are good candidates for a particular RNL. Table 2 shows suggested resources for the SYSTEM inclusion RNL, Table 3 shows suggested resources for the RESERVE conversion RNL and, Table 4 shows suggested resources for the SYSTEMS exclusion RNL.

For each resource shown, the figures include information on the resource name and a brief description of why you should consider placing the particular resource in the RNL.

Note: You must specify the parts of the resource name shown in upper case letters exactly as shown, and you must replace the parts of the resource name shown in lower case letters with your installation-specific information.

Table 2. SYSTEM Inclusion RNL Recommendations

Qname	Rname	Notes
SYSDSN	dsname (optional)	Include a generic qname entry for SYSDSN to make data sets that go through MVS allocation global resources; use entries in the SYSTEMS exclusion RNL to make specific data sets local resources. The default RNL contains a generic entry for SYSDSN. A generic name is most useful, but the name can also be specific.
SYSIKJUA	none	You must include this entry if the TSO/E data set SYS1.UADS is to be a global resource. The name must be generic. Remember to delete the entry for SYSDSN,SYS1.UADS from the default SYSTEMS exclusion RNL.
SYSIKJBC	none	You must include this entry if the TSO/E data set SYS1.BRODCAST is to be a global resource. The name must be generic. Remember to delete the entry for SYSDSN,SYS1.BRODCAST from the default SYSTEMS exclusion RNL.

Table 2. SYSTEM Inclusion RNL Recommendations (continued)

Qname	Rname	Notes
SYSZVOLS	none	Include a generic qname entry for SYSZVOLS to insure that a tape volume is only used by one job at a time if multiple MVS images are sharing tape drives and volume-serial numbers are unique. If tape drive(s) are not being used by multiple MVS images, this entry is not required.

Table 3. RESERVE Conversion RNL Recommendations

Qname	Rname	Notes
SYSIEWLP	dsname (optional and padded to 44 bytes)	Include an entry to convert this reserve if all systems that share the resource are part of the complex. The entry serializes access between ISPF and the linkage editor. The name can be specific or generic.
SPZAPLIB	dsname	Include an entry to convert this reserve if all systems that share the resource are part of the complex. The name can be specific or generic.
SYSIGGV2	catalog dsname (optional and padded to 20 or 44 bytes)	Include this entry to convert the reserves for VSAM and ICF catalogs. Because the RNAME contains more than just the catalog name, you must always use a generic specification. If you do not, updates to specific records in the catalog will not be properly serialized.
SYSZRACF	none	Include this entry to convert the reserves for the RACF data base. The name can be generic or specific.
SYSVTOC	none	If you plan to run DFDSS DEFRAG programs with MVS SP2.2 or a later version in a multisystem environment, you can convert SYSVTOC reserves by including a generic entry. Otherwise, SYSVTOC is generally not a good candidate for reserve conversion because reserves are of short duration and I/O intensive. See SYSVTOC in Table 4.
any	any	Include an entry for any reserve that you want to convert. Global resource serialization will treat the resource as a global resource, and the system will not issue the reserve. The name can be specific or generic.

Table 4. SYSTEMS Exclusion RNL Recommendations

Qname	Rname	Notes
SYSZVVDS	none	Include this entry to treat SYSZVVDS reserves, which are of short duration and I/O intensive, as local resources. The name is generic.
SYSVTOC	volser of SYS1.DCMLIB data set	For MVS releases earlier than SP2.2, include this entry to IPL with MVS/XA DFP. The name can be specific or generic. For MVS SP2.2 and later releases, you do not need to include this entry.
SYSVTOC	none	Include this entry to treat SYSVTOC reserves, which are of short duration and I/O intensive, as local resources. The name is generic.
SYSZJES2		In a JES2 environment, include an entry for each checkpoint data set specified in the CKPTDEF initialization statement. The name can be specific or generic. The qname is always SYSZJES2
	volser dsname	For MVS/SP Version 1.3.6 or MVS/SP Version 2 Release 1.5, use the volser and dsname specified for PRIMARY and DSNAME in CKPTDEF; for MVS/SP Version 2.2 or later releases, include a separate entry for each checkpoint data set and use the volser and dsname specified for CKPT1, CKPT2, NEWCKPT1, and NEWCKPT2 in CKPTDEF. See *z/OS JES2 Initialization and Tuning Reference*.
SYSZIAT	volser dsname	In a JES3 environment, include an entry for the checkpoint data set. The name must be generic.
SYSDSN	dsname	Include an entry for every system data set that is to be a local resource. The default RNLs contain several (see Figure 6 on page 23). The name can be specific or generic.
SYSCTLG	none	You must include an entry for SYSCTLG. The name must be generic.
SYSVSAM	dsname (optional)	To make a VSAM data set a local resource, include an entry for the VSAM data set that is to be a local resource. To make all VSAM data sets local resources, use a generic qname entry for SYSVSAM. SYSVSAM and SYSDSN data set serialization must be consistent.

Table 4. SYSTEMS Exclusion RNL Recommendations (continued)

Qname	Rname	Notes
SYSIGGV2	catalog dsname) optional and padded to 20 or 44 bytes)	Supply a specific entry for any VSAM catalog used by any system that is not part of the complex. If the catalog dsname is less than 20 bytes, pad it to 20 bytes; if the catalog dsname is more than 20 bytes, pad it to 44 bytes.

Defining the RNLs

The RNLs on all systems in the complex must be the same; that is, each RNL on each system must contain the same resource name entries, and these resource name entries must appear in the same order.

You use the GRSRNLxx parmlib member to define the RNLs. During IPL, specifying the desired member(s) on the GRSRNL system parameter tells global resource serialization where it can find the RNLs. When the complex matches the sysplex, issuing the SET GRSRNL command tells global resource serialization where it can find the updated RNLs. However, the SET GRSRNL command does not work on any system in a mixed complex. Once you purge non-sysplex systems from the complex, however, so the sysplex matches the complex, you can use the SET GRSRNL command. See “Changing the RNLs for a Ring” on page 148 for further information about using the SET GRSRNL command.

IBM supplies a default, member GRSRNL00 of SYS1.PARMLIB, that defines the default RNLs. See Figure 6 on page 23.

You can either use GRSRNL00 as is, modify it, or create additional GRSRNLxx members. You might find it useful to leave GRSRNL00 as is and use one or more separate members to define your own entries. Separating the IBM-supplied entries from your installation-dependent entries can make future migration easier. You might also find it useful to set up one member for generic entries and another member for specific entries.

z/OS MVS Initialization and Tuning Reference contains detailed information about specifying the entries in GRSRNLxx. The worksheet shown in Table 5 on page 35 lists the RNL entries IBM supplies in GRSRNL00 and includes blank slots for your own entries.

Each resource entry consists of:

- An RNL identifier, which is RNL(EXCL) for the SYSTEMS exclusion list, RNL(INCL) for the SYSTEM inclusion list, and RNL(CON) for the RESERVE conversion list
- An entry type indicator, which is TYPE(SPECIFIC) if the entry is a specific name or TYPE(GENERIC) if the entry is a generic name
- A qname, in the form QNAME(name)
- An optional rname, in the form RNAME(name)

Test GRSRNLxx carefully to ensure that it does not include syntax errors. In SYS1.SAMPLIB, IBM supplies an RNL syntax checker that can detect such errors. Member ISGRNLCK of SYS1.SAMPLIB contains information about using the RNL syntax checker, or see the appendix of this book for information about the RNL syntax checker and its messages. To minimize the testing, create a single GRSRNLxx member, test it, and then copy it to the parmlibs of all systems.

Table 5. GRSRNLxx Worksheet

List Identifier	**Type Indicator**	**Qname**	**Rname**
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(PASSWORD)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.BRODCAST)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.DAE)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.DCMLIB)
RNLDEF RNL(EXCL)	TYPE(GENERIC)	QNAME(SYSDSN)	RNAME(SYS1.DUMP)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.LOGREC)
RNLDEF RNL(EXCL)	TYPE(GENERIC)	QNAME(SYSDSN)	RNAME(SYS1.MAN)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.NUCLEUS)
RNLDEF RNL(EXCL)	TYPE(GENERIC)	QNAME(SYSDSN)	RNAME(SYS1.PAGE)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.STGINDEX)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.SVCLIB)
RNLDEF RNL(EXCL)	TYPE(SPECIFIC)	QNAME(SYSDSN)	RNAME(SYS1.UADS)
RNLDEF RNL(INCL)	TYPE(GENERIC)	QNAME(SYSDSN)	

Chapter 3. ENQ/RESERVE/DEQ Monitor

The main objective of the global resource serialization monitor tool is to assist in planning the RNLs for global resource serialization implementation. The tool monitors ENQ, DEQ, and RESERVE requests, and collects data about the resources and the requestors.

The objectives of the tool are:

1. Assist in planning the RNLs for global resource serialization implementation.
   - Find the name and the scope of ENQ.
   - Measure the rate and time of the RESERVEs.
2. Reduce DASD contentions and interlock exposures by helping to identify RESERVEs for which changes to RNLs could reduce elapsed time for some jobs and to verify the results of RNL changes that are made.
   - Report RESERVE activities with total and maximum RESERVE time on shared DASD.
   - Report resources that contributed to the RESERVE time.
   - Verify the results when RNLs are implemented.
3. Provide information to assist in the analysis of results of global resource serialization tuning.
   - Measure the global resource serialization ENQ delay for global enqueues, the actual RESMIL value, and the ENQ/DEQ requests rate.
   - Trace global resource serialization ENQ delay using a major name SYSZENQM and a minor name ENQDELAY and minor name with delay value, date and time information (see Figure 10 on page 41, Figure 11 on page 42, and “Restrictions” on page 68).

An interactive ISPF application allows viewing and printing of the collected data. Alternatively, the data can be written to a sequential data set. Reports can be generated by modifying the sample procedures provided in SYS1.SAMPLIB.

Installation

The ENQ Monitor requires the allocation of two sequential data sets with **BLKSIZE=3892,LRECL=3892 RECFM=F** (required attributes) used by the monitor to collect the ENQ/DEQ data. The data set names will be on the DD statements OUTPUT1 and OUTPUT2 in the JCL to start the monitor (see “Monitor Execution” on page 38).

Each block has room for 30 ENQ/DEQ SVCs. If the monitor collects 100 events per second, 12000 blocks will be filled in one hour. One or both output data sets can be DUMMY. See “Monitor Execution” on page 38 for additional information.

Prepare the JCL to start the monitor. Sample JCL is ISGRUNAU in SYS1.SAMPLIB.

Allocate a data set used by the reports procedures with space allocation of TRK=(1,1), RECFM=FB, LRECL=132, BLKSIZE=18348 for DDNAME LOGR. The data set name is a variable in the reports procedures. See “Logs” on page 56 and Figure 31 on page 61.

Prepare the report procedures from the sample members ISGAJE1, ISGAJE1A, ISGAJE2, ISGAJE2A, ISGAJE3 and ISGAJE3A.

All the sample JCL is in SYS1.SAMPLIB, or see

- Figure 29 on page 59 - ISGAJE1
- Figure 30 on page 60 - ISGAJE1A
- Figure 31 on page 61 - ISGAJE2
- Figure 32 on page 63 - ISGAJE2A
- Figure 33 on page 65 - ISGAJE3
- Figure 34 on page 67 - ISGAJE3A

For the procedure variables see “In Stream Procedures Variables” on page 57.

Monitor Execution

The ENQ monitor can be started by either starting a procedure or submitting a batch job. This job should be considered as a non-ending job. TIME=1440 or TIME=NONLIMIT is suggested. It is recommended that you run the job at the highest possible dispatching priority in your system. If the monitor is not at a high dispatching priority, virtual storage may become exhausted and ENQ/DEQ processing may be impacted.

```
//* Function: Run this job to start ENQ Monitor before starting
//*           ENQ Monitor ISPF interface or using the modify
//*           command.
//*
//* Operation: This JCL can be copied to the SYS1.PROCLIB and issue
//*            'S ISGEUNAU' from the MVS console to start the ENQ
//*            Monitor.
//*
//* Suggested modifications:
//*    1. Uncomment //*OUTPUTX if hardcopy output is needed.
//*    2. Modify //OUTPUTX DD DSN=USERID.AUDIT>OUTX,DISP=SHR to
//*       a correct pre-allocated dataset.
//*
//*       When allocates the dataset, it has to be in the following
//*       format:
//*              Organization  . . . : PS
//*              Record format . . . : F
//*              Record length . . . : 3892
//*              Block size  . . . . : 3892
//*
//* Recovery Operations:  None
//*
//* Distribution Library:  ASAMPLIB
//JOBNAME  JOB CLASS=A,MSGCLASS=A,TIME=NOLIMIT
//*
//*  JOB TO START THE MONITOR
//*
//*
//JOBLIB DD DSN=SYS1.LINKLIB,DISP=SHR
//STEP001 EXEC PGM=ISGAUDIT,PARM='DSP=32'
//OUTPUT1 DD DSN=USERID.AUDIT.OUT1,DISP=SHR
//OUTPUT2 DD DSN=USERID.AUDIT.OUT2,DISP=SHR
//*OUTPUT1 DD DUMMY
//*OUTPUT2 DD DUMMY
//SYSUDUMP DD SYSOUT=*
```

Figure 7. JCL to Run the Monitor

The optional keyword DSP on the PARM field can be used to specify the desired size of the dataspace in MB (megabytes). **DSP=nnn** which can range from **1 to 999**. The default dataspace size is 32 MB. The two output sequential data sets must be different data sets or can be DUMMY data sets. When one data set is full, the monitor automatically switches to the alternate. If both are full, the monitor terminates.

When the monitor is restarted, it will append the new data to the end of OUTPUT1 data set. It is possible to process the data collected while the monitor is active. This can be done either by switching to the alternate data set with the MODIFY option SW command (see “Monitor Control” on page 45) or by selecting the data to process with the DATE keyword with the TO-TIME less than the actual time (see “Report Programs Parameters” on page 57).

If the events' rate causes loss of data, consider using a 3990-3 DASD FAST WRITE facility. Data can be lost if an unexpected error occurs during the process of copying information to the ENQ Monitor's address space. The MODIFY option L command and ISPF main panel display the number of lost events if loss of data occurs.

The monitor terminates when both output data sets are full. If OUTPUT2 is **DUMMY**, when OUTPUT1 is full the monitor does not terminate but continues collecting data in the dataspace. If both data sets are DUMMY, data are collected in storage.

An ISPF application can be invoked to display and print the data saved in the dataspace. For additional information see “ISPF Application” and “Monitor Control” on page 45.

When the dataspace is full, the monitor stops collecting data. The ISPF application can still display the dataspace information.

If the monitor is started as a procedure, it cannot be CANCELled or FORCEd, it can only be stopped. If the monitor is submitted as a batch job, it can be cancelled or stopped.

ISPF Application

To start the application, execute the SYS1.SBLSCLI0(ISGACLS0) EXEC from the ISPF/PDF Option 6 (Command).

Figure 8 on page 40 shows the Main Menu displayed when global resource serialization is in ring configuration.

```
                            ENQ/DEQ Monitor - Main Menu
Select an option:

__  1.  MAJOR Names                  Date &   Time      : 1995.160   06:00
    2.  Resource Name List           Monitor started at : 1995.159   10:5
    3.  Volume List                  Elapsed seconds    :            68790
    4.  Filter List                  SMF System ID      :             SC47
-----------------------------------------------------------------------------
GRS Ring -> From: SC49      To: SC52      This: SC47      NUMSYS: 7
-----------------------------------------------------------------------------
                                  Time of Delay High. . : 1995.160 04:05:28
Global Requests . . . :    24885  Enqueue Delay Hi - Low:     1260    12
Local  Requests . . . :   140708  Enqueue Delay     msec:       31

Major Names . . . . . :       39  ACCELSYS. . . . . . . :        2
Minor Names . . . . . :     1516  RESMIL  . . . . . msec:        0
Volumes . . . . . . . :       11  Data Space Used .bytes:   221900   10 %
Number of Events. . . :   344009  Active Filter. . . . .:       08
Lost Events . . . . . :        0  Events Rate  . . . . .:        3

Command ===> ___________________________________________________________
F1=Help   F2=Split  F3=Exit   F9=Swap   F12=Cancel
```

Figure 8. GRS Ring Main Menu - ISPF Application

If the monitor is active, migration from global resource serialization ring to star configuration will be automatically recognized by the monitor. Figure 9 shows the Main Menu displayed when global resource serialization is in a star configuration.

```
                            ENQ/DEQ Monitor - Main Menu
Select an option:

__  1.  MAJOR Names                  Date &   Time      : 1996.241   06:04
    2.  Resource Name List           Monitor started at : 1996.241   04:22
    3.  Volume List                  Elapsed seconds    :           6165
    4.  Filter List                  SMF System ID      :           SC47
------------------------------------------------------------------------------
GRS Star -> Number of Lock Entries: 1048576               NUMSYS: 10
------------------------------------------------------------------------------
                                  Time of Delay High. . : 1996.241 05:40:00
Global Requests . . . :     4159  Enqueue Delay Hi - Low:   192484    302
Local  Requests . . . :    12194  Enqueue Delay  mic-sec:      405

Major Names . . . . . :       44
Minor Names . . . . . :      292
Volumes . . . . . . . :        2  Data Space Used .bytes:    47276    2 %
Number of Events. . . :    33762  Active Filter. . . . .:       08
Lost Events . . . . . :        0  Events Rate  . . . . .:        5

Command ===> ___________________________________________________________
F1=Help   F2=Split  F3=Exit   F9=Swap   F12=Cancel
```

Figure 9. GRS Star Main Menu - ISPF Application

Press **PF1** to display a help panel.

Option 1 shows the ENQ activities listed by major names, RNL action and the number of global and local ENQs if global resource serialization is active.

Figure 10 on page 41 shows the panel displayed when Option 1 is selected.

```
                    ENQ/DEQ Monitor - Major Name List      ROW 1 TO 10 OF 65

Enter S to select a Major Name for details     .
      L major on command line to locate a Major.   Elapsed seconds:    6640

   Sel.   ----------   -------  ----   ----    -------  -average-   -Reserved-
   Field  Major Name   Scope    Exit   RNL     Counter     msec       seconds
   _      SYSZVVDS     SYSS            CONV       3554      23            86
   _      SYSZVVDS     SYS                        3152
   _      SYSZSDSF     SYSS            INCL         32
   _      SYSZRAC2     SYS                        3665
   _      SYSZRACF     RES             EXCL        338      39            13
   _      SYSZPSWD     SYS                          15
   _      SYSZMCS      SYS                        1053
   _      SYSZLOGR     SYS      YES                 37
   _      SYSZLLA1     SYS                         117
   _      SYSZJES2     SYS                         386
   _      SYSZJES2     RES                        1125    1101          1251
   _      SYSZISTH     SYS                          16
   _      QNAME        SYS                          17

Command ===> __________________________________________________________________
F1=Help      F2=Split     F3=Exit      F4=Print     F5=Sort_maj  F6=Sort_scp
F7=Backward  F8=Forward   F9=Swap     F10=Sort_cnt F11=Sort_avg F12=Sort_res
```

Figure 10. Option 1 - Major Name List

Press **PF1** to display a help panel.

Press **PF4** to print the entire major name list.

Press **PF5, PF6, PF10, PF11, PF12** to sort on major name, scope, count, average, and reserved seconds.

Command **L major_name** will locate the major name and position it if exists in the collected data.

Select a major name on the displayed row to get information about the minor names associated with that major name.

Major name column displays the major name of the resource.

Scope column displays the resource scope. An asterisk (*) the left of the resource scope indicates a change of resource scope after scanning the RNLs.

For example,

– *SYSS on the scope column with INCL on the RNL column means the resource scope was changed from SYSTEM to SYSTEMS.

– *SYS on the scope column with EXCL on the RNL column means the resource was changed from SYSTEMS to SYSTEM.

– SYSS on the scope column with CONV on the RNL column means the resource scope was changed from a RESERVE macro to an ENQ with a scope of SYSTEMS. The RESERVE on the DASD will be suppressed.

– RES on the scope column with EXCL on the RNL column means the resource scope was changed from SYSTEMS to SYSTEM. The RESERVE on the DASD will not be suppressed.

Exit column indicates whether the request was altered by one of the ENQ/DEQ installation exit routines.

RNL column displays the action taken by RNL processing.

– Blank in the column means no change in the resource scope after scanning the RNLs.
– CONV means the resource name matched an entry in the RESERVE Conversion List.
– INCL means the resource name matched an entry in the SYSTEMS Inclusion List.
– EXCL means the resource name matched an entry in the SYSTEM Exclusion List.
– NO means RNL=NO keyword was specified with the resource name.

Counter column displays the total number of requests on this major name.

Figure 11 shows the panel displayed when a specific major name is selected.

```
                    ENQ/DEQ Monitor - Minor Name List       ROW 1 TO 9 OF 17


Minor Name list for:              Major Name  : QNAME
                                  RNL . . . . :
                                  Scope . . . : SYSTEM

Enter S to select a Minor Name for Jobnames    .
      L min.  on command line to locate a Minor.

  Sel.   ----------------------------------------------------  --------
  Field  Minor Name:                                           Counter:
  _      01292787 95.160 04:05:28                                     1
  _      01120841 95.160 04:33:16                                     1
  _      01075989 95.160 04:31:58                                     1
  _      01056722 95.160 01:24:29                                     1
  _      00954460 95.160 01:58:21                                     1
  _      00893109 95.159 22:39:37                                     1
  _      00553288 95.160 06:06:09                                     1
  _      00526344 95.160 03:25:03                                     1
  _      00510494 95.160 05:37:46                                     1

Command ===> ___________________________________________________________
F1=Help      F2=Split     F3=Exit      F4=Print     F5=Sort_min  F6=Sort_cnt
F7=Backward  F8=Forward   F9=Swap     F10=Sort_tme
```

Figure 11. Selected Row - Minor Name List

Press **PF1** to display a help panel.

Press **PF4** to print the entire minor name list.

Press **PF5, PF6** to sort on minor name, counter.

Select a minor name on a displayed row to get information about jobnames, userids and program names involved in the ENQ or RESERVE processing for that resource.

Command **L minor_name** will locate the minor name if it exists in the collected data.

Press **PF10** to sort minor names by timestamp.

Selecting a specific minor name results in a display of the job and program names with indication of exclusive or shared use.

Press **PF5 and PF6** to sort on jobname, program name. Figure 12 is an example of the panel displayed when a specific minor name is selected.

```
                        ENQ/DEQ Monitor - Jobname List    ROW 1 TO 1 OF 1


Jobname list for Major Name  : QNAME
                 Minor Name  : 01292787 95.160 04:05:28
                 Minor Length: 24
 --------  --------   ----------       -------- ---       ----------
 Job_name  User_ID    Enqs x Job       Pgm_name E/S       Enqs x PGM
 MONITOR   STC                 1       SVC-255   E                 1
******************************* BOTTOM OF DATA *************************

Command ===> __________________________________________________________
F1=Help      F2=Split     F3=Exit    F4=Print   F5=S_enq_j   F6=S_enq_p
F7=Backward  F8=Forward   F9=Swap
```

Figure 12. Selected Row - Jobname List

Only 52 bytes of minor names will be displayed.

Press **PF1** to display a help panel.

Press **PF4** to print the entire jobname list.

Option 2 of the main menu shows a selection panel to display the active RNL's entries. This option offers the same result as MVS D GRS,RNL=INCL (or EXCL or CON).

Option 3 of the main menu shows RESERVE activities.

Figure 13 on page 44 shows the panel displayed when Option 3 is selected.

Select S on a single volume to display RESERVE activities on that volume. Figure 14 on page 44 shows the information displayed when S is selected on a single volume.

Select A on a single volume to display the active RESERVEs on the volume. Figure 15 on page 45 shows the information displayed when A is selected on a single volume with active RESERVEs.

Command **L volume_name** will locate the desired volume if it exists in the collected data.

```
                         ENQ/DEQ Monitor - VOLUME List

 Enter S to  select a Volume for details
       A for active Reserves on  Volume
       L volume on command line to locate a Volume

-- ------ --------- Dev. Max ---------- ------------ Reserve Time -------
S. Vol.   Total Res nbr  Res Elap.(sec)  Avg.(ms)  Min.(ms)  Max.(ms) Tot
 _ STS004       201 02AD  03       1496       159        11       845
 _ STS002       582 01A6  05       1485        21         6       506
 _ STS001      1114 01AD  04       1496        43         6      2951
 _ RUBB01        61 0234  01       1477       105        34       488
 _ RES51B         1 02A0  01       1258     26784     26784     26784
 _ RES51A       129 0236  02       1499        31         8       629
 _ PR0003         1 02AF  01       1478        55        55        55
 _ PR0002         1 01AC  01       1478        44        44        44
 _ PR0001       261 01AB  03       1479        18         8       179
 _ HSMMG1        12 01A1  02       1129        82        17       364
 _ DB0003         1 02A9  01       1480        43        43        43
 _ DB0002         1 01AA  01       1481        46        46        46
 _ DB0001        12 01A9  04       1482        33        12       359
 _ CAT510      2136 0237  06       1499       146         6      1334

Command ===> ___________________________________________________________________
F1=Help      F2=Split     F3=Exit      F4=Print     F5=Sort_vol  F6=Sort_cnt
F7=Backward  F8=Forward   F9=Swap     F10=Sort_avg F11=Sort_max F12=Sort_tot
```

Figure 13. Option 3 - Volume List

Press **PF1** to display a help panel.

Press **PF4** to print the entire volume selection list.

Press **PF5, PF6, PF10, PF11, PF12** to sort on volume, total reserve count, average reserve time, maximum reserve time, and total reserve time.

Select a minor name to get the information about the jobnames and program names that issued RESERVE.

```
                      ENQ/DEQ Monitor - VOLUME Entry List      ROW 1 TO

Volume entry list for:

 Volser. . . . . . : STS001      Average Reserve Time (ms) : 32
 Tot.nr of Reserve : 487         Minimum Reserve Time (ms) : 6
 Dev.nr. . . . . . : 01AD        Maximum Reserve Time (ms) : 1765
 Max Reserve Cnt. .: 04          Total   Reserve Time (sec): 15
 Elapsed Time (sec): 1594

Interval
- Rate - ------ -------- ---------------------  ------------ Time -----
S  min.   Count MajName  Minor name (max 22 ch)  Avg ms  Min ms  Max ms
_     0       5 SYSZVVDS STS001 .                    31      30      32
_     0       2 SYSZVVDS STS001 .                    22      21      23
_     0       4 SYSZVVDS STS001 .                    29      27      31
_     8     214 SYSZVVDS STS001                      19       4     133

Command ===> ___________________________________________________________
F1=Help      F2=Split     F3=Exit      F4=Print     F5=Sort_maj  F6=Sort_cnt
F7=Backward  F8=Forward   F9=Swap     F10=Sort_avg F11=Sort_max F12=Sort_tot
```

Figure 14. Option 3 - Volume Entry List

```
                      ENQ/DEQ Monitor - Active Reserve List    Row 1 to 1 of 1

Active Reserve for :

 Volser. . . . . . : CAT510      Average Reserve Time (ms) : 288
 Tot.nr of Reserve : 5315        Minimum Reserve Time (ms) : 6
 Dev.nr. . . . . . : 0237        Maximum Reserve Time (ms) : 1438
 Max Reserve Cnt. .: 04          Total   Reserve Time (sec): 1553
 Elapsed Time (sec): 8083        Volume  Reserve Rate (min): 39

-------- ---------------------------------------- ----------- -------- --------
Major    Minor name (max 40 ch)                   Active msec Jobname  Pgmname
SYSZJES2 CAT510SYS1.HASPCKPT                              968  JES2     HASJES20
******************************* Bottom of data ********************************

Command ===> ___________________________________________________________
F1=Help    F2=Split   F3=Exit    F9=Swap   F12=Cancel
```

Figure 15. Option 3 - Volume Active Reserve List

Note: The average, minimum, and maximum reserve time displayed in Figure 14 on page 44 and Figure 15 can be out of sync if there is an active RESERVE request on that volume.

Option 4 of the main menu shows the active filter.

Figure 16 shows the panel displayed when option 4 is selected.

```
                        ENQ/DEQ Monitor - Filter  List        Row 1 to 4 of 4

Filter: 08                       DISCARD  SCOPE=STEP

Object:   Object name:                                                Action
--------  ------------------------------------------------------------ -------
MAJOR     SYSZTIOT                                                    DISCARD
MAJOR     SYSZJWTP                                                    DISCARD
RESOURCE  SYSDSN   USER.LINKLIB                                       DISCARD
RESOURCE  SYSDSN   SYS95                                              DISCARD
******************************* Bottom of data *******************************
```

Figure 16. Option 4 - Filter List

Monitor Control

The monitor supports the MODIFY command with the following options:

- Change the filter table **(option I)**.
- List the active filter table, the active output data set, the number of events recorded, the number of lost events, the ENQ delay of a systems enqueue and the RESMIL value in milliseconds **(option L)**.

  Note: The ENQ delay and RESMIL are measured at the time of the command. The monitor encounters the same contention for the processor and storage as does any other address space in the system. Thus, even after the system grants the global resource request, the monitor may not receive control immediately because of processor or storage contention, and the ENQ delay measurement may not be accurate.

RESMIL is not displayed if GRS=NONE is specified in IEASYSxx or global resource serialization is in a star complex.

- List the enqueue activities by MAJOR names, RNLs ACTION, if global resource serialization is active, and the approximate number of global and local requests (ENQs+DEQs) **(option T)**.
- List the RESERVE's activities by volume **(option V)**.
- Switch the active output data set **(option SW)**.
- List the active RNL's entries **(option R)**. This option offers a function similar to the MVS DISPLAY GRS,RNL=ALL command.
- Stop the monitor **(option STOP)**.
- Cancel the monitor if it is a batch job **(option C)**.

To stop the monitor the MVS P JOBNAME command can be used along with the MODIFY option STOP.

Figure 17 shows all the supported options.

```
F  JOBNAME,I=xx          RE-INITIALIZE FILTER TABLE
                               xx RANGE FROM 00 TO 09

F  JOBNAME,L              DISPLAY INTERCEPTED SVCS
                                ACTIVE  DDNAME & FILTER-TABLE
                                NUMBER TRACED EVENTS
                                NUMBER LOST   EVENTS
                                ENQ  DELAY IN MICROSEC
                                RESMIL        IN MILLISEC

F  JOBNAME,T              DISPLAY THE ENQ/RES MAJOR-NAMES
                               ACTIVITIES

F  JOBNAME,T=MAJOR     DISPLAY THE ENQ/RES MAJOR-MINOR
                                 NAMES ACTIVITIES

F  JOBNAME,V                DISPLAY THE VOLUMES WITH RESERVE
                                 ACTIVITIES

F  JOBNAME,V=VOLSER     DISPLAY THE VOLUME's RESERVES


F  JOBNAME,T=FREEMAIN   RESET THE DATASPACE's CONTENT
                V=FREEMAIN

F  JOBNAME,R                 LIST THE ACTIVE RNLs

F  JOBNAME,SW              SWITCH OUTPUT DATA SET

F  JOBNAME,STOP           STOP THE MONITOR. PARTIALLY
                                  FILLED BUFFER IS WRITTEN.

P  JOBNAME                  STOP THE MONITOR. PARTIALLY
                                 FILLED BUFFER IS WRITTEN.

C  JOBNAME                  ONLY IF NOT STARTED. PARTIALLY
                                 FILLED BUFFER IS NOT WRITTEN
```

Figure 17. AUDIT MODIFY Command Options

Figure 18 on page 47 shows sample output for option L if global resource serialization is in a ring configuration.

```
F JOBNAME,L

ISGAU008 - ISGAMF08 ACTIVE
ISGAU008 - OUTPUT1  ACTIVE
ISGAU008 - I=00004718 L=00000000 ENQ-DELAY=00009274 RESMIL=0010

I=xxx         number of events traced     L=yyy  number of lost events
ENQ-DELAY=zzz time in microsec required by a SYSTEMS ENQ to complete
```

(global resource serialization in ring configuration)
Figure 18. AUDIT MODIFY Option L Output Example

Figure 19 shows sample output for option L if global resource serialization is in a star complex or GRS=NONE is specified in IEASYSxx.

```
F JOBNAME,L

ISGAU008 - ISGAMF08 ACTIVE
ISGAU008 - OUTPUT1  ACTIVE
ISGAU008 - I=00004718 L=00000000 ENQ-DELAY=00009274

I=xxx         number of events traced     L=yyy  number of lost events
ENQ-DELAY=zzz time in microsec required by a SYSTEMS ENQ to complete
RESMIL=wwww   not displayed if GRS=NONE is specified in IEASYSxx or
              global resource serialization is in a star complex.
```

Figure 19. AUDIT MODIFY Option L Output Example (GRS=NONE or GRS in Star)

The MODIFY option T command can be used to find out what are the **major names** used in the system and to verify the **RNLs action**. For a sample output see Figure 20 on page 48 and Figure 21 on page 48.

```
F JOBNAME,T

  GLOBAL=00002880 LOCAL=00003124 number of GLOBAL (SYSTEMS) and
                                LOCAL(SYSTEM) requests (enqs)


ELEMENTS=00000030   RNL          ELEMENTS=major names' number
                                 RNL=action taken by GRS

00000358                  RESERVE
00000316                  SYSTEM
00000002                  SYSTEM
00000216                  SYSTEM
00000036                  RESERVE
00000020                  SYSTEM
00000286               E*RESERVE
00000054                  SYSTEM
00000130                  SYSTEM
00000034               C*SYSTEMS
00000036                  SYSTEM
00000022                  SYSTEMS
00000316                  RESERVE
00000012                  SYSTEM
00000436                I*SYSTEMS
00000004                N SYSTEMS

C*  ->  RESERVE-converted       SYSTEMS   HW-RESERVE eliminated
E*  ->  RESERVE-excluded        SYSTEM    HW-RESERVE issued
I*  ->  system -included   from SYSTEM    to SYSTEMS
E*  ->  systems-excluded   from SYSTEMS   to SYSTEM
N   ->  RNL=NO     request
```

Figure 20. AUDIT MODIFY Option T Example

The command MODIFY option T=major lists the minor names used by the selected major name. For a sample output see Figure 21.

```
F JOBNAME,T=SYSVTOC

Rt COUNT VOLSER  DEVNO  MAX   ELAPSED SEC  AVE    MIN    MAX   TOTAL
min.                    RES.               msec.msec.msec.sec.
--------------------------------------
00000047 SYSVTOC      RESERVE
00 00010 STS002   STS002                  000183 000071 000325 000001
00 00014 RUBB01   RUBB01                  000114 000046 000153 000001
00 00003 PR0002   PR0002                  000108 000057 000141 000000
00 00007 PR0001   PR0001                  000130 000068 000147 000000
00 00001 HSMMG5   HSMMG5                  000067 000067 000067 000000
00 00002 HSMMG4   HSMMG4                  000102 000047 000158 000000
00 00002 HSMMG3   HSMMG3                  000122 000061 000184 000000
00 00004 HSMMG2   HSMMG2                  000216 000166 000306 000000
00 00002 HSMMG1   HSMMG1                  000093 000050 000137 000000
00 00002 DB0002   DB0002                  000156 000152 000161 000000
```

Figure 21. AUDIT MODIFY Option T=Major Example

The MODIFY command option V lists the volumes with RESERVE activities. For a sample output see Figure 22 on page 49 and Figure 23 on page 49.

```
F JOBNAME,V

COUNT    VOLSER  DEVNO  MAX   ELAPSED SEC  AVE    MIN    MAX   TOTAL
                        RES.               msec.msec.msec.sec.
00000125 STSO04  02AD   04   *00002102*   000047 000012 001546 000005
00000650 STSO02  01A6   04   *00002692*   000041 000008 002156 000027
00000773 STSO01  01AD   06   *00002626*   000046 000006 002558 000035
00000205 RUBB01  0234   03   *00002638*   000021 000006 000163 000004
00000002 RES43B  023B   01   *00001592*   000097 000089 000105 000000
00000004 PR0003  02AF   01   *00000213*   000197 000143 000231 000000
00000003 HSMMG2  01A3   01   *00001032*   000232 000183 000306 000000
00000013 HSMMG1  01A1   02   *00001032*   000089 000018 000342 000001
00000110 DB0002  01AA   02   *00001821*   000018 000006 000152 000001
00000039 DB0001  01A9   02   *00000615*   000012 000006 000119 000000
00002469 CAT430  023C   03   *00002698*   000214 000006 001243 000529
```

Figure 22. AUDIT MODIFY Option V Example

The MODIFY command option V=volser lists the RESERVE requests issued against the selected volume. For a sample output see Figure 23.

```
F JOBNAME,V=CAT430

Rt COUNT VOLSER  DEVNO  MAX   ELAPSED SEC  AVE    MIN    MAX   TOTAL
min.                    RES.               msec.msec.msec.sec.

00001352 CAT430  023C   03   *00001922*   000272 000006 001243 000369
--------------------------------------------
00 00479 SYSZVVDS CAT430                  000016 000004 000187 000007
02 00065 SYSZRACF SYS1.RACF               000033 000016 000140 000002
10 00329 SYSZJES2 CAT430SYS1.HASPCKPT     001096 001064 001243 000359
00 00479 SYSIGGV2 CATALOG.CAT430          000019 000005 000188 000009

First two digits = Rate per minute
```

Figure 23. AUDIT MODIFY Option V=Volser Example

The MODIFY command options T=FREEMAIN and V=FREEMAIN can be used to reinitialize the dataspace without stopping and restarting the monitor.

The MODIFY option R command shows the active RNL’s entries used.

Messages - Abends - Return Codes

Figure 24 on page 50 lists the messages issued by ENQ Monitor. They are self-explanatory.

```
 - ISGAU001  -  INVALID REQUEST

               modify command with wrong parameter

 - ISGAU002  -  FILTER TABLE NOT FOUND

               program continues with the old filter table

- ISGAU002  -  FILTER TABLE UNCHANGED

               program continues with the old filter table

- ISGAU002  -  SPECIFIED TABLE IS THE SAME AS THE
                     CURRENT TABLE

               program continues with the old filter table

 - ISGAU003  -  MODIFY REQUEST DONE

 - ISGAU004  -  PARM FIELD NOT VALID

               program ends during initialization

 - ISGAU005  -  AUDIT ALREADY ACTIVE

               job submitted/started twice



 - ISGAU007  -  DDNAME  FULL, PLEASE SAVE

               dynamic switch to the other output data set

 - ISGAU008  -  FILTERxx ACTIVE                - response to MODIFY,L
            -  ddname   ACTIVE
            -  I=xxxxxx L=yyyyyyyy ENQ-DELAY=zzzzzzzz
            -  I=xxxxxx L=yyyyyyyy ENQ-DELAY=zzzzzzzz RESMIL=wwww

 - ISGAU009  -  DATA SET SWITCHED            - response to MODIFY,S

 - ISGAU009  -  DATA SET NOT SWITCHED -
                     DATA SET MAY BE FULL

               Output dataset will not switch

 - ISGAU010  -  FILTER RE-INITIALIZED        - response to MODIFY,I=xx

 - ISGAU012  -  BOTH OUTPUT DATA SETS ARE FULL

 - ISGAU013  -  ISGAMCST NOT AVAILABLE

 - ISGAU014  -  CANNOT STOP MONITOR -
                      SYSTEM LX NOT AVAILABLE

                     ENQ Monitor cannot be started

 -  ISGAU014  -  CANNOT START MONITOR -
                        NO COMMON STORAGE

                     ENQ Monitor cannot be started

 -  ISGAU014  -  CANNOT START MONITOR -
                        NO PRIVATE STORAGE

                     ENQ Monitor cannot be started
```

Figure 24. AUDIT Messages

The abend issued by the monitor is shown in Figure 25.

```
- ABEND 1FF

          RC=8    STOP/MODIFY PROBLEMS
```

Figure 25. AUDIT Abends

The monitor terminates if both output data sets are full or an unexpected error occurs. For any abend conditions, the monitor will write a logrec record for diagnostic information.

Filter Facility

This monitor uses a filter facility to determine what resources will be monitored and what data will be collected by the monitor. The default filter is ISGAMF08. Example of a filter is shown in Figure 26 on page 54.

The name of the active filter can be displayed with command:

```
F JOBNAME,L
```

and can be dynamically changed with command:

```
F JOBNAME,I=xx
```

The name of the filter should be ISGAMFxx. xx can range from 00 to 09.

Sample filter ISGAMF00 in SYS1.SAMPLIB is an exact copy of the default member ISGAMF08. If filter needs to be changed, it should be assembled and linkedited in an authorized library or SYS1.LINKLIB with AC(0).

Two macros are used to build the filter option.

- The macro **GFLG** used to generate the flag byte to control the monitor. **This macro must be used only once in the table.** The GFLAG also controls the interception of scope **STEP** requests (STEP=Y is recommended to discard all the STEP requests).

```
GFLG  FILTER=Y/N,MATCH=Y/N,STEP=Y/N

     FILTER  =  N (TRACE ALL)

                DEFAULT=Y

     MATCH   =  Y (TRACE IF A NAME ENTRY MATCHES COLLECTED DATA)
     MATCH   =  N (DO NOT TRACE IF A NAME ENTRY MATCHES
                             COLLECTED DATA)

                DEFAULT=Y

     STEP    =  Y (TRACE   SCOPE=STEP REQUESTS)
             =  N (DISCARD SCOPE=STEP REQUESTS)

                DEFAULT=N
```

- The macro **NAME** used to generate the names' list. The possible types of a NAME can be MAJOR, MINOR and JOB/STC/TSU.

```
NAME  N=,M=,T=,[L=]

          N= Major name        1 to  8 chars

          M= Minor name        1 to 52 chars

          T=type on entry   U=Resource - Major & Minor names
                            M=Major name
                            J=jobname
                            S=started-task
                            T=tso-user

OPTIONAL ==>  L=length of compare - valid values 1-60
                default=length of character string (except
                for Major name which is considered 8 byte).
                If L is higher than character string, the NAME
                is padded with blanks.
                Used only with T=U,J,S,T
```

The trace control operates at **two hierarchical levels**.

1. Level one:
   - The resources whose MAJOR name is specified in a name entry with keyword **T=M** are not traced. For instance if the resources with major name SYSDSN have to be discarded the required coding is the following:

```
GFLG  FILTER=Y

SVCF                  /*this statement is required*/

NAME  N=SYSDSN,T=M
```

2. Level two:
   - The resources whose MAJOR and MINOR is specified in a NAME entry with keyword **T=U** are processed according to the GFLAG setup:
     – **GFLAG MATCH=Y** writes a trace entry if the ENQ/DEQ resource matches a name entry type=U
     – **GFLAG MATCH=N** writes a trace entry if the ENQ/DEQ resource does not match a name entry type=U

   Example 1: If the resources representing the temporary data sets for year ’96 (resource major SYSDSN minor SYS96039.xxxx.yyyy) have to be discarded, the required coding is:

```
GFLG  FILTER=Y,MATCH=N

SVCF                  /*this statement is required*/

NAME  N=SYSDSN,M=SYS96,T=U,L=13

    note: checked with length of 13 bytes
          (8 major name and first 5 minor name bytes)
```

   Example 2: If only the resources with major names SYSZVVDS and SYSIGGV2 have to be traced, the required coding is:

```
GFLG  FILTER=Y,MATCH=Y

SVCF                   /*this statement is required*/

NAME  N=SYSZVVDS,T=U,L=8        NAME  N=SYSIGGV2,T=U,L=8

    note: checked with length of 8 bytes
          (8 major name, any minor name)
```

- The resources used by JOB/STC/TSU whose name is specified in a NAME entry with keyword **T=J/S/T** are processed according to the GFLAG setup:
  - **GFLAG MATCH=Y** writes a trace entry if the requestor name matches a name entry type=J/S/T
  - **GFLAG MATCH=N** writes a trace entry if the requestor name does not match a name entry type=J/S/T

Example 3: To see all the resources used by started task TSO, NET and tso users starting with IPO1, (the resources with scope STEP are discarded by default), the required coding is:

```
GFLG  FILTER=Y,MATCH=Y

SVCF                   /*this statement is required*/

NAME  N=TSO,T=S,L=8
NAME  N=NET,T=S,L=8
NAME  N=IPO1,T=T,L=4

note: stcs TSO end NET checked with length of 8, name padded
      with five blanks.
```

The following table summarizes the possible combinations and actions of the filter:

GFLG	No-Match	Match (*)
FILTER=Y, MATCH=Y	No-Trace	Trace
FILTER=Y, MATCH=N	Trace	No-Trace
FILTER=N	Trace	Trace

(*)MATCH means that the resource name specified in a NAME entry type T=U matches the MAJOR and MINOR names of the ENQ/DEQ request, or for NAME entries type J/S/T, the job/stc/tso name matches the requestor.

The following is a filter coding sample.

```
*********************************************************************
*       SELECT ONE OF THE FOLLOWING
*       GFLAG DEFAULT FILTER=Y,MATCH=Y,STEP=N

GFLAG   EQU   *
*       GFLG  FILTER=N                       NO TRACE AT ALL
*
        GFLG  MATCH=N,FILTER=Y               NO MATCH -> TRACE
*
*       GFLG  MATCH=Y,FILTER=Y               MATCH    -> TRACE
*
*********************************************************************
*
        SVCF                       THIS STATEMENT IS REQUIRED
*
*********************************************************************
NAME1   EQU   *                    THIS STATEMENT IS REQUIRED
*********************************************************************
*       GENERATE THE NAME TABLE ENTRY WITH THE MACRO NAME
*
        NAME  N=SYSZTIOT,T=M        MAJOR NAME 'SYSZTIOT' NOT TRACED
        NAME  N=SYSZJWTP,T=M        MAJOR NAME 'SYSZJWTP'     "
        NAME  N=SYSZJES2,M=CVCB,T=U,L=12
        NAME  N=SYSDSN,M=SYS96,L=13,T=U
*
* Note:
* The GFLAG requests TRACE for NO-MATCH.
* The resources with the following MAJOR & MINOR are NOT TRACED
*
*       SYSZTIOT                all major SYSZTIOT
*       SYSZJWTP                all major SYSZJWTP
*       SYSZJES2 CVCB           checked with length of 12 chars.(8+4)
*       SYSDSN SYS96            checked with length of 13 chars.(8+5)
* (temp dsn for year '96)
*
**********************************************************************
```

Figure 26. Filter Coding Example

Reports

Programs and JCL procedures are provided to generate three reports from the collected data. Three procedures are for single MVS system input, and three are for multiple MVS systems input to support sysplex. For multiple systems, input to the procedures is concatenated. These programs do not require authorization.

They are:

1. Procedure ISGAJE1 for **sequential trace report** with single MVS system input. Program used is ISGAMED1. The output generated is shown in Figure 35 on page 72.
2. Procedure ISGAJE1A for **sequential trace report** with multiple MVS systems input. Programs used are ISGAMED2, ISGAMED3 and SORT. The output generated is shown in Figure 36 on page 73.

   The reports contain the following information:

   - Date and time of the request.
   - SMF system id.
   - Jobname of the requester.
   - Program name of the requester.
   - Module authorization information (only for ISGAJE1).
   - SVC type.

- RNL action.
- Scope of the request.
- Volume serial for reserve requests.
- Major and minor name
- Device number for reserve requests.
- Minor name length.

3. Procedure ISGAJE2 for **volume reserve time report** with single MVS system input.
4. Procedure ISGAJE2A for **volume reserve time report** with multiple MVS systems input. The output generated is shown in Figure 37 on page 74.

   Programs used are ISGAMEDM - ISGAMVOL - ISGAMCTM - ISGAMMRT and SORT.

   For every volume with reserve activity the following is given:

   - Count of reserve requests.
   - Time when the volume had the longest reserve.
   - Highest volume reserve count.
   - Average, minimum and maximum reserve time in msec.
   - Total reserve time in sec.
   - Reserve rate per minute.
   - The list of resources that reserved the volume with the timing information.

   The output is sorted by volume reserve time for ISGAJE2 and by SMF system id and volser for JCL652A.
5. Procedure ISGAJE3 for **resource report** with single MVS system input.
6. Procedure ISGAJE3A for **resource report** with multiple MVS systems input. The output generated is shown in Figure 38 on page 75.

   Programs used are ISGAMEDM - ISGAMCNT - ISGAMSRT - ISGAMERN and SORT.

   For each major name the following is given:

   - Count of ENQ requests.

     Note: If DEQ is issued for each ENQ, the total count of requests for the resource is doubled.
   - Scope of the request.
   - SMF system id.
   - List of minor names used with the RNL action:
     a. *C reserve-converted --> SYSTEMS and NO-HW-RESERVE
     b. *E reserve-excluded --> SYSTEM and HW-RESERVE
     c. *E systems excluded --> SYSTEM
     d. *I system included --> SYSTEMS
     e. N keyword RNL=NO
     f. 'blank' no action
     g. Length of the minor name (ML).
     h. Timing information for reserve requests.

Logs

The volume-reserve-time procedure on STEP002 generates on LOG2 DD statement the list of RESERVE/RELEASE activity from which the report is generated. With the time of the longest continuous reserve given in the volume report, it is possible to find in the LOG2 data set the names of the resources involved. If the above information is not required, the LOG2 DD statement can be specified as DUMMY. Figure 39 on page 76 gives an example for Reserve/Release trace at time of Max.

On STEP007 the ISGAMMRT program on LOGV DD statement, logs the VOLUME list from which the report is created. The ISGAMMRT program also creates on LOGR DD statement a data set with the reserve resource names with the time statistics.

NOTE

Because the LOGR data set is required by the resources-usage-procedure, the procedure for volume-reserve-time should be run **before** the resources-usage-procedure.

If LOGR data set is specified as DUMMY, the resources-usage will not have the timing information.

The resources-usage procedure on STEP007, generates on LOG1 output dd statement the MAJOR by SCOPE names from which the report is created. If the above information is not required, the LOG1 DD statement can be specified as DUMMY.

All the reports and logs can be spool, tape or disk data sets.

ATTENTION

The reserve timing are incorrect if reserve requests are discarded with the filter, if data are lost, and if a job is cancelled or ABEND with an active reserve.

Temporary Data Sets

The temporary data sets used by the procedures should be changed according to the size of the trace data set. The size can be substituted modifying the variable in the sample in-stream procedures.

In Stream Procedures Variables

```
VOLUME RESERVE TIME REPORT   -  procedure JCL2

INPUT -->  input data set name

OUT1  -->  Intermediate output  = 1.2 the size of input - CYLS

OUT2  -->  Intermediate output  = 2/3 the size of OUT1   - CYLS

OUT3  -->  Intermediate output  = 1 cylinder

WORK1 -->  sort workfile        = for OUT1 sorting       - CYLS

WORK2 -->  sort workfile        = 1 cylinder             - CYLS

LOGR  -->  data set name for LOGR


RESOURCES USAGE REPORT       -  procedure JCL3

INPUT -->  input data set name

OUT1  -->  Intermediate output  = 1.2 the size of input  - CYLS

WORK1 -->  sort workfile        = for OUT1 sorting       - CYLS

LOGR  -->  data set name for LOGR
```

Figure 27. In Steam Procedures Variables

Report Programs Parameters

The PARM field is supported by ISGAMEDM, ISGAMED1, ISGAMVOL, ISGAMMRT, ISGAMCNT and ISGAMERN and they allow:

- Selection by date and time with LOCAL TIME values. **ISGAMEDM-ISGAMED1 'PARM=DATE'**
- Difference between LOCAL TIME and the TOD (ABSOLUTE TIME) that is collected by the monitor. **ISGAMEDM-ISGAMED1 PARM=DELTA**
- Clear the input data set. **ISGAMED1 PARM=CLEAR** supported only with procedure ISGAJE1 (single MVS system input).
- Perform volume reserve time analysis for selected volumes. **ISGAMVOL PARM=volser**
- Limit the volume reserve time report to top xx volumes. **ISGAMMRT PARM=TOP**
- Limit the resources report to the selected MAJOR names. **ISGAMCNT PARM=major1,major2,majorx**
- Limit the resources report to resources with count higher than yy. **ISGAMERN PARM=COUNT**

The supported PARM values are shown in Figure 28 on page 58.

```
ISGAMEDM - ISGAMED1

  DATE=(yyddd.hhmm-yyddd.hhmm)   local-time
                      or

  DATE=(yyyyddd.hhmm-yyyyddd.hhmm)

  select   from   :     to
             (both must be specified)

   yyyy up to 9999
   yy    up to 99
   ddd  up to 366
   hh    up to 23
   mm   up to 59


  DELTA=(+]-h)

   local time delta from TOD

   h   from 0 to 12


  CLEAR

   input data set is cleared if it is not currently active
   with AUDIT. Supported only with procedure ISGAJE1


ISGAMVOL

 volume1,volume2,volumex

  volumes to process for reserve time report


ISGAMMRT

 TOP=xxxxxxxx          from  1 to 99999999

  list the top xx-xx volumes.


ISGAMCNT

 major1,major2,majorx

  major names to select for resources report


ISGAMERN

 COUNT=xxxxxxxx          from  1 to 99999999

  list the resources with use count high or equal to xx-xx.
```

Figure 28. PARM Supported by Report Programs

If a PARM keyword or a PARM value is not valid, the program terminates.

Region Requirements

The procedures for volume-reserve-time report and for resource-usage report require a region size below 16MB large enough to hold an internal table created by the programs. The table requires 144 byte of virtual storage for each resource name that has been requested by the RESERVE macro and 56 byte for each

DASD volume with reserve activity. For example, to process 10 thousand different resources and 300 volumes, 1.5MB of virtual storage will be used.

The ISGAMVOL program at the end of its processing issues messages about the number of table entries used.

```
ELEMENTS=00000988      (resource name entries)
     VOLUMES =00000105      (volumes  entries)
```

Use different selection during the sort steps to get different aggregation of the data collected. The layout of the output records generated by the programs are given in the appendix.

The following is the JCL for the reports' procedures:

```
//ISGAJE1  JOB CLASS=A,MSGCLASS=X
//*
//*        SEQUENTIAL TRACE REPORT
//*
//JOBLIB DD DSN=SYS1.MIGLIB,DISP=SHR
//STEP001  EXEC PGM=ISGAMED1,
//*
//*    TRACE REPORT
//*
//*Note: DNS=USERID.AUDIT.OUT1,DISP=SHR has to be modified to get the
//*      correct dataset.
//*
//INPUT  DD DSN=USERID.AUDIT.OUT1,DISP=SHR
//OUTPUT DD SYSOUT=*,
//       DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSUDUMP DD SYSOUT=*
```

Figure 29. JCL for Trace Report for Single MVS System Input

```
//ISGAJE1A JOB CLASS=A,MSGCLASS=X
//*
//*        SEQUENTIAL TRACE REPORT
//*
//*****************************************************************
//JOBLIB DD DSN=SYS1.MIGLIB,DISP=SHR
//JCL1A     PROC  WORK1=90,OUT1=300,
//             INPUT1=USERID.AUDIT.OUT1,
//             INPUT2=USERID.AUDIT.OUT2,
//             INPUT3=USERID.AUDIT.OUT3,
//             INPUT4=USERID.AUDIT.OUT4
//*            UP TO 32 INPUT DATA SETS
//*****************************************************************
//STEP001 EXEC PGM=ISGAMED2,
// PARM='DATE=(95215.0800:95215.1100),DELTA=(+2)'
//*****************************************************************
//*
//*   TRACE REPORT
//*
//*****************************************************************
//INPUT     DD DSN=&INPUT1,DISP=SHR
//          DD DSN=&INPUT2,DISP=SHR
//          DD DSN=&INPUT3,DISP=SHR
//          DD DSN=&INPUT4,DISP=SHR
//*         UP TO 32 INPUT DATA SETS
//OUTPUT    DD DSN=&&OUT2,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSUDUMP DD SYSOUT=*
//*
//STEP002   EXEC PGM=SORT,
//          COND=(0,LT,STEP001)
//*
//*         SORT  TOD
//*
//SORTIN    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD=DSN=&&OUT3,DISP=(,PASS), UNIT=SYSDA, SPACE=(CYL, &OUT1),
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP003   EXEC PGM=ISGAMED3,
//          COND=(0,LT,STEP001)
//*
//*         TRANSLATE TOD
//*
//INPUT     DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD SYSOUT=*,DCB=(LRECL=132,RECFM=FB,BLKSIZE=13200)
//SYSUDUMP  DD SYSOUT=*
//          PEND
//          EXEC  JCL1A
//STEP002.SYSIN DD *
 SORT FIELDS=(1,8,A),FORMAT=BI,FILSZ=E5000,EQUALS
```

Figure 30. JCL for Trace Report for Multiple MVS Systems Input

```
//ISGAJE2  JOB CLASS=A,MSGCLASS=X
//*
//*       VOLUMES RESERVE TIME REPORT
//*********************************************************************
//JCL2      PROC WORK1=30,WORK2=1,OUT1=90,OUT2=60,OUT3=1,
//           INPUT=USERID.AUDIT.OUT1,LOGR=USERID.LOGR
//*********************************************************************
//*
//*       VOLUMES RESERVE TIME REPORT
//*
//STEP001   EXEC PGM=ISGAMEDM,
//*         PARM='DELTA=(+2),DATE=(94011.0800:94012.0900)'
//INPUT     DD DSN=&INPUT,DISP=SHR
//OUTPUT    DD DSN=&&OUT2,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//STEP002   EXEC PGM=ISGAMVOL,
//          COND=(0,LT,STEP001)
//*         PARM='TPVOL ,XA9RES'
//*
//*       INSERTS VOLID AND RESERVE COUNT IN PROBABLE RELEASE
//*
//INPUT     DD DSN=&&OUT2,DISP=(OLD,PASS)
//OUTPUT    DD DSN=&&OUT3,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//OUTPUT1   DD DSN=&&OUT4,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT2),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//*OG2      DD DUMMY
//LOG2      DD SYSOUT=*,
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSDUMP   DD SYSOUT=*
//*
//STEP003   EXEC PGM=SORT,
//          COND=(0,LT,STEP002)
//*
//*      SORT  VOLID - SMFID
//*
//SORTIN    DD DSN=&&OUT3,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD DSN=&&OUT2,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP004   EXEC PGM=ISGAMCTM,
//          COND=(0,LT,STEP001)
//*
//* RESERVE TIME AND FREQUENCY
//*
//INPUT     DD DSN=&&OUT2,DISP=(OLD,PASS)
//*UTPUT    DD SYSOUT=*,DCB=(LRECL=132,RECFM=FB,BLKSIZE=13200)
//OUTPUT    DD DSN=&&OUT5,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT3),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//WORK      DD DSN=&&OUT3,DISP=(OLD,PASS)
//SYSUDUMP  DD SYSOUT=*
//STEP005   EXEC PGM=SORT,
//          COND=(0,LT,STEP001)
//*
//*     SORT  TOTAL VOLUME RESERVE TIME
//*
```

Figure 31. JCL for Volume Reserve Report for Single MVS System Input (Part 1 of 2)

```
//SORTIN    DD DSN=&&OUT5,DISP=(OLD,PASS)
//SORTOUT   DD DSN=&&OUT3,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//STEP006   EXEC PGM=SORT,
//          COND=(0,LT,STEP005)
//*
//*     SORT  TOTAL RESOURCE RESERVE TIME
//*
//SORTIN    DD DSN=&&OUT4,DISP=(OLD,PASS)
//SORTOUT   DD DSN=&&OUT2,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//STEP007   EXEC PGM=ISGAMMRT,
//          COND=(0,LT,STEP001),
//          PARM='TOP=20'
//*
//*     MERGE VOLUME AND RESOURCE DATA
//*
//INPUT1    DD DSN=&&OUT2,DISP=(OLD,PASS)
//INPUT2    DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD SYSOUT=*
//LOGV      DD SYSOUT=*
//LOGR      DD DSN=&LOGR,DISP=SHR
//SYSDUMP   DD SYSOUT=*
//          PEND
//          EXEC  JCL2
//STEP003.SYSIN DD *
 SORT FIELDS=(53,6,A,126,4,A),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP005.SYSIN DD *
 SORT FIELDS=(37,8,D),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP006.SYSIN DD  *
 SORT FIELDS=(110,10,D),FORMAT=BI,FILSZ=E5000,EQUALS
```

Figure 31. JCL for Volume Reserve Report for Single MVS System Input (Part 2 of 2)

```
//ISGAJE2A JOB CLASS=A,MSGCLASS=X
//*
//*        VOLUME RESERVE TIME REPORT
//******************************************************************
//JOBLIB DD DNS=SYS1.MIGLIB,DISP=SHR
//JCL2A     PROC  WORK1=90,WORK2=30,OUT1=300,OUT2=100,OUT3=1,
//           INPUT1='USERID.AUDIT.OUT1',LOGR='USERID.LOGR',
//           INPUT2='USERID.AUDIT.OUT2',
//           INPUT3='USERID.AUDIT.OUT3',
//           INPUT4='USERID.AUDIT.OUT4'
//*          UP TO 32 INPUT DATA SETS
//******************************************************************
//*
//*        VOLUME RESERVES TIME REPORT
//*
//******************************************************************
//STEP001   EXEC PGM=ISGAMEDM,
//          PARM='DELTA=(+2),DATE=(93202.1400:93203.0800)'
//INPUT     DD DSN=&INPUT1,DISP=SHR
//          DD DSN=&INPUT2,DISP=SHR
//          DD DSN=&INPUT3,DISP=SHR
//          DD DSN=&INPUT4,DISP=SHR
//*          UP TO 32 INPUT DATA SETS
//OUTPUT    DD DSN=&&OUT2,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LREC=132,RECFM=FB,BLKSIZE=18348)
//STEP002   EXEC PGM=ISGAMVOL,
//          COND=(0,LT,STEP001)
//*         PARM='TPVOL ,XA9RES'
//*
//*       INSERTS VOLID AND RESERVE COUNT IN PROBABLE RELEASES
//*
//INPUT     DD DSN=&&OUT2,DISP=(OLD,PASS)
//OUTPUT    DD DSN=&&OUT3,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LRECL=132,RECRM=FB,BLKSIZE=18348)
//OUTPUT1   DD DSN=&&OUT4,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&&OUT2),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//*OG2      DD DUMMY
//LOG2      DD SYSOUT=*,
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSUDUMP  DD SYSOUT=*
//*
//STEP003   EXEC PGM=SORT,
//          COND=(0,LT,STEP002)
//*
//*      SORT  VOLID AND SMFID
//*
//SORTIN    DD DSN=&&OUT3,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*,
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SUSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SUSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SUSDA,SPACE=(CYL,&WORK1)
//STEP004   EXEC PGM=ISAMCTM,
//          COND=(0,LT,STEP003)
//*
//* RESERVE TIME AND FREQUENCY
//*
```

Figure 32. JCL for Volume Reserve Report for Multiple MVS Systems Input (Part 1 of 2)

```
//INPUT     DD DSN=&&OUT2,DISP=(OLD,PASS)
//*UTPUT    DD SYSOUT=*,DCB=(LRECL=132,RECFM=FB,BLKSIZE=13200)
//OUTPUT    DD DSN=&&OUT5,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT3),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//WORK      DD DSN=&&OUT3,DISP=(OLD,PASS)
//SYSDUMP   DD SYSOUT=*
//STEP005   EXEC PGM=SHORT,
//          COND=(0,LT,STEP004)
//*
//*     SORT  VOLUME, SMFID, TOTAL VOLUME RESERVE TIME
//*
//SORTIN    DD DSN=&&OUT5,DISP=(OLD,PASS)
//SORTOUT   DD DSN=&&OUT5,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//STEP006   EXEC PGM=SHORT,
//          COND=(0,LT,STEP005)
//*
//*     SORT  TOTAL RESOURCE RESERVE TIME
//*
//SORTIN    DD DSN=&&OUT4,DISP=(OLD,PASS)
//SORTOUT   DD DSN=&&OUT2,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK2)
//STEP007   EXEC PGM=ISAMMRT,
//          COND=(0,LT,STEP006)
//*         PARM='TOP=20'
//*     MERGE VOLUME AND RESOURCE DATA
//*
//INPUT1    DD DSN=&&OUT2,DISP=(OLD,PASS)
//INPUT2    DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD SYSOUT=*
//LOGV      DD SYSOUT=*
//LOGR      DD DSN=&LOGR,DISP=SHR
//SYSUDUMP  DD SYSOUT=*
//          PEND
//          EXEC JCL2A
//STEP003.SYSIN DD *
 SORT FIELDS=(53,6,A,126,4,A),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP005.SYSIN DD *
 SORT FIELDS=(25,6,D,32,4,A,37,8,D),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP006.SYSIN DD *
 SORT FIELDS=(110,10,D),FORMAT=BI,FILSZ=E5000,EQUALS
```

Figure 32. JCL for Volume Reserve Report for Multiple MVS Systems Input (Part 2 of 2)

```
//ISGAJE3  JOB CLASS=A,MSGCLASS=X
//*      RESOURCES  REPORT
//*********************************************************************
//JCL3      PROC   WORK1=30,OUT1=180,INPUT=USERID.AUDIT.OUT1,
//          LOGR=USERID.LOGR
//*********************************************************************
//*
//*      RESOURCES REPORT
//*
//STEP001   EXEC PGM=ISGAMEDM,
//*         PARM='DATE=(93274.0800:93274.1300),DELTA=(+2)'
//INPUT     DD DSN=&INPUT,DISP=SHR
//OUTPUT    DD DSN=&&OUT2,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//STEP002   EXEC PGM=SORT,
//          COND=(0,LT,STEP001)
//*
//*      SORT SCOPE,  MAJOR/MINOR NAME,  SMFID
//*
//SORTIN    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD DSN=&&OUT3,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP003   EXEC PGM=ISGAMCNT,
//*         PARM=('SYSZRACF,SYSZJES2,SYSDSN')
//          COND=(0,LT,STEP002)
//*
//*      COUNT RESOURCE
//*
//INPUT     DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD DSN=&&OUT2,DISP=(OLD,PASS)
//SYSUDUMP  DD SYSOUT=*
//STEP004   EXEC PGM=SORT,
//          COND=(0,LT,STEP003)
//*
//*      SORT  MAJOR/SCOPE AND NUMBER OF REQUEST
//*
//SORTIN    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD DSN=&&OUT3,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP005   EXEC PGM=ISGAMSRT,
//          COND=(0,LT,STEP001)
//*
//*      INSERT COUNT FOR SORT
//*
//INPUT     DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*UTPUT    DD SYSOUT=*
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//STEP006   EXEC PGM=SORT,
//          COND=(0,LT,STEP005)
```

Figure 33. JCL for Resource Usage Report for Single MVS System Input (Part 1 of 2)

```
//*
//*      SORT  SCOPE AND NUMER OF MAJOR REQUEST
//*
//SORTIN    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD DSN=&&OUT3,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP007   EXEC PGM=ISGAMERN,
//          COND=(0,LT,STEP006),
//          PARM='COUNT=00000001'
//*
//*    COUNT RESOURCE WITH SAME SCOPE
//*
//INPUT    DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT   DD SYSOUT=*,
//         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//LOG1     DD SYSOUT=*,
//         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//*    LOGR IS CREATED BY  VOLUMES-RESERVE-TIME  REPORT
//LOGR     DD DSN=&LOGR,DISP=SHR
//SYSUDUMP  DD SYSOUT=*
//         PEND
//         EXEC  JCL3
//STEP002.SYSIN     DD *
 SORT FIELDS=(42,7,A,60,61,A,126,4,A),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP004.SYSIN     DD *
 SORT FIELDS=(61,8,A,42,7,A,11,8,D),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP006.SYSIN DD *
 SORT FIELDS=(42,7,A,20,8,D),FORMAT=BI,FILSZ=E5000,EQUALS
```

Figure 33. JCL for Resource Usage Report for Single MVS System Input (Part 2 of 2)

```
//ISGAJE3A JOB CLASS=A,MSGCLASS=X
//*
//*        RESOURCES REPORT
//*****************************************************************
//JOBLIB DD DSN=SYS1.MIGLIB,DISP=SHR
//JCL3A     PROC  WORK1=90,WORK2=30,OUT1=300,OUT2=150,OUT3=31,
//          INPUT1='USERID.AUDIT.OUT1',LOGR='USERID.LOGR',
//          INPUT2='USERID.AUDIT.OUT2',
//          INPUT3='USERID.AUDIT.OUT3',
//          INPUT4='USERID.AUDIT.OUT4'
//*         UP TO 32 INPUT DATA SETS
//*****************************************************************
//*
//*      RESOURCES REPORT
//*
//*****************************************************************
//STEP001   EXEC PGM=ISGAMEDM,
//*         PARM='DARE=(93202.1400:93203.0800) ,DELTA=(+2)'
//INPUT     DD DSN=&INPUT1,DISP=SHR
//          DD DSN=&INPUT2,DISP=SHR
//          DD DSN=&INPUT3,DISP=SHR
//          DD DSN=&INPUT4,DISP=SHR
//*         UP TO 32 INPUT DATA SETS
//OUTPUT    DD DSN=&&OUT2,DISP=(,PASS) ,UNIT=SYSDA,SPACE=(CYL,&OUT1),
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//STEP002   EXEC PGM=SORT,
//          COND=(0,LT,STEP001)
//*
//*      SORT SCOPE,  MAJOR, SMF-ID, MINOR
//*
//SORTIN    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*,
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD DSN=&&OUT3,DISP=(,PASS),UNIT=SYSDA,SPACE=(CYL,&OUT1)
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP003   EXEC PGM=ISGAMCNT,
//          COND=(0,LT,STEP002)
//*         PARM=('SYSZRACF,SYSZJES2,SYSDSN')
//*
//*      COUNT RESOURCE
//*
//INPUT     DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD DSN=&& OUT2,DISP=(OLD,PASS)
//SYSUDUMP  DD SYSOUT=*
//STEP004   EXEC PGM=SORT,
//          COND=0,LT,STEP003)
//*
//*      SORT  MAJOR/SCOPE AND NUMBER OF REQUEST
//*
```

Figure 34. JCL for Resource Usage Report for Multiple MVS Systems Input (Part 1 of 2)

```
//SORTIN    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*,
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD DSN=&&OUT3,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK03  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP005   EXEC PGM=ISGAMSRT
//          COND=(0,LT,STEP004)
//*
//*      INSERT COUNT FOR SORT
//*
//INPUT     DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*UTPUT    DD SYSOUT=*
//*         DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//STEP006   EXEC PGM=SORT,
//          COND=(0,LT,STEP005)
//*
//*      SORT  SCOPE, MAJOR, SMFID, NUMBER OF REQUESTS
//*
//SORTIN    DD DSN=&&OUT2,DISP=(OLD,PASS)
//*ORTOUT   DD SYSOUT=*
//*         DCB=(LREC=132,RECFM=FB,BLKSIZE=18348)
//SORTOUT   DD DSN=&&OUT3,DISP=(OLD,PASS)
//SYSOUT    DD DUMMY
//SORTWK01  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//SORTWK02  DD UNIT=SYSDA,SPACE=(CYL,&WORK1)
//STEP007   EXEC PGM=ISGAMERN,
//          COND=(0,LT,STEP006),
//          PARM='COUNT=00000001'
//*
//*    COUNT RESORCE WITH SAME SCOPE
//*
//INPUT     DD DSN=&&OUT3,DISP=(OLD,PASS)
//OUTPUT    DD SYSOUT=*,
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//LOG1      DD SYSOUT=*
//          DCB=(LRECL=132,RECFM=FB,BLKSIZE=18348)
//LOGR      DD DSN=&LOGR,DISP=SHR
//SYSUDUMP  DD SYSOUT=*
//          PEND
//          EXEC  JCL3A
//STEP002.SYSIN     DD *
SORT FIELDS=(42,7,A,126,4,A,60,61,A),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP004.SYSIN     DD *
SORT FIELDS=(61,8,A,42,7,A,11,8,D),FORMAT=BI,FILSZ=E5000,EQUALS
//STEP006.SYSIN DD *
SORT FIELDS=(42,7,A,60,8,A,126,4,A,20,8,D),FORMAT=BI,                 X
              FILSZ=E5000,EQUALS
```

Figure 34. JCL for Resource Usage Report for Multiple MVS Systems Input (Part 2 of 2)

Restrictions

The tool has some restrictions:

- The ENQ RET=TEST requests are traced, but they are discarded during data reduction.
- The maximum length of the minor name traced is 52 bytes (data set name length plus member name). The reported minor name length can be used to see if the minor name has been truncated.
- Data are collected at the entry of the SVC. If RNLs are active, the action is simulated.

- Only the first parameter list entry is traced for RESERVE requests.
- The maximum RESERVE time measurable is around 4 hours 45 minutes, the lowest reserve time is rounded to 1 millisecond.
- If the same RESERVE resource name (major and minor) is used for different volumes, the results are incorrect.
- The timings given in the volume-reserve-time procedure are incorrect if RESERVE requests are discarded with the filter.
- The timings given in the volume-reserve-time procedure are incorrect if a job is cancelled or ABENDs with an active RESERVE.
- The maximum ENQ delay-time measurable is 99.99 seconds.
- The RESERVE count is registered before the hardware reserve is issued. Therefore for volumes with high contention, it may be incorrect along with the measured reserve time.
- If DEQ requests are issued without outstanding reserve the measured reserve time may be incorrect. This has been noticed with CATALOG address space and HSM subsystem.
- In a global resource serialization complex, only the ENQ/DEQ issued in the system where the monitor is active are traced.
- The monitor encounters the same contention for the processor and storage as does any other address space in the system. Thus, even after the system grants the global resource request, the monitor may not receive control immediately because of processor or storage contention, and the ENQ delay measurement may not be accurate. It has been experienced that the tool can lose data if the global resource serialization ENQ delay exceeds 500 msec. or more.
- The NUMSYS (number of systems in the global resource serialization complex) value is updated periodically through an internal command or when a Modify command is entered.

Resources Used and Recommendations

The program does not use common virtual storage below 16M. Filter table and main table reside in ESQA.

The monitor starts with 200 buffers in provate storage. It can be expanded if more storage is required. Each buffer is 4K is size. It contains a header and 30 logical records.

The number of buffers depends on the numbers of events to trace and on the speed of the output device. A counter of lost events is maintained by the monitor and is displayed with the MODIFY L command. An indication of lost event is also written in the output data set. See “Monitor Physical Output Record” on page 70.

The main program writes the buffers on the sequential data sets using the macros WRITE - CHECK for each physical record and executes a TCLOSE after each buffer is written to the sequential data set. If 300 ENQ/DEQs are generated per second, 10 buffers will be written out in one second. This causes 10 I/O requests to the output data set. The data set can be allocated on a volume with DFW (DASD FAST WRITE) option active if the device cannot keep up with the I/O requests.

If the data collected in the dataspace is good enough for the analysis, specify the output data sets as DUMMY.

Diagnostic Information

The main program is protected with an ESTAE that retries for abends X'B37', X'D37', and X'E37' unless the two output data sets are full.

If the monitor abends, a software logrec is written for diagnostic information.

The data collection routine is protected with an FRR. If a problem happens, the FRR routine writes a record in the SYS1.LOGREC and flags the logical record header with the word ERRO.

If the ISPF application abends, the ABEND code is displayed on the panel and a dump is taken if a SYSUDUMP statement is present in the logon procedure.

Monitor Physical Output Record

The record written to the output data set is a physical buffer containing an header and 30 audit records.

Each AUDIT LOGICAL RECORD is 128 bytes long and the layout is given in “DSECT Monitor Physical and Logical Record” on page 77. The HEADER can have different contents, that is:

```
          C'PREC'            NORMAL RECORD

          c'ERRO'           ERROR DURING DATA COLLECTION - RETRIED
```

The record contains the TOD (ABSOLUTE TIME) when SVC was issued, the jobname, the program name, the type of request, the scope, the volume serial (for reserve), the major name, the minor name up to 52 characters, the minor name length, the device number (reserve), the RNL action and the SMF system identifier.

Monitor Utilization Hints

The following table lists monitor’s scope with reference pages.

Scope	Monitor facility	Reference
Monitor Installation		“Installation” on page 37
Monitor Execution		“Monitor Execution” on page 38
Monitor Control		“Monitor Control” on page 45
Report the resources names used	RESOURCES REPORT and ISPF APPLICATION	Figure 33 on page 65 Figure 10 on page 41
Measure the volume reserve time(*)	VOLUME REPORT and ISPF APPLICATION	Figure 31 on page 61 Figure 13 on page 44
Measure the rate and time of RESERVE requests(**)	RESOURCES REPORT and ISPF APPLICATION	Figure 33 on page 65 Figure 14 on page 44
Find programs/applications using a resource	TRACE REPORT and ISPF APPLICATION	Figure 29 on page 59 Figure 12 on page 43

Scope	Monitor facility	Reference
Find nested reserves causing high volume reserve	VOLUME REPORT and LOG2	“Logs” on page 56
Monitor the resources used by an application	FILTER MATCH with keywords J/S/T	“Filter Facility” on page 51
Monitor the unknown resources	FILTER NOMATCH with keywords M/U	“Filter Facility” on page 51
Interactively see the ENQ delay and the current RESMIL value	MODIFY option L and ISPF APPLICATION	Figure 19 on page 47 Figure 8 on page 40 Figure 11 on page 42
Interactively see the major/scope counts	MODIFY option T and ISPF APPLICATION	Figure 20 on page 48 Figure 8 on page 40
Interactively see the RNL’s tables action	MODIFY option T and ISPF APPLICATION	Figure 20 on page 48 Figure 10 on page 41

(*)The volume reserve time is incorrect if reserve requests are discarded with the filter facility or data are lost.

(**)Knowing the rate and time it is possible to choose between including the RESERVE requests in the CONVERSION or EXCLUSION RNL list.

```
--------------------------------------------------------------------------------------------------------------------------------
PROGRAM = NOT-PRB, no CDE associated            SCOPE -> RESERVE  XX = DEVICE RESERVE COUNT

AUT     = A, module  authorized                       -> RELEASE  XX = DEVICE RESERVE COUNT
        = L, from auth. library                       -> REL/SYS  XX = DEQ ASSOCIATED WITH RESER
                                                      -> SYSTEM(S)SH = SHARED
RNL     = N, keyword RNL=NO                           ->          EX = EXCLUSIVE
        = C* converted    SYSTEMS no HW-RESERVE       ->          G  = GENERIC DEQ
        = E* excluded     SYSTEM  +  HW-RESERVE       ->         ' ' = SYSTEM  DEQ
        = E* excluded     SYSTEM  from SYSTEMS        -> REL/SYS ' ' = SYSTEMS DEQ
        = I* included     SYSTEMS from SYSTEM

SMF     = SMF-ID

ML      = Minor Name Length

SVC     = ENQT, keyword RET=TEST
--------------------------------------------------------------------------------------------------------------------------------

     TIME     JOBNAME PROGRAM  AUT SVC RNL SCOPE     VOLSER   MAJOR     MINOR                                         DEV SMF  ML

DATE  1994 217

13 53.41.96  $FRANCOE SVC-255     ENQ  N SYSTEMS EX         AUDITCOD ENQDELAY                                          ISP1 08
13 53.41.96  $FRANCOE SVC-255     DEQ  N REL/SYS            AUDITCOD ENQDELAY                                          ISP1 08
13 53.41.96  $FRANCOE SVC-034     ENQ    SYSTEM  EX         SYSIEFSD Q10                                               ISP1 03
13 53.41.97  $FRANCOE SVC-034     DEQ    SYSTEM             SYSIEFSD Q10                                               ISP1 03
13 53.41.97  CATALOG  IGGPACDV AL DEQ    RELEASE 03 STS001  SYSZVVDS STS001                                            ISP1 08
13 53.41.97  CATALOG  IGGPACDV AL DEQ    RELEASE 02 STS001  SYSZVVDS STS001                                            ISP1 06
13 53.41.97  CATALOG  IGGPACDV AL DEQ    SYSTEM             SYSZVVDS CATALOG.TSOCAT1                                   ISP1 44
13 53.41.97  CATALOG  IGGPACDV AL DEQ    REL/SYS            SYSIGGV2 CATALOG.TSOCAT1                                   ISP1 20
13 53.41.97  CATALOG  IGGPACDV AL DEQ    REL/SYS            SYSIGGV2 ROC.SPAUL.SCRIPT                        CATALOG.  ISP1 88
13 53.43.62  $FRANCO  ISFMAIN   L ENQ    SYSTEM  EX         SDSFINDX ISF.HASPINDX                            RES42B    ISP1 50
13 53.43.73  $FRANCO  ISFMAIN   L DEQ    SYSTEM             SDSFINDX ISF.HASPINDX                            RES42B    ISP1 50
13 53.46.38  JES2     HASJES20 AL ENQ  E*RESERVE 01 CAT422  SYSZJES2 CAT422MVS422.SYS1.HASPCKPT                     0222ISP1 50
13 53.46.81  ROC      ISREDIT   L ENQ    RESERVE 01 STS002  SPFEDIT  ROC.CICSCO.SCRIPT                              01A6ISP1 44
13 53.46.81  ROC      SVC-019     ENQ    SYSTEMS EX         SYSZDSCB STS002AROC.CICSCO.SCRIPT                          ISP1 24
13 53.47.13  $FRANCO  ISFMAIN   L ENQ    SYSTEM  EX         SDSFINDX ISF.HASPINDX                            RES42B    ISP1 50
13 53.47.22  $FRANCO  ISFMAIN   L DEQ    SYSTEM             SDSFINDX ISF.HASPINDX                            RES42B    ISP1 50
13 53.47.42  ROC      SVC-019     ENQ    SYSTEMS EX         SYSZDSCB STS002SROC.CICSCO.SCRIPT                          ISP1 24
13 53.47.45  ROC      SVC-019     DEQ    REL/SYS            SYSZDSCB STS002SROC.CICSCO.SCRIPT                          ISP1 24
13 53.47.45  ROC      SVC-019     DEQ    REL/SYS            SYSZDSCB STS002AROC.CICSCO.SCRIPT                          ISP1 24
13 53.47.45  ROC      ISREDIT   L DEQ    REL/SYS            SPFEDIT  ROC.CICSCO.SCRIPT                                 ISP1 44
13 53.47.50  JES2     HASJES20 AL DEQ    RELEASE 00 CAT422  SYSZJES2 CAT422MVS422.SYS1.HASPCKPT                        ISP1 50
13 53.48.13  ROC      ISREDIT   L DEQ    REL/SYS            SPFEDIT  ROC.CICSCO.SCRIPT                       ESE1      ISP1 52
13 53.50.68  SMS      IGDICMT0 AL ENQ    SYSTEM  EX         SYSZIGDI ICMRT.CMDSADDR_LOCKED                             ISP1 21
13 53.50.68  SMS      IGDICMT0 AL ENQ    RESERVE 01 STS002  IGDCDSXS SMS.IPC1.COMMDS                                01A6ISP1 44
13 53.50.73  SMS      IGDICMT0 AL DEQ    RELEASE 00 STS002  IGDCDSXS SMS.IPC1.COMMDS                                   ISP1 44
13 53.50.74  SMS      IGDICMT0 AL DEQ    SYSTEM             SYSZIGDI ICMRT.CMDSADDR_LOCKED                             ISP1 21
13 53.51.15  $FRANCO4 SVC-099     ENQ  I*SYSTEMS EX         SYSDSN   PROVA                                             ISP1 05
13 53.51.18  $FRANCO4 SVC-099     ENQ    SYSTEM  EX         SYSIEFSD Q4                                                ISP1 02
13 53.51.19  $FRANCO4 SVC-026     ENQ  C*SYSTEMS EX MVS4R1  SYSVTOC  MVS4R1                                            ISP1 06
13 53.51.20  $FRANCO4 SVC-026     DEQ    REL/SYS            SYSVTOC  MVS4R1                                            ISP1 06
13 53.51.20  ELOESA2  SVC-216     ENQ    SYSTEM  EX         SYSZLLA1 UPDATE                                            ISP1 06
13 53.51.25  ELOESA2  SVC-216     DEQ    SYSTEM             SYSZLLA1 UPDATE                                            ISP1 06
13 53.51.25  LLA      CSVLLCRE AL ENQ    SYSTEM  EX         SYSZLLA1 UPDATE                                            ISP1 06
13 53.51.31  LLA      CSVLLCRE AL DEQ    SYSTEM             SYSZLLA1 UPDATE                                            ISP1 06
13 53.51.79  PER      ISREDIT   L ENQ    RESERVE 01 PR0001  SPFEDIT  DISO34.INSTLIB                                 01ABISP1 44
13 53.52.00  PER      SVC-019     DEQ    REL/SYS            SYSZDSCB PR0001SDISO34.INSTLIB                             ISP1 21
13 53.52.00  PER      SVC-019     DEQ    REL/SYS            SYSZDSCB PR0001ADISO34.INSTLIB                             ISP1 21
13 53.52.00  PER      ISREDIT   L DEQ    REL/SYS            SPFEDIT  DISO34.INSTLIB                                    ISP1 44
13 53.52.07  PER      ISREDIT   L DEQ    REL/SYS            SPFEDIT  DISO34.INSTLIB                          DSVFPM    ISP1 52
13 53.52.53  JES2     HASJES20 AL ENQ    RESERVE 01 CAT422  SYSZJES2 CAT422MVS422.SYS1.HASPCKPT                     0222ISP1 50
13 53.53.24  $FRANCO  SVC-034     ENQ    SYSTEM  EX         SYSIEFSD Q10                                               ISP1 03
13 53.53.24  $FRANCO  SVC-034     DEQ    SYSTEM             SYSIEFSD Q10                                               ISP1 03
13 53.53.30  $FRANCOE SVC-034     ENQ    SYSTEM  EX         SYSIEFSD Q10                                               ISP1 03
13 53.53.30  $FRANCOE SVC-034     DEQ    SYSTEM             SYSIEFSD Q10                                               ISP1 03
13 53.53.63  JES2     HASJES20 AL DEQ    RELEASE 00 CAT422  SYSZJES2 CAT422MVS422.SYS1.HASPCKPT                        ISP1 50
13 53.53.83  ROC      ISREDIT   L ENQ    SYSTEMS EX         SPFEDIT  ROC.CICSCO.SCRIPT                       HEAD1     ISP1 52
13 53.55.12  $FRANCO  ISFMAIN   L ENQ    SYSTEM  EX         SDSFINDX ISF.HASPINDX                            RES42B    ISP1 50
13 53.55.24  $FRANCO  ISFMAIN   L DEQ    SYSTEM             SDSFINDX ISF.HASPINDX                            RES42B    ISP1 50
13 53.56.32  ELOESA2  SVC-216     ENQ    SYSTEM  EX         SYSZLLA1 UPDATE                                            ISP1 06
```

Figure 35. Trace Report for Single MVS System

```
----------------------------------------------------------------------------------------------------------------------------
PROGRAM = NOT-PRB, no CDE associated            SCOPE -> RESERVE  XX = DEVICE RESERVE COUNT

                                                      -> RELEASE  XX = DEVICE RESERVE COUNT
                                                      -> REL/SYS  XX = DEQ ASSOCIATED WITH RESER
                                                      -> SYSTEM(S)SH = SHARED
RNL     = N, keyword RNL=NO                           ->          EX = EXCLUSIVE
        = C* converted    SYSTEMS no HW-RESERVE       ->          G  = GENERIC DEQ
        = E* excluded     SYSTEM  +  HW-RESERVE       ->         ' ' = SYSTEM  DEQ
        = E* excluded     SYSTEM  from SYSTEMS        -> REL/SYS ' ' = SYSTEMS DEQ
        = I* included     SYSTEMS from SYSTEM

SMF     = SMF-ID

ML      = Minor Name Length

SVC     = ENQT, keyword RET=TEST
----------------------------------------------------------------------------------------------------------------------------

REPORTING SMFID=SC47       START=(1995.248 - 07:37.59.120)       END=(1995.248 - 07:39.25.768)
REPORTING SMFID=SC49       START=(1995.248 - 07:38.09.870)       END=(1995.248 - 07:39.23.449)
REPORTING SMFID=SC52       START=(1995.248 - 07:37.50.468)       END=(1995.248 - 07:38.46.077)
SELECTION DATE=(95240.0800:95255.1100)
----------------------------------------------------------------------------------------------------------------------------
     TIME   SMFID JOBNAME  PGMNAME SVC RNL SCOPE     VOLSER  MAJOR     MINOR                                        DEV      ML

DATE  1995 248

07 38.15.89 SC54 SMS      IGDICMT0 ENQ   SYSTEM  EX         SYSZIGDI  ICMRT.CMDSADDR_LOCKED                                   2
07 38.15.89 SC54 SMS      IGDICMT0 ENQ C*SYSTEMS EX TOTCAT  IGDCDSXS  SYS1.COMMDS10                                0FC7   4
07 38.15.93 SC54 SMS      IGDICMT0 DEQ C*SYSTEMS    TOTCAT  IGDCDSXS  SYS1.COMMDS10                                       4
07 38.15.94 SC54 SMS      IGDICMT0 DEQ   SYSTEM             SYSZIGDI  ICMRT.CMDSADDR_LOCKED                               2
07 38.15.98 SC47 SMS      IGDICMT0 ENQ   SYSTEM  EX         SYSZIGDI  ICMRT.CMDSADDR_LOCKED                               2
07 38.15.98 SC47 SMS      IGDICMT0 ENQ C*SYSTEMS EX TOTCAT  IGDCDSXS  SYS1.COMMDS10                                0FC7   4
07 38.16.05 SC47 SMS      IGDICMT0 DEQ C*SYSTEMS    TOTCAT  IGDCDSXS  SYS1.COMMDS10                                       4
07 38.16.05 SC47 SMS      IGDICMT0 DEQ   SYSTEM             SYSZIGDI  ICMRT.CMDSADDR_LOCKED                               2
07 38.16.14 SC52 *MASTER* SVC-076  ENQ   SYSTEM  EX         SYSZLOGR  RECORDER                                            0
07 38.16.14 SC52 DUMPSRV  IEAVTSDS ENQ   SYSTEM  EX         SYSIEA01  SDPOSTEX                                            0
07 38.16.14 SC52 DUMPSRV  IEAVTSDS DEQ   SYSTEM             SYSIEA01  SDPOSTEX                                            0
07 38.16.14 SC52 *MASTER* SVC-076  DEQ   SYSTEM             SYSZLOGR  RECORDER                                            0
//                        //                                //
07 38.25.78 SC47 DUMPSRV  SVC-083  DEQ   SYSTEM             SYSZDRK      U83                                             08
07 38.25.94 SC54 SMS      IGDICMT0 ENQ   SYSTEM  EX         SYSZIGDI ICMRT.CMDSADDR_LOCKED                               21
07 38.25.94 SC54 SMS      IGDICMT0 ENQ C*SYSTEMS EX TOTCAT  IGDCDSXS SYS1.COMMDS10                                0FC7   44
07 38.26.01 SC54 SMS      IGDICMT0 DEQ C*SYSTEMS    TOTCAT  IGDCDSXS SYS1.COMMDS10                                       44
07 38.26.01 SC54 SMS      IGDICMT0 DEQ   SYSTEM             SYSZIGDI ICMRT.CMDSADDR_LOCKED                               21
07 38.26.04 SC52 *MASTER* SVC-076  ENQ   SYSTEM  EX         SYSZLOGR RECORDER                                            08
07 38.26.04 SC52 DUMPSRV  IEAVTSDS ENQ   SYSTEM  EX         SYSIEA01 SDPOSTEX                                            08
07 38.26.04 SC52 DUMPSRV  IEAVTSDS DEQ   SYSTEM             SYSIEA01 SDPOSTEX                                            08
```

Figure 36. Trace Report for Multiple MVS Systems

```
------------------------------------------------------------------------------------------------------------------------------------
** VOLUME CAT410 **
-------------------
START=1992.26610.15.28   END=1992.26710.45.26   VOLUME=CAT410    SMFID=ISP1     ELAPSED SECONDS=00000120

 COUNT   TIME OF MAX                             DEV  MAX-COUNT SMFID  VOLUME  AV-MSEC   MIN-MSEC  MAX-MSEC  TOTAL-SEC RATE/MIN

0002694592.266 13.05.00.36                      02AB       05   ISP1  CAT410  00000600  00000005  00003218  00016157  00000019

00014535 SYSZJES2 CAT410SYS1.HASPCKPT                                  CAT410  00001106  00001076  00007264  00016059  00000010
00006032 SYSIGGV2 CATALOG.CAT410                                       CAT410  00000021  00000000  00001787  00000131  00000004
00006048 SYSZVVDS CAT410                                               CAT410  00000017  00000004  00000695  00000104  00000004
00000307 SYSZRACF SYS1.RACF.BKUP1                                      CAT410  00000084  00000042  00000228  00000025  00000000
00000001 SYSIGGV2 CATALOG.TSOCAT2                            CATALOG.  CAT410  00000517  00000517  00000517  00000000  00000000
00000002 SYSIGGV2 DSMUTMSG.TEXT                              CATALOG.  CAT410  00000370  00000247  00000493  00000000  00000000
00000001 SYSIGGV2 DSMAPA1.TEXT                               CATALOG.  CAT410  00000132  00000132  00000132  00000000  00000000
00000010 SYSZVVDS CAT410                                               CAT410  00000045  00000026  00000127  00000000  00000000
00000008 SYSZVVDS CAT410                                               CAT410  00000031  00000031  00000032  00000000  00000000
00000002 SYSIGGV2 @PL.@W000002.DZJOPTWS                      CATALOG.  CAT410  00000013  00000012  00000015  00000000  00000000

------------------------------------------------------------------------------------------------------------------------------------
** VOLUME CICS01 **
-------------------
START=1992.26611.00.01   END=1992.26710.00.02   VOLUME=CICS01    SMFID=ISP1     ELAPSED SECONDS=00000120

 COUNT   TIME OF MAX                             DEV  MAX-COUNT SMFID  VOLUME  AV-MSEC   MIN-MSEC  MAX-MSEC  TOTAL-SEC RATE/MIN

0000026392.266 16.35.26.62                      02A6        03  ISP1   CICS01  00000021  00000005  00000364  00000005  00000000

00000181 SYSZVVDS CICS01                                               CICS01  00000017  00000005  00000080  00000003  00000000
00000024 SYSVTOC  CICS01                                               CICS01  00000080  00000055  00000141  00000001  00000000
00000050 SYSIGGV2 CATALOG.CIC210                                       CICS01  00000028  00000008  00000364  00000001  00000000
00000004 SYSIGGV2 CATALOG.CIC161                                       CICS01  00000048  00000027  00000092  00000000  00000000
00000002 SYSZVVDS CICS01                                               CICS01  00000039  00000025  00000053  00000000  00000000
00000001 SYSIGGV2 NVAS2.AEMSAMP0                             CATALOG.  CICS01  00000021  00000021  00000021  00000000  00000000

------------------------------------------------------------------------------------------------------------------------------------
** VOLUME DB0001 **
-------------------
START=1992.26611.00.03   END=1992.26710.00.04   VOLUME=DB0001    SMFID=ISP1     ELAPSED SECONDS=00000120

 COUNT   TIME OF MAX                             DEV  MAX-COUNT SMFID  VOLUME  AV-MSEC   MIN-MSEC  MAX-MSEC  TOTAL-SEC RATE/MIN

0000017692.266 16.33.13.83                      01A9        01  ISP1   DB0001  00000024  00000005  00000211  00000004  00000000

00000149 SYSZVVDS DB0001                                               DB0001  00000017  00000005  00000211  00000002  00000000
00000027 SYSVTOC  DB0001                                               DB0001  00000058  00000045  00000112  00000001  00000000

------------------------------------------------------------------------------------------------------------------------------------
** VOLUME DB0001 **
-------------------
START=1992.26611150.35   END=1992.26710.23.34   VOLUME=DB0001    SMFID=ISP2     ELAPSED SECONDS=00000120

 COUNT   TIME OF MAX                             DEV  MAX-COUNT SMFID  VOLUME  AV-MSEC   MIN-MSEC  MAX-MSEC  TOTAL-SEC RATE/MIN

0000012092.267 12.12.33.47                      01A9        01  ISP2   DB0001  00000020  00000010  00000309  00000002  00000000

00000101 SYSZVVDS  DB0001                                              DB0001  00000017  00000010  00000309  00000002  00000000
00000019 SYSVTOC  DB0001                                               DB0001  00000068  00000045  00000080  00000001  00000000

------------------------------------------------------------------------------------------------------------------------------------
** VOLUME DB0002 **
-------------------
START=1992.26611.00.04   END=1992.26710.00.05   VOLUME=DB0002

 COUNT   TIME OF MAX                             DEV  MAX-COUNT SMFID  VOLUME  AV-MSEC   MIN-MSEC  MAX-MSEC  TOTAL-SEC RATE/MIN

0000013192.266 16.33.25.85                      01AA        01  ISP1   DB0002  00000025  00000005  00000143  00000003  00000000

00000103 SYSZVVDS DB0002                                               DB0002  00000018  00000005  00000143  00000001  00000000
00000028 SYSVTOC  DB0002                                               DB0002  00000052  00000039  00000121  00000001  00000000

------------------------------------------------------------------------------------------------------------------------------------
** VOLUME PR0002 **
-------------------
START=1992.26611.00.03   END=1992.26710.00.04   VOLUME=ISPDB4    SMFID=ISP1     ELAPSED SECONDS=00000120

 COUNT   TIME OF MAX                             DEV  MAX-COUNT SMFID  VOLUME  AV-MSEC   MIN-MSEC  MAX-MSEC  TOTAL-SEC RATE/MIN

0000010792.266 14.00.03.71                      02A5        02  ISP1   ISPDB4  00000030  00000005  00000135  00000003  00000000

00000076 SYSZVVDS ISPDB4                                               ISPDB4  00000016  00000005  00000059  00000001  00000000
00000024 SYSVTOC  ISPDB4                                               ISPDB4  00000078  00000058  00000135  00000001  00000000
00000007 SYSIGGV2 CATALOG.CSPDB4                                       ISPDB4  00000036  00000007  00000106  00000000  00000000

------------------------------------------------------------------------------------------------------------------------------------
```

Figure 37. Volumes Reserve Time Report

```
------------------------------------------------------------------------------------------------------------------------------------
** MAJOR  SYSZJES2 **
--------------------
 COUNT              MAJOR                                                      VOLUME  AV-MSEC MIN-MSEC MAX-MSEC  TOT-SEC  RATE/MIN
00001901           SYSZJES2           SCOPE=RESERVE              SMFID=ISP1

RNL (ML)   COUNT              MINOR

*E   50   00001901  SYSZJES2 CAT422MVS422.SYS1.HASPCKPT                        CAT422   001112  001077  00001391  00002034  000011
------------------------------------------------------------------------------------------------------------------------------------
** MAJOR  SYSZRACF **
--------------------
 COUNT              MAJOR                                                      VOLUME  AV-MSEC MIN-MSEC MAX-MSEC  TOT-SEC  RATE/MIN
00000968           SYSZRACF           SCOPE=RESERVE              SMFID=ISP1

RNL (ML)   COUNT              MINOR

09   00000966  SYSZRACF SYS1.RACF                                              CAT422   000049  000001  00000246  00000046  000005
15   00000002  SYSZRACF SYS1.RACF.BKUP1                                        RES42A   000130  000125  00000135  00000000  000000
------------------------------------------------------------------------------------------------------------------------------------
** MAJOR  SYSVTOC  **
--------------------
 COUNT              MAJOR                                                      VOLUME  AV-MSEC MIN-MSEC MAX-MSEC  TOT-SEC  RATE/MIN
00000750           SYSVTOC            SCOPE=RESERVE              SMFID=ISP1

RNL (ML)   COUNT              MINOR

06   00000490  SYSVTOC  RUBB01                                                 RUBB01   000148  000005  00001723  00000059  000002
          //       //
------------------------------------------------------------------------------------------------------------------------------------
 COUNT              MAJOR                                                      VOLUME  AV-MSEC MIN-MSEC MAX-MSEC  TOT-SEC  RATE/MIN
00000120           SYSVTOC            SCOPE=RESERVE              SMFID=ISP2

RNL (ML)   COUNT              MINOR

06   00000120  SYSVTOC  RUBB01                                                 RUBB01   000150  000010  00000756  00000018  000002
          //       //
------------------------------------------------------------------------------------------------------------------------------------
** MAJOR  SPFEDIT  **
--------------------
 COUNT              MAJOR                                                      VOLUME  AV-MSEC MIN-MSEC MAX-MSEC  TOT-SEC  RATE/MIN
00000358           SPFEDIT            SCOPE=RESERVE              SMFID=ISP1


RNL (ML)   COUNT              MINOR

44   00000107  SPFEDIT  DBR.PROFILE                                            PR0002   000174  000131  00000373  00000017  000000
44   00000050  SPFEDIT  ROC.PROFILE                                            STSO01   000224  000150  00000352  00000010  000000
          //         //
------------------------------------------------------------------------------------------------------------------------------------
** MAJOR  SYSIEFSD **
--------------------
 COUNT              MAJOR
00007167           SYSIEFSD           SCOPE=SYSTEM               SMFID=ISP1

RNL (ML)   COUNT              MINOR

02   00002189  SYSIEFSD Q4
          //      //
------------------------------------------------------------------------------------------------------------------------------------
** MAJOR  SYSDSN   **
--------------------
 COUNT              MAJOR
00000042           SYSDSN             SCOPE=SYSTEM               SMFID=ISP1

RNL (ML)   COUNT              MINOR

09   00000041  SYSDSN   SYS1.UADS
08   00000001  SYSDSN   SYS1.DAE
------------------------------------------------------------------------------------------------------------------------------------
** MAJOR  SYSDSN   **
--------------------
 COUNT              MAJOR
00001452           SYSDSN             SCOPE=SYSTEMS              SMFID=ISP1

RNL (ML)   COUNT              MINOR

I*   18   00000049  SYSDSN   DBR.ISR0001.BACKUP
I*   18   00000047  SYSDSN   FUM.ISR0001.BACKUP
          //          //
------------------------------------------------------------------------------------------------------------------------------------
```

Figure 38. ENQ/RESERVE Resources Report

```
16 58.59.98  IPOUSR4  NOT-PRB     DEQ    REL/SYS 00 XA9RES  SYSVTOC  XA9RES                                    IPO1

16 59.02.48  JES2     HASJES20 AL ENQ    RESERVE 01 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                   01C5IPO1

16 59.09.91  CATALOG  IGGPACDV AL ENQ    RESERVE 02 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                 01C5IPO1
16 59.09.91  CATALOG  IGGPACDV AL ENQ    RESERVE 03 XA9RES  SYSZVVDS XA9RES                                01C5IPO1
16 59.09.94  CATALOG  IGGPACDV AL DEQ    RELEASE 02 XA9RES  SYSZVVDS XA9RES                                    IPO1
16 59.10.03  CATALOG  IGGPACDV AL DEQ    REL/SYS 01 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                     IPO1
16 59.10.69  CATALOG  IGGPACDV AL ENQ    RESERVE 02 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                 01C5IPO1
16 59.10.70  CATALOG  IGGPACDV AL ENQ    RESERVE 03 XA9RES  SYSZVVDS XA9RES                                01C5IPO1
16 59.10.72  CATALOG  IGGPACDV AL DEQ    RELEASE 02 XA9RES  SYSZVVDS XA9RES                                    IPO1
16 59.10.76  CATALOG  IGGPACDV AL DEQ    REL/SYS 01 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                     IPO1
16 59.10.91  CATALOG  IGGPACDV AL ENQ    RESERVE 02 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                 01C5IPO1
16 59.10.91  CATALOG  IGGPACDV AL ENQ    RESERVE 03 XA9RES  SYSZVVDS XA9RES                                01C5IPO1
16 59.10.96  CATALOG  IGGPACDV AL DEQ    RELEASE 02 XA9RES  SYSZVVDS XA9RES                                    IPO1
16 59.10.98  CATALOG  IGGPACDV AL DEQ    REL/SYS 01 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                     IPO1
16 59.11.13  CATALOG  IGGPACDV AL ENQ    RESERVE 02 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                 01C5IPO1
16 59.11.13  CATALOG  IGGPACDV AL ENQ    RESERVE 03 XA9RES  SYSZVVDS XA9RES                                01C5IPO1
16 59.11.15  CATALOG  IGGPACDV AL DEQ    RELEASE 02 XA9RES  SYSZVVDS XA9RES                                    IPO1
16 59.11.17  CATALOG  IGGPACDV AL DEQ    REL/SYS 01 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                     IPO1
16 59.11.35  CATALOG  IGGPACDV AL ENQ    RESERVE 02 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                 01C5IPO1
16 59.11.35  CATALOG  IGGPACDV AL ENQ    RESERVE 03 XA9RES  SYSZVVDS XA9RES                                01C5IPO1
16 59.11.43  CATALOG  IGGPACDV AL DEQ    RELEASE 02 XA9RES  SYSZVVDS XA9RES                                    IPO1
16 59.11.51  CATALOG  IGGPACDV AL DEQ    REL/SYS 01 XA9RES  SYSIGGV2 CATALOG.MASTER.XA9RES                     IPO1
16 59.11.89  IPOUSR4  ISRUDA      ENQ    RESERVE 02 XA9RES  SPFEDIT  TOOLS.PRC                             01C5IPO1
16 59.12.65  JES2     HASJES20 AL DEQ    RELEASE 01 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                       IPO1
16 59.17.66  JES2     HASJES20 AL ENQ    RESERVE 02 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                   01C5IPO1
16 59.27.96  JES2     HASJES20 AL DEQ    RELEASE 01 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                       IPO1
16 59.32.97  JES2     HASJES20 AL ENQ    RESERVE 02 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                   01C5IPO1
16 59.43.22  JES2     HASJES20 AL DEQ    RELEASE 01 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                       IPO1

16 59.44.76  IPOUSR4  ISRUDA      DEQ    REL/SYS 00 XA9RES  SPFEDIT  TOOLS.PRC                                 IPO1

16 59.48.23  JES2     HASJES20 AL ENQ    RESERVE 01 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                   01C5IPO1
16 59.58.37  JES2     HASJES20 AL DEQ    RELEASE 00 XA9RES  SYSZJES2 XA9RESSYS1.HASPCKPT                       IPO1
```

Figure 39. Reserve/Release Trace at Time of Max

The trace at time of max is the ouput of **LOG2** dd statement of ISGAJE2 procedure. See Figure 31 on page 61.

Records Layout

DSECT Monitor Physical and Logical Record

```
BUFF     DSECT                    SP 229
ACPB         DC    4C'ACPB'      Buffer eye catcher
NEXT     DC    1F'0'         4
SRBOFFB  EQU   *-LOCK             OFFSET SRB IN BUFFER
SRBAREA  DC    44X'00'       8    SRB FOR BUFFER SCHEDULE
OFFDATA  EQU   *-LOCK
DATA     EQU   BUFFSIZ-OFFDATA

RECORD   DSECT                    30 RECORDS PER BUFFER
HEADER   DC    4C'0'
NORMAL   EQU   C'PREC'        NORMAL
ERROR    EQU   C'ERRO'            ERROR DURING DATA COLLECTION
LOST     EQU   C'LOST'            DATA LOST PREVIOUSLY
RFLAG    DC    X'00'
JOBINIT  EQU   X'80'
STCTSU   EQU   X'40'
SVCNUMB  DC    X'00'
TOD      DC    8X'00'
JOBNAME  DC    8C'0'
DEVNO    DC    2X'00'            DEVICE NUMBER BINARY
         DC    1X'00'            SPARE
CONRNL   DC    1C'0'             RNL ACTION
SMFID    DC    4C'0'             SMFID
ENQFLG1  DC    X'00'             ENQ/DEQ FLAGS
ENQFLG2  DC    X'00'
VOLSER   DC    6C'0'             VOLSER
PGMNAME1 DC    8C'0'             NAME
ATTR1    DC    X'00'             ATTRIBUTE
SUBRECL  EQU   *-PGMNAME1
MAJOR    DC    8C' '             MAJOR NAME
MINOR    DC    52C' '            MINOR NAME
MINORLEN DC    1X'00'            MINOR LENGTH
USERID   DC    8c' '             Userid
         DC    11X'00'
RESCNT   DC    X'00'             VOLUME RESERVE COUNT
ENDREC   EQU   *
```

ISGAMEDM ISGAMED1 ISGAMVOL Output Record Fields

```
*
*  Output record of data reduction programs ISGAMEDM-ISGAMED1-ISGAMVOL
--------------------------------------------------------------------
start length     contents         format      comments
--------------------------------------------------------------------

  1 -  8         TOD            8 BIN       ISGAMEDM-ISGAMVOL

  1 - 13         DATE         13 CHAR    ISGAMED1

  1 - 11         TIME         11 CHAR      ISGAMED1

 14 -  8        JOBNAME         8 CHAR

 23 -  8        PGNAME          8 CHAR

 32 -  2        PGM AUTH        2 CHAR       A L

 35 -  3        REQUEST         3 CHAR       ENQ/DEQ

 40 -  1        RNL             1 CHAR

 42 -  7        SCOPE           8 CHAR       SYSTEM(S)/RESERVE

 50 -  2        SCOPE1          2 CHAR       EX-SH  RES/CNT

 53 -  6        VOLID           6 CHAR

 61 -  8        MAJOR NAME      8 CHAR

 69 - 52        MINOR NAME     52 CHAR

122 -  4       DEVICE NUMBER    4 CHAR

126 -  4       SMF ID           4 CHAR

131 -  2       MINOR NAME LEN   2 CHAR
```

EDSORTED Output Record Fields

```
*
*  Output record of data reduction program ISGAMCNT
---------------------------------------------------------------
start length     contents         format      comments
---------------------------------------------------------------

  1 -  8        TOTAL COUNT      8 CHAR

 35 -  3        REQUEST          3 CHAR       ENQ/DEQ

 40 -  1        RNL              1 CHAR

 42 -  7        SCOPE            8 CHAR       SYSTEM(S)/RESERVE

 50 -  2        SCOPE1           2 CHAR       EX-SH  RES/CNT

 53 -  6        VOLID            6 CHAR

 61 -  8        MAJOR NAME       8 CHAR

 69 - 52        MINOR NAME      52 CHAR

122 -  4        DEVICE NUMBER    4 CHAR

126 -  4        SMF ID           4 CHAR

131 -  2        MINOR NAME LENGTH  CHAR
```

ISGAMCTM Output Record Fields

```
*
*  Output record of data reduction program ISGAMCTM
*
---------------------------------------------------------------
start length     contents         format      comments
---------------------------------------------------------------

 1 -  8        YYYY DDD         6 CHAR      date of max

 9 - 11        HH.MM.SS.mm     11 CHAR      time of max

21 -  4        DEVICE NUMBER    4 CHAR

25 -  6        VOLID            6 CHAR

32 -  4        SMFID            4 CHAR

37 -  8        TOT RES TIME     8 CHAR      seconds

46 -  8        AVERAGE          8 CHAR      msec

55 -  8        MINIMUN          8 CHAR      msec

64 -  8        MAXIMUM          8 CHAR      msec

73 -  8        NUM OF REQUEST   8 CHAR

82 -  2        MAX CONC RES     2 CHAR
```

Part 2. Global Resource Serialization Star

Chapter 4. Star Processing

In a star complex, global resource serialization uses a XES lock structure to serialize requests for global resources.

Figure 40 shows an example overview of a three-system star complex. All systems in a star complex must be members of the same sysplex and be connected to a coupling facility containing the global resource serialization lock structure, ISGLOCK, to manage contention for global resources. For practical purposes, where global resource serialization star complex is concerned, the terms sysplex and complex are synonymous. No channel-to-channel (CTC) connection of systems, other than those managed by XCF, will be supported by global resource serialization in a star complex.

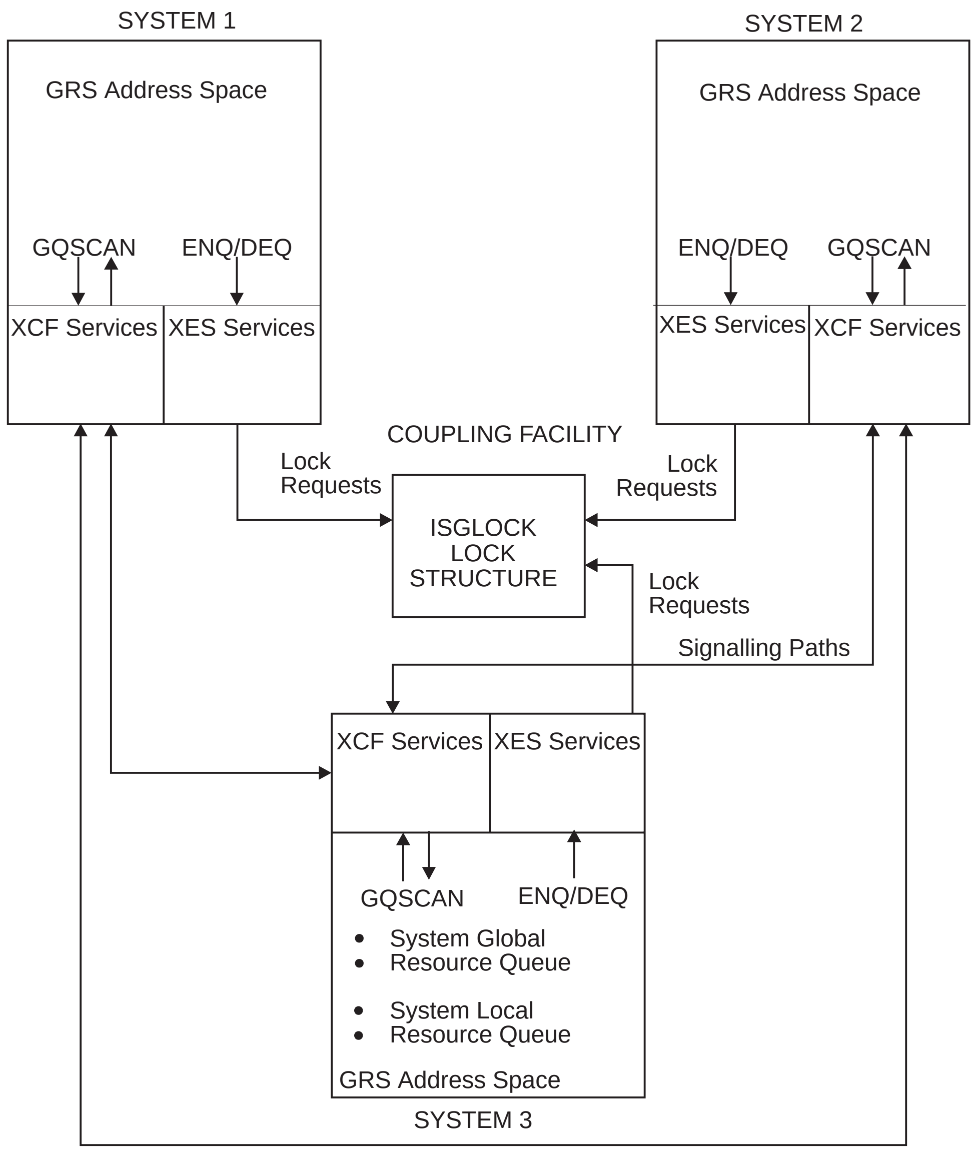


Figure 40. Overview of the Global Resource Serialization Star Complex

The ISGLOCK Lock Structure: When a system in a star complex issues an ENQ, DEQ, or RESERVE request for a global resource, the request will be converted by global resource serialization to a lock request against the ISGLOCK lock structure. Global resource serialization uses the ISGLOCK lock structure to coordinate the requests to ensure proper resource serialization across all systems in the complex. The status of each request is returned to the system that originated the request. Based on the results of these lock requests, global resource serialization will respond to the requestor with the outcome of the serialization request.

Global ENQ/DEQ Processing Overview

In a star complex, requests for ownership of global resources will be handled through ISGLOCK, the lock structure, on a coupling facility that is fully connected with all the systems in the sysplex. Global resource serialization uses the ISGLOCK lock structure to reflect a composite system level view of the interest in every global resource, for which there is at least one requestor. In general, this composite view is altered each time a change is made to the set of requestors for the resource.

Each time an ENQ request is received, global resource serialization processing analyzes the state of the resource request queue for the resource. If the new request alters the composite state of the queue, an **IXLLOCK** macro request is made to reflect the changed state of the resource for the requesting system. If the resource is immediately available, the requestor is then granted ownership of the resource.

If the resource is not immediately available, global resource serialization will maintain the request in the waiting state. When the appropriate DEQ request is received, global resource serialization will either resume or post the requestor (depending on the ENQ options).

GQSCAN Processing Overview

In a global resource serialization star sysplex, the basic flow of a GQSCAN request for global resource information is illustrated by the highlevel diagram in Figure 41.

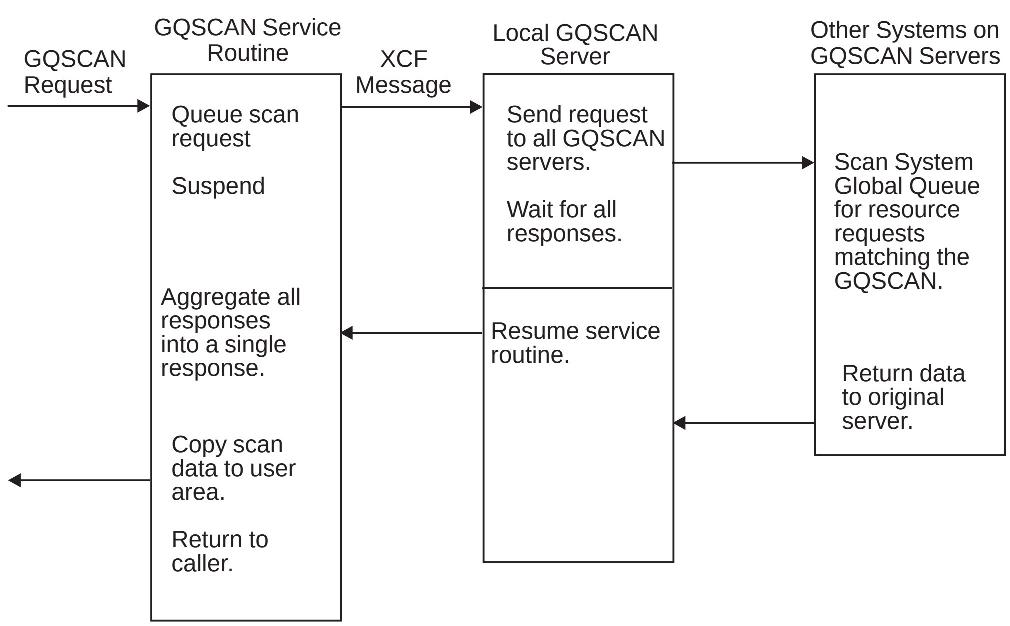


Figure 41. Overview of GQSCAN Request for Global Resource Data

- The request for global resource information is queued to the GQSCAN server on that system.
- The GQSCAN requestor will be suspended. For GQSCAN users that do not need information about other systems and do not want to be suspended, see “Cross-System Processing Option”.
- Global resource serialization processing will then package the request for transmission and send it to each of the other systems in the star complex.
- Each system in the complex will scan its system global resource queue for global resource requests that match the GQSCAN selection criteria, and respond to the originating system server with the requested global resource information, if any, and a return code.
- The originating system waits for responses from all of the systems in the sysplex and builds a composite response, which is returned to the caller’s output area via GQSCAN’s back-end processing. Control is then returned to the caller with the appropriate return code.

Cross-System Processing Option

The XSYS option on the GQSCAN macro allows the GQSCAN issuer to indicate whether cross-system processing should be performed. You can specify the option XSYS=NO to turn cross-system processing off for that GQSCAN request. If the no cross-system option, XSYS=NO, is specified, only the global resource information for the caller’s system will be returned. This type of GQSCAN will run under the caller’s task, without causing the unit of work to be suspended.

Specifying XSYS=NO benefits users of GQSCAN that cannot be suspended and do not require data about requestors on other systems in the complex. For more information about the GQSCAN macro, see *z/OS MVS Programming: Authorized Assembler Services Reference ENF-IXG*.

Processing System Failures

There is no disruption to the star complex when a failure has occurred requiring that a system be removed from the sysplex. Processing for removing the system from the sysplex amounts to a dequeueing of all requests for global resources that originated on that system. Global resource serialization continues processing global requests for the remaining systems. See *z/OS MVS Setting Up a Sysplex* for information on planning sysplex availability and recovery.

Chapter 5. Planning a Star Complex

Decisions you make about how you want to process requests for various resources set your installation's goals for global resource serialization. The actual global resource serialization star complex that you design is one of the tools you use to achieve these goals.

A global resource serialization star complex consists of all the systems that are able to share global resources.

Designing the complex involves answering these basic questions:
1. What resources does your installation want to share?
2. Which systems use these resources?

The resources your systems need to share determine the systems in the complex. The most likely candidates, of course, are those systems that are already serializing access to resources on shared DASD volumes and, especially, those systems where interlocks, contention, or data protection by job scheduling are causing significant problems.

Notes

- In a star complex the terms, sysplex and complex are synonymous, in that the systems in the complex are the same as the systems in the sysplex.
- "Systems" refers to the number of MVS images, not the number of processors.
- Only one sysplex can exist in any global resource serialization complex.

It is possible for a single installation to have two or more global resource serialization complexes, each operating independently. However, the independent complexes cannot share resources. Also, there should be no common links made available to global resource serialization on any two complexes.

To avoid a data integrity exposure, ensure that no system outside the complex can access the same shared DASD as any system in the complex. If that is unavoidable, however, you must serialize the data on the shared DASD with the RESERVE macro. You need to decide how many of these systems to combine in one complex.

The design of the star global resource serialization more efficiently and effectively in large complexes than the ring. See "Methods of Serializing Global Resources" on page 7. Designing your star complex is relatively simple, because all of the systems in the star complex are part of the same sysplex.

Designing a Star Complex

The star method for processing requests for global resources operates in a sysplex like any other MVS component that uses the coupling facility. Unlike the ring method, which may require you to set up XCF signalling paths for the SYSGRS group, the star method will operate well without any special definitions. There is no need to set up XCF signalling paths between systems or to define CTC links directly to global resource serialization.

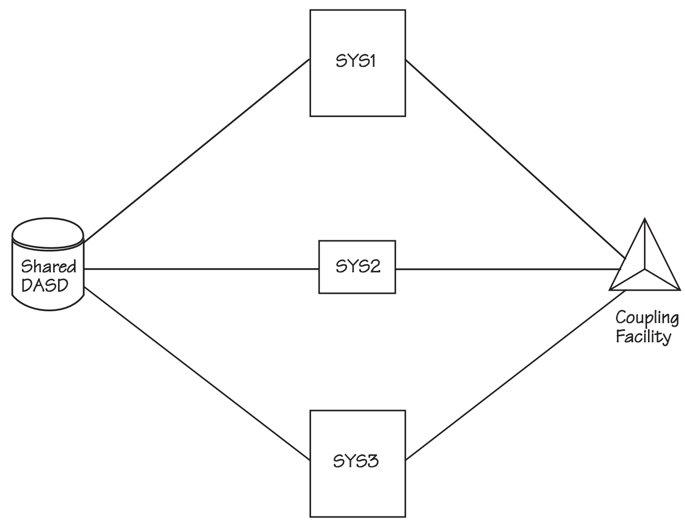


Figure 42. The Star Concept

XCF requires a DASD data set, called a sysplex couple data set, to be shared by all systems. An alternate data set can be used to facilitate migrating from a ring to a star complex. On the sysplex couple data set, MVS stores information related to the sysplex, systems, and XCF groups, such as global resource serialization.

The following policies are used to manage global resource serialization:

- Coupling facility resource management (CFRM) policy, which is required, defines how MVS manages coupling facility resources.
- Sysplex failure management (SFM) policy, which is optional, defines how MVS is to manage system and signaling connectivity failures and PR/SM reconfiguration actions. IBM recommends using the SFM policy.

Defining the Sysplex Couple Data Set for the Star Complex

You must format the sysplex couple data set to accept global resource serialization before you can:

- Initialize a star complex, or
- Migrate to a star complex from a ring complex.

When preparing a star complex, use the IXCL1DSU utility to allocate the sysplex couple data set. Under the DEFINEDS statement for the TYPE(SYSPLEX) couple data set, add the following parameters:

```
DEFINEDS
  DATA TYPE(SYSPLEX)
    ITEM NAME (GRS) NUMBER(1)
```

Figure 43. Syntax of the Global Resource Serialization Record for IXCL1DSU

Where:

ITEM NAME(GRS) NUMBER(1)
Allocates the couple data set storage for use by global resource serialization.

The above keyword specification is a requirement for a star complex. If the specification is omitted, no storage will be allocated for use by global resource serialization. For more information on the utility, see *z/OS MVS Setting Up a Sysplex*.

A sysplex couple data set with the global resource serialization record may be formatted and brought on-line any time prior to migrating to a star complex. Use the SETXCF command to:

- Make a newly formatted sysplex couple data set the alternate sysplex couple data set, then
- Specify the alternate sysplex couple data set as the primary one.

See *z/OS MVS Setting Up a Sysplex* and *z/OS MVS System Commands* for information on the use of the SETXCF command.

Use of the Sysplex Couple Data Set

In a star complex, the Resource Name Lists (RNLs) will be maintained on the sysplex couple data set. The RNLs will be initialized by the first system to join the sysplex. All subsequent systems will read this data from the sysplex couple data set and compare it to the version used during system initialization. RNLs are specified via the GRSRNL= parameter in the IEASYSxx member of parmlib. If the RNLs used by the system during initialization do not match those in the sysplex couple data set, message ISG312W is issued and the system is put into a X'0A3' wait state.

Dynamic RNL Processing: In a global resource serialization star complex, dynamic RNL changes will be completed by changing the RNLs on the coupling facility, ensuring that all new systems to join the complex use the proper set of RNLs. For more information on changing RNLs see “Changing RNLs for a Star Complex” on page 101.

The CFRM Couple Data Set

Management of global resources in the star complex is performed via a coupling facility lock structure. The coupling facility is managed by the coupling facility resource management (CFRM) policy, which resides on the CFRM coupling facility data set.

The CFRM policy defines:

- The lock structure
- The amount of coupling facility storage to be used for the lock structure
- The preference list of coupling facilities in which the structure resides, and
- An unordered exclusion list of other structures that should not be allocated in the same coupling facility as the specified lock structure.

At least one coupling facility must be installed and defined to MVS before you can configure a star complex. However, IBM recommends that you **do not** use the star method of serializing global resources if there is only one coupling facility available for use in your installation. In this case, failure of the coupling facility will result in all of the systems in the sysplex being terminated with a X'0A3' wait state.

Global resource serialization uses a lock structure, named ISGLOCK, to serialize global resources across the sysplex and record which systems have requestors for particular resources. ISGLOCK **must** be specified in the CFRM policy by using ISGLOCK as the structure name on the NAME parameter.

Following is an example of the structure definition for the ISGLOCK structure. See Figure 45 to determine the size for ISGLOCK.

```
STRUCTURE
     NAME(ISGLOCK)
     SIZE(8448)
     PREFLIST(CFACIL01,CFACIL02)
     EXCLLIST(ABCSTR)
```

Figure 44. Specifying Global Resource Serialization Lock Structure in the CFRM Policy

Note that the optional CFRM policy parameter, INITSIZE, is not specified in the ISGLOCK structure definition. It is not necessary to specify INITSIZE because global resource serialization does not support structure alter.

For information on managing coupling facility resources, see *z/OS MVS Setting Up a Sysplex*. For a discussion of GRS rebuild processing, see “ISGLOCK Rebuild Processing” on page 95.

Sizing the ISGLOCK Structure

As stated before, global resource serialization uses the lock structure, ISGLOCK, to manage resource serialization requests for the sysplex. You specify the size of ISGLOCK in your CFRM policy. The size is based on the following factors:

- The size and type of systems in the sysplex, and
- The type of workload being performed.

Global resource serialization requires that the lock structure contains at least 32767 (32K) locks. Typically, a small sysplex, made up of smaller processors, running a transaction processing workload will use a smaller lock size than a larger sysplex, composed of large processors, running a batch/TSO workload combination.

IBM recommends using the method described in Figure 45 to determine the size for ISGLOCK.

```
# lock table entries = peak # resources * 100

Round # lock table entries up to next power of 2

Lock table size (in bytes) = # lock table entries * 8

Structure Size (in K bytes) = (lock table size/1024) + 256
```

Figure 45. Formula for Determining SIZE Parameter for the CFRM Policy

Where:

Peak # Global Resources
Is the number of unique globally managed resources (**SYSTEMS** ENQs and converted RESERVEs) measured at a time of peak system utilization.

IBM has provided a program named ISGSCGRS in SYS1.LINKLIB, that runs GQSCAN. ISGSCGRS returns the number of global resources in the complex. The JCL for the program is in SYS1.SAMPLIB(ISGCGRS).

If the calculated structure size is less than 8448K, start with a structure size of 8448K (1048576 locks).

Getting the Right Structure Size

When it is created (the number of lock entries cannot be altered), IBM recommends that your CFRM policy specifies that your INITSIZE parameter is equal to the SIZE parameter (SIZE=INITSIZE) for the structure.

When the first system joins the star, global resource serialization uses information about the structure size specified in the CFRM policy and then creates the largest lock structure that will fit within that size. Message ISG3371I is issued to document the size of the structure. If the size of the ISGLOCK lock structure created by global resource serialization is less than the CFRM policy size, global resource serialization will issue message ISG322A. If you receive this message, check the coupling facility configuration. If either the policy size or the amount of storage available in the coupling facility is insufficient, global resource serialization issues message ISG338W.

The size of the lock structure can be tuned by checking the number of false contention occurrences in the resource management facility (RMF) report. If the false contention rate is high (greater than one or two percent), use a larger lock structure (double the number of lock entries) to reduce the rate. You can increase the policy size for the structure and then rebuild the structure to reduce the amount of false contention. To rebuild a coupling facility structure, use the SETXCF STAR T, REBUILD command.

See “Rebuilding the ISGLOCK Structure” on page 103 on the use of the SETXCF command.

Defining Parmlib Members for a Star Complex

Initializing a star complex requires specifying STAR on the GRS= system parameter in the IEASYS*xx* parmlib member, or in response to message `IEA101A SPECIFY SYSTEM PARAMETERS`. The definitions of the START, JOIN, and TRYJOIN options apply to a ring complex only. The NONE option applies when global resource serialization is not required.

For a star complex, the syntax of the GRS= parameter and the specification for initiating a system into a star complex is described below. The processing that occurs for the star option is described in “Bringing Up a Star Complex” on page 93. This section also describes what occurs when systems with mismatched GRS= specifications are initialized into the same GRS complex.

GRS=STAR

Figure 46. Syntax for the GRS= System Parameter

STAR
Specifies that the system being IPLed is to join a global resource serialization star complex. If no global resource serialization complex has yet been established (that is, there are no systems active in either a ring or star complex), the system will be initialized as the first system in a global resource serialization star complex.

Note: The GRSRNL= parameter should also be specified if the GRS= parameter specifies STAR.

Global Resource Serialization Star Definition Parameter (GRSDEF)

Basically, the GRSCNFxx parmlib member is **not** required when initializing a star complex that uses the default component trace (CTRACE) parmlib member, CTIGRS00, supplied by IBM.

If you want to initialize a star complex using a CTRACE parmlib member other than the default supplied by IBM, you must use the GRSDEF statement in the GRSCNFxx parmlib member.

```
GRSDEF  [MATCHSYS{(name)}]
                 [{(*)}  ]

        [CTRACE (parmlib member name)]
```

Figure 47. Parameters in the GRSCNFxx Statement

When defining a star complex, you only need to specify two parameters on the GRSDEF statement in the GRSCNFxx member of parmlib.

For further information on the above parameters, refer to *z/OS MVS Initialization and Tuning Reference*.

MATCHSYS({*name* **| *})**
specifies the name of the system the GRSDEF parameters are to be associated with. If MATCHSYS(*) is specified, the GRSDEF parameters are to be used by all systems for which there is no GRSDEF statement with a matching system name.

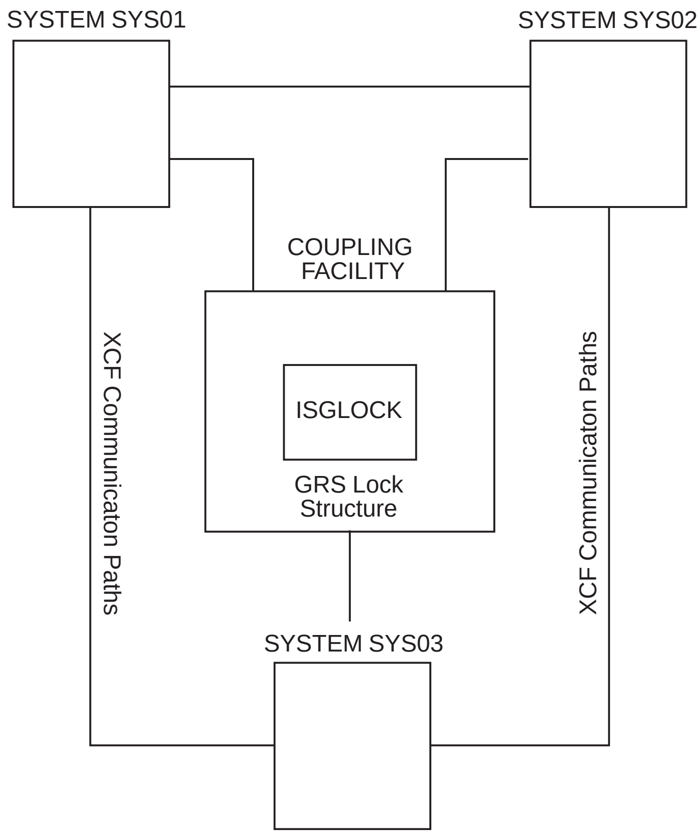
CTRACE(*parmlib member name***)**
specifies the name of a member of parmlib that contains the trace options for global resource serialization.

Aside from the two GRSDEF parameters listed above, all the other parameters on the GRSDEF statement apply only to initializing systems in a ring complex. Although they can be specified on the GRSDEF statement(s) and will be parsed and syntax checked, they will not be used when initializing systems into a global resource serialization star complex.

Global resource serialization will ignore non-applicable parameters on the GRSDEF statement(s) when initializing systems into a star complex as well as when initializing systems into a ring complex. It is possible for an installation to create a single GRSCNFxx parmlib member that can be used for the initialization of either a star or a ring complex. This will help in the transition from a ring to a star complex if the installation elects to use the SETGRS MODE=STAR capability to make the transition. When ring-related parameters are ignored, global resource serialization will issue message ISG313I indicating the parameter and the reason.

When initializing a system into either a ring or a star complex, syntax or specification errors in the GRSCNFxx parmlib member will, in most cases, result in the initialization failing. The failure might occur whether or not the parameter in error was applicable to the particular type of complex being initialized. In these cases, an error message will always be issued and then if it is possible for system processing to continue without global resource serialization, the operator will be prompted to specify *NONE* or else re-IPL the system. If it is not possible to continue (for example, **PLEXCFG=MULTISYSTEM** was specified), then initialization will be terminated with an X'0A3' wait state with reason code X'0C'.

Figure 48 shows an example configuration consisting of a three system sysplex (SYS01, SYS02, and SYS03) and a set of GRSCNFxx parameters that might be used to initialize the systems as a global resource serialization star complex. In this example, the global resource serialization lock structure (ISGLOCK) must have been previously defined to the CFRM policy.




```
GRSCNFxx parmlib member:
                              /* SYSTEM DEFINITIONS .........

   GRSDEF MATCHSYS(*)         /* GRSDEF FOR SYSTEMS SYS01 AND SYS02     */
          CTRACE(CTIGRS01)    /* PARMLIB MEMBER CTIGRS01 CONTAINS TRACE */
                              /* OPTIONS                                */

   GRSDEF MATCHSYS(SYS03)     /* GRSDEF FOR SYSTEM SYS03                */

          CTRACE(CTIGRS02)    /* PARMLIB MEMBER CTIGRS02 CONTAINS TRACE */
                              /* OPTIONS                                */
```

Figure 48. Example Global Resource Serialization Star Parmlib Definition

Bringing Up a Star Complex

Initializing a star complex requires specifying STAR on the GRS= system parameter, which can be defined either in a IEASYS*xx* parmlib member or specified at the IPL prompting for system parameters.

Specify GRS=STAR, for each system that is to be part of a star complex. (See Figure 46 on page 91 for a discussion of the GRS= system parameters.) If the system is the first system in the complex, it will initialize the global resource serialization lock structure, ISGLOCK, on a coupling facility to start a star complex.

Prior to the availability of OW43278, the first system to IPL into a sysplex using global resource serialization was required to IPL in ring mode if a CFRM policy had not previously been activated in the sysplex. To establish the environment for a star complex, the GRS= keyword in IEASYSxx had to be modified from GRS=TRYJOIN to GRS=STAR. Next, the CFRM policy would be started using the

```
SETXCF START,POLICY,TYPE=CFRM,POLNAME=polname
```

command. Finally, the operator would issue the `SETGRS MODE=STAR` command to set global resource serialization to star mode. Subsequent systems could then IPL into the star complex.

OW43278 eliminates the need to initially IPL in ring mode when a CFRM policy had not been previously activated in the sysplex. With OW43278, for the first initialization of the sysplex, you can specify the name of the CFRM policy to be started at IPL-time in the COUPLExx parmlib member that is used to initialize the sysplex if there is no previously-activated CFRM policy. (If there is a previously-activated CFRM policy, the CFRMPOL specification is ignored and the system uses the name of the CFRM policy that was previously in effect.) The system uses the CFRM policy name specified by the CFRMPOL keyword on the COUPLE statement to identify the policy to be started only if there is no other previously-activated CFRM policy in effect. The ability to specify a CFRM policy to be started at IPL-time allows you to initialize your sysplex in global resource serialization star mode, if the CFRM policy started contains the ISGLOCK structure required for star mode. Thus, a system with OW43278 installed can specify GRS=STAR in the IEASYSxx parmlib member and CFRMPOL(cfrmpolname) in the COUPLExx parmlib member prior to IPL and successfully IPL the first system and subsequent systems into a global resource serialization star configuration.

Systems without OW43278 installed, or those at OS/390 Release 4 or lower, must continue to establish their star complex by first IPL-ing in ring mode, modifying the IEASYSxx parmlib member, starting the CFRM policy, and then issuing the `SETGRS MODE=STAR` command.

Potential Error Scenarios

Because global resource serialization supports two types of complexes, a star or a ring, it is possible that due to an error in the specification of the GRS= parameter, the installation could accidentally try to IPL a system into the wrong type of complex. The possible error cases and the action taken by global resource serialization in each case are as follows:

- If a sysplex-capable MVS system (a system running at least MVS/ESA SP 4.1.0) is IPLed with one of the ring-related parameters (GRS=START, JOIN, or TRYJOIN) and a star complex already exists, the system will fail with a X'0A3' wait state with a X'84' reason code.
- If a down-level MVS system (at least an MVS/ESA SP 4.1.0 system, but not OS/390 release 2) is IPLed with one of the ring-related parameters (GRS=START, JOIN, or TRYJOIN), and a star complex already exists, the system will fail with a X'0A3' wait state with a X'84' reason code.
- If a down-level MVS system (prior to MVS/ESA SP 4.1.0) is IPLed with one of the ring-related parameters (START, JOIN, or TRYJOIN) and a star complex

already exists, global resource serialization will not be able to detect this type of error. See “Error Scenarios You Can Avoid”.

- If the installation is running a ring complex where all systems are interconnected using CTC support rather than XCF communication, and the operator or system programmer accidently specifies GRS=STAR when IPLing a system that should be part of the ring, global resource serialization will not be able to detect this type of error. See “Error Scenarios You Can Avoid”.

Error Scenarios You Can Avoid

In the preceding topic, the result of the last two scenarios is the creation of two separate global resource serialization complexes that will not correctly serialize resources across the two sets of systems. This problem will not occur if you correctly migrate the complex from a mixed-ring complex to a star complex.

- If your goal is to run in a global resource serialization star complex, make sure that the CTC definitions are removed from the GRSCNFxx member used to define the star complex, or
- If you desire to remain in a ring complex, do **not** add the global resource serialization record to the sysplex couple data set.

Initial Processing Environment

In addition to the IEASYSxx GRS= parameter indicating how GRS should initialize the system, the PLEXCFG= parameter allows the installation to indicate the processing environment into which the system is being IPLed. The GRS= system parameter is checked against this parameter to ensure that the system is being initialized properly for the particular environment the installation wants to establish. The relationship of the GRS=STAR parameter to the options that can be specified on the PLEXCFG= parameter is described in Table 6. The PLEXCFG=options and their meanings can be found in *z/OS MVS Initialization and Tuning Reference*.

Table 6. GRS=STAR Relationship to PLEXCFG= Options

PLEXCFG=	Initialization Action Taken by MVS
XCFLOCAL	Prompt for **NONE**
MONOPLEX	Prompt for **NONE**
ANY	If XCF is in local mode, then prompt for **NONE**. If XCF is in sysplex mode, then initialize the system to run as a member of a global resource serialization star complex.
MULTISYSTEM	Initialize the system to run as a member of a global resource serialization star complex.

ISGLOCK Rebuild Processing

Global resource serialization will attempt rebuild processing in response to a policy decision made by CFRM or SFM, or in response to the operator issuing the SETXCF START,REBUILD command. As global resource serialization on each system is notified of the rebuild or the structure or connectivity failure, message ISG323A will be issued to indicate global resource serialization requestors will be suspended due to a rebuild in progress. Each system will then proceed to perform its part of the rebuild process.

For a structure or connectivity error, the first system in the star complex to be notified will respond by automatically initiating a rebuild of the lock structure, ISGLOCK. Depending on the active SFM policy, MVS determines whether a rebuild is to be done:

- If so, global resource serialization will continue with the rebuild process.

  Any systems without connectivity to the original lock structure will be terminated with a X'0A3' wait state and a reason code X'D0'.
- If not, the rebuild will be stopped, message ISG236I will be issued and global resource serialization will attempt to return to and use the original lock structure.

Any systems without connectivity to the original lock structure will be terminated with a X'0A3' wait state and a reason code X'D0'.

If the rebuild completes successfully, message ISG325I will be issued to indicate the rebuild is complete and normal global resource serialization processing has been resumed.

Coupling Facility Structure Failure

If the global resource serialization lock structure, ISGLOCK, fails at any time during global resource serialization initialization, the system will wait for the other systems to do the rebuild and then continue with the IPL.

Following initialization, if a global resource serialization coupling facility structure failure occurs, global resource serialization will initiate a rebuild of the structure. For a discussion of global resource serialization rebuild processing, see “ISGLOCK Rebuild Processing” on page 95.

Loss Of Connectivity to a Coupling Facility Structure

If at any time during global resource serialization initialization, connectivity to the global resource serialization coupling facility structure is lost, the system will finish initialization and then either participate in the rebuild or enter a wait state (SFM policy decision).

When loss of connectivity occurs early in global resource serialization initialization, re-IPLing the system is the appropriate action to take.

Following initialization, if a system loses connectivity to the lock structure, ISGLOCK, global resource serialization initiates a rebuild of the structure.

Specifying Global Resource Serialization Tracing Options (CTRACE)

Use the CTRACE parameter in GRSCNFxx to specify the CTRACE options you want for your installation. For more information about global resource serialization component trace, see *z/OS MVS Diagnosis: Tools and Service Aids*. For information about how to specify the options you want, see *z/OS MVS Initialization and Tuning Reference*.

The CTRACE parameter in GRSCNFxx allows you to modify the default tracing options used by global resource serialization. Since the defaults provide adequate serviceability information, you should change them only upon the recommendation of your IBM service representative.

Trace options are provided to select which events should be traced. The options which pertain to the star processing environment are CONTROL, REQUEST, MONITOR, SIGNAL, and FLOW. Each can be made more specific by specifying CONTROL*n*, REQUEST*n*, MONITOR*n*, and SIGNAL*n*, or FLOW*n* to provide greater flexibility and granularity in selecting which events to be traced. When viewing the trace data using the IPCS CTRACE subcommand, filtering options are provided to limit the scope of the data displayed, and subheaders are shown which briefly describe each trace key.

Minimum Options (MINOPS)

Minimum options (MINOPS) are defined for GRS=STAR so that exceptional events will be traced at all times, regardless of the options specified. CTRACE will permit the trace state to be ON (with both the specified and minimum options in effect) or MIN (only the minimum options in effect). The trace will never be OFF. When viewing the trace data using the IPCS CTRACE subcommand, filtering options are available to limit the scope of the data displayed.

Chapter 6. Operating the Star Complex

This chapter is concerned with operating a star complex. Because the systems in the complex must match the systems in the sysplex, building and operating the complex is straightforward. If the design has been properly implemented there is little need for operator intervention. However, the procedures for operating the systems in the complex are important.

Reference Books

As you read this chapter and you develop your operator procedures, consult the following books:

For sysplex operations involving the coupling facility, see *z/OS MVS Setting Up a Sysplex*.

For exact text and responses to global resource serialization messages, see *z/OS MVS System Messages, Vol 9 (IGF-IWM)*, and which contains a complete description of how to use the DISPLAY command with global resource serialization.

For a description of how to plan your recovery procedures, see *z/OS MVS Recovery and Reconfiguration Guide*.

Operating the Star Complex

In general, your operational planning focuses on three areas: building the complex, normal operations, and recovery operations. The design of your complex affects all three areas.

As previously discussed, systems in a star sysplex are connected to a coupling facility via communication links, and to each other via XCF managed CTCs, or XES signaling paths, or both.

Building the Complex

The process of building a global resource serialization complex can have two phases: a configuration check and the IPL of the systems.

Configuration Check

Before a system is IPLed to start or join a global resource serialization star complex, the operator should verify that:

1. The lock structure, ISGLOCK, is specified in the coupling facility resource management (CFRM) policy.
2. All coupling facilities that can contain the lock structure are specified in the CFRM preference list.
3. All connections to shared resources (such as DASD) are correct.
4. The sysplex couple data set has been previously formatted with the global resource serialization parameter so that the global resource serialization record which contains the RNLs is available.

If the shared resource connections are incorrect, a serious data integrity exposure could occur. This exposure occurs when systems in the complex are serializing access to a global resource by means of an ENQ macro with a scope of SYSTEMS. For example, if the RESERVE conversion RNL for the complex contains an entry for a resource, this entry causes global resource serialization on each system in the complex to suppress the reserve for that resource. If a system outside the star complex can use a reserve to access the same resource at the same time, the resource could be damaged.

IPL

The GRS= system parameter indicates to MVS at IPL time that a system is to be part of a global resource serialization star complex. The GRS and GRSCNF parameters remain in effect for the duration of the IPL; the only way to change their value is to IPL the system again. You can change the RNLs without having to reIPL the entire complex. Use the SET GRSRNL command to accomplish this change. See “Changing RNLs for a Star Complex” on page 101 for more information.

There are several ways you can specify the global resource serialization parameters. To minimize operator intervention during IPL, it is generally best to specify GRS, GRSRNL, and GRSCNF in the IEASYSxx parmlib member or take the default values. See “Defining Parmlib Members for a Star Complex” on page 91.

You can specify GRS=STAR in IEASYSxx on each system in the sysplex. The first system in the star sysplex to initialize will initialize the global resource serialization lock structures on a coupling facility to start the star complex. See *z/OS MVS Setting Up a Sysplex*.

Normal Operations in a Sysplex

Once the complex is built, it requires little, if any, operator intervention. If a problem occurs, either global resource serialization or some other system component will detect the problem and issue messages that describe it before the operator could notice it.

For example, some of the error messages that global resource serialization issues indicate damage to resources or to the resource control blocks. These messages are ISG031E, ISG032E, ISG033E, ISG034E and ISG035E. The problem that causes any of these messages can also cause the job requesting the resource to terminate abnormally. If the damage is extensive, the problem can cause multiple jobs to terminate abnormally, requiring the system to IPL again to restore the control blocks.

During normal processing, operators can use system commands to monitor and control global resource serialization. The system commands related to global resource serialization are:

- DISPLAY GRS, which displays the status of each system in the complex. For more information see “Displaying the Status of Systems in a Star Complex” on page 101.
- SET GRSRNL, which changes the RNLs dynamically. For more information see “Changing RNLs for a Star Complex” on page 101.
- SETGRS, which is used to migrate systems in an active ring sysplex to a star sysplex. For more information see “Using the SETGRS Command to Convert to a Star Complex” on page 104.
- VARY XCF,sysname,OFFLINE, which removes a system from the complex (and also the global resource serialization star complex). For more information, see *z/OS MVS Setting Up a Sysplex*.

Note: The VARY GRS command is not supported in a star complex. If the command is entered, it will be rejected with message ISG153I.

Displaying the Status of Systems in a Star Complex

The DISPLAY GRS (D GRS) command shows the state of each system in the complex. Note that D GRS shows system status only as it relates to the global resource serialization star. D GRS does not reflect how well a system is running.

You can also use D GRS to display the local and global resources requested by the systems in the star complex, the contents of the RNLs, and jobs that are delayed or suspended by a SET GRSRNL command. Issuing a D GRS command without any other parameters shows the same display as issuing a D GRS,SYSTEM command. These uses are described in *z/OS MVS System Commands*.

You can issue D GRS from any system in the star complex, and at any time after the star complex has been started. The D GRS display shows the status of the star from that system's point of view; thus, the displays issued from different systems might show different results. Figure 49 shows an example of the information D GRS produces and explains the values that can appear in each field.

```
20.30.03  ISG343I  20:30:02  GRS STATUS 540
SYSTEM    STATE              SYSTEM    STATE
 SYS2      CONNECTED          SYS1      CONNECTED
 SYS3      CONNECTING         SYS4      CONNECTING
```

SYSTEM The name of the system.

STATE The state of the system at the time when the command was issued.

- **CONNECTING** The system is processing the GRS=STAR parameter. It is not yet a member of the star complex.
- **CONNECTED** The system is part of the star complex.
- **REBUILDING** The system is not part of a star complex, but is rebuilding the ISGLOCK lock structure. All tasks that are trying to obtain global resources are suspended by the system.

Figure 49. D GRS Star Explanation

In addition to the states defined for the star complex, the number of locks defined to the ISGLOCK lock structure is displayed. See *z/OS MVS System Messages, Vol 9 (IGF-IWM)* for a description of message ISG343I, which details the output of the DISPLAY GRS command.

Changing RNLs for a Star Complex

You can dynamically change the RNLs that global resource serialization uses in a star configuration, because the sysplex always matches the complex.

To change the RNLs currently being used by global resource serialization, set up the GRSRNLxx parmlib members with the new RNLs. Next, issue the SET GRSRNL command on a system that has access to those members. The new RNLs are then communicated to all systems in the complex. Keep in mind that if the complex is operating under a GRSRNL=EXCLUDE command, you cannot issue either a SET GRSRNL=EXCLUDE or the SET GRSRNL= command. Note that even though only one system needs the updated parmlib members to start the change, you must copy the updated GRSRNLxx parmlib members to each system's parmlib. Any system that needs to can then IPL again into the same complex. For example, if you issue SET GRSRNL=(BN,K1) to change RNLs, and you use IEASYSK1 to IPL your systems, IEASYSK1 should contain GRSRNL=(BN,K1). Otherwise, the change will be in effect only for the duration of the IPL.

Global resource serialization ensures that the integrity of all resources is maintained throughout the RNL change. In particular, before an RNL change can complete, special processing may be performed if any jobs are using the resources that are different in the old and new RNLs. These resources are known as *affected* resources. Jobs issuing new requests for these resources are suspended until the RNL change is complete. These are known as *suspended jobs*. The following message is issued on each system in the complex that has suspended one or more jobs:

```
ISG210E RNL CHANGE WAS INITIATED BY SYSTEM sysname
        SOME JOBS ARE BEING SUSPENDED UNTIL RNL CHANGE COMPLETES.
```

If any job currently holds one or more of the affected resources, the change is delayed until all of the affected resources are freed. Jobs holding an affected resource (and thereby delaying the RNL change) are *delaying jobs*. When jobs are holding affected resources and delaying the change, the following messages are issued on whichever console originated the RNL change:

```
ISG219E RNL CHANGE WAITING FOR RESOURCES TO BE FREED.
        TO LIST DELAYING JOBS, USE ROUTE SYSNAME,DISPLAY GRS,DELAY.
        TO LIST SUSPENDED JOBS, USE ROUTE SYSNAME,DISPLAY GRS,SUSPEND.
ISG220D REPLY C TO CANCEL RNL CHANGE COMMAND, OR S FOR SUMMARY OF RNL
        CHANGE PROGRESS.
```

Getting a List of Delaying Jobs: The DISPLAY GRS,DELAY (D GRS,DELAY) operator command lists the jobs that hold affected resources and are causing the change to be delayed. The jobs listed might release the affected resources normally, or they can be cancelled at the discretion of the installation. Once these jobs release the affected resources, the RNL change completes.

Getting a List of Suspended Jobs: The DISPLAY GRS,SUSPEND (D GRS,SUSPEND) operator command lists the jobs that are being suspended due to the RNL change. The jobs listed will remain suspended until the RNL change completes, or until the RNL change is cancelled.

Responding to the ISG220D Message: Replying to message ISG220D with an S produces a summary of the RNL change progress. This summary indicates the number of jobs on each system that are delaying or are suspended by the RNL change. Replying to message ISG220D with a C causes the RNL change to be cancelled.

If the operator chooses not to respond to message ISG220D with a C, the change will take place when all delaying jobs release the affected resources.

Cancelling the RNL Changes or Jobs: There might be instances where the operator must either cancel the RNL change or cancel jobs that hold the affected resources. For example:

1. A job that is not cancellable is holding affected resources for a long time, you might want to cancel the RNL changes.

2. If a job holding an affected resource cannot DEQ that resource because it is suspended by global resource serialization pending a new ENQ for another affected resource, you might want to cancel RNL changes.
3. If the job is waiting for some other work in the system that has issued an ENQ for an affected resource and has become suspended, you might want to cancel RNL changes.
4. A job that is suspended by the RNL change is considered more important than the RNL change, you might want to cancel RNL changes.

See *z/OS MVS System Commands* for more information about DISPLAY GRS and SET GRSRNL commands.

Rebuilding the ISGLOCK Structure

MVS services include a **rebuild** function that allows the global resource serialization coupling facility structure, ISGLOCK, to be resized. The operator can initiate a rebuild of the structure by entering the following command:

```
SETXCF START,REBUILD,STRNAME=ISGLOCK
```

An operator's rebuild request results in the structure being recreated on either the same coupling facility or a different coupling facility, depending on the current coupling facility resource management (CFRM) policy for the structure.

In conjunction with the rebuild function, there is a **stop rebuild** function which allows an in-process rebuild to be terminated. If a rebuild of a structure has been initiated and the operator wants to terminate it, the operator can enter the following command. Global resource serialization always honors a **stop rebuild** request and attempts to return to, and use, the original lock structure. Any systems that no longer have access to the original structure will be terminated with a X'0A3' wait state and a reason code of X'C8'.

```
SETXCF STOP,REBUILD,STRNAME=ISGLOCK
```

Shutting Down a Coupling Facility

You might, for whatever reason, want to shut down a coupling facility that contains the ISGLOCK lock structure. Before you shut down the original coupling facility, make sure that another coupling facility is available for use by the sysplex. The ISGLOCK lock structure has the following properties:

- The ISGLOCK lock structure cannot be deleted.
- Failure to connect to the new structure during rebuild, depending on the sysplex failure management (SFM) policy, cause one of the following conditions:
  - Systems that cannot connect are put into a wait state.
  - Rebuild is cancelled.
  - Global resource serialization tries continuously to rebuild the structure, if the original problem is a structure failure and either the new structure fails or the operator tries to stop the rebuild.

The procedures to shut down a coupling facility containing the ISGLOCK lock structure, when there is another coupling facility available, are as follows:

1. Reduce the workload (the less the workload, the faster rebuild will complete)
2. Issue SETXCF START,REBUILD,STRNAME=ISGLOCK,LOC=OTHER
3. Wait for message ISG325I on all systems:

   ```
   ISG325I GRS LOCK STRUCTURE (ISGLOCK) REBUILD HAS COMPLETED ON
   sysname.
   ```

4. Shutdown the original coupling facility

Steps in Converting to a Star Complex

There are two phases to migration that you need to consider. They are:

1. Migrating to the new release.

   If the installation does not plan to run a star complex after the new release is installed, re-IPL the system specifying GRS=JOIN to bring the system back into the ring complex. The only systems that should remain in the ring complex are systems connected to the coupling facility.
2. Converting from a ring complex to a star complex.

Converting to a Star Complex

If your installation is already running a ring, do the following to migrate to a star complex:

1. Set up new GRSCNFXX and IEASYSxx parmlib members to define the parameter information that will be needed later for the star complex. See *z/OS MVS Initialization and Tuning Reference*.
2. If the complex is a mixed complex, convert any non-sysplex systems to sysplex systems, or remove non-sysplex systems from the complex. Make sure that non-sysplex systems are not using resources that are shared by systems in the sysplex.
3. Do any hardware changes that need to be done to prepare for the use of the coupling facility hardware.
4. Define the ISGLOCK lock structure for global resource serialization. The structure must be accessible to all systems in the complex.
5. Create a new sysplex couple data set that contains the global resource serialization record, and make the new data set the active sysplex couple data set.
6. At this point, depending on what is best for your installation you can:
   - Take down the entire ring complex and re-IPL each system specifying GRS=STAR, or
   - Use the SETGRS MODE=STAR command to migrate from a ring to a star complex without a complex-wide IPL.

Using the SETGRS Command to Convert to a Star Complex

The SETGRS command is used to migrate an active ring to a star complex without requiring a complex-wide IPL. You can not use the SETGRS command to migrate from a star to a ring complex. (Returning to a ring complex requires an IPL of the complex.)

```
SETGRS MODE=STAR
```

MODE=STAR
: Indicates that the ring complex is to be converted to a global resource serialization star complex.

If you elect to use the SETGRS command, to dynamically switch from a ring complex to a star complex, do the following:

1. Make sure that there are no ring disruptions or dynamic RNL changes in progress.
2. Notify the interactive user community that there may be a temporary holdup in their activity for several minutes while the migration takes place.

3. Issue the SETGRS MODE=STAR command on any system in the complex.

It will take a few minutes for the migration to complete. As each system migrates to the star the following messages are issued:

- `ISG331I SYSTEM` *sysname* `INITIATED SYSPLEX-WIDE MIGRATION TO GRS STAR MODE. THIS SYSTEM IS PARTICIPATING IN THE MIGRATION.`
- `ISG337I GRS LOCK STRUCTURE (ISGLOCK) CONTAINS` *lockentries* `LOCKS.`
- `ISG300I GRS STAR COMPLEX INITIALIZATION COMPLETE.`

If the operator issues the D GRS command during migration, a variety of statuses will be displayed. First, the status for all system in the ring will change to migrating. The systems will then disappear from the list of systems in the message display, and the display changes to the star format. When the systems reappear, their status will be displayed as connecting. There is no cause for alarm if some systems are missing from the message display at this point in the migration. Once migration is complete, all systems should be displayed as connected.

Conditions During Dynamic Conversion: While the system is processing a SETGRS MODE=STAR command, GQSCAN does not work (fails with return code X'0C' with reason code X'10'), and the following global resource serialization requests are suspended:

- ENQ
- DEQ
- RESERVE

The length of time global resource serialization requestors are suspended may be a few minutes while the ISGLOCK lock structure and global resource serialization sysplex couple data set records are initialized with all of the complex-wide information, and significant changes are made to the internal control block structures. IBM recommends that you migrate at a time when the amount of global resource request activity is likely to be minimal.

- During the migration to a star complex, ISG377E and ISG378E may be issued, indicating a global resource serialization ring disruption is in progress, and may remain outstanding for a long time. This is normal. They will be removed before the ring complex has completed migration to a star complex.
- Because to the restructuring of global resource serialization control structures, some ABEND records may appear in LOGREC during a SETGRS MODE=STAR migration. However, no dumps will be taken for this class of expected abends.

Part 3. Global Resource Serialization Ring

Chapter 7. Ring Processing

As stated earlier, a global resource serialization ring complex consists of one or more systems connected by communication links. Global resource serialization uses the links to pass information about requests for global resources from one system in the complex to another.

Regardless of the physical configuration of systems and links, the global resource serialization complex consists of every system that indicates at IPL time that it is to be part of the complex. For various reasons, such as a system or link failure, not all of the systems in the complex might be actively using global resource serialization at any particular time. Those systems that are actively using global resource serialization to serialize access to global resources make up the **global resource serialization ring**.

Figure 50 shows a four-system global resource ring serialization complex. When all four systems in the complex are actively using global resource serialization, the complex and the ring are the same.

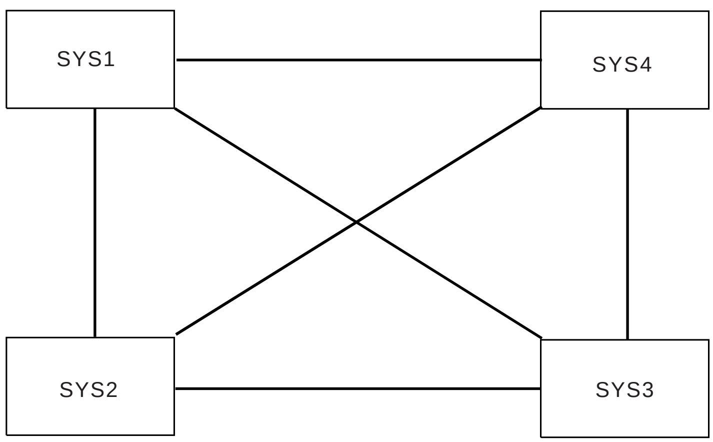


Figure 50. Fully-Connected Four-System Complex

The complex shown in Figure 50 has a communication link between each system and every other system; such a complex is a **fully-connected complex**. A sysplex requires full connectivity between systems. Therefore, when the sysplex and the complex are the same, the complex has full connectivity. Although a mixed complex might not be fully connected, a fully-connected complex allows the systems to build the ring in any order and allows any system to withdraw from the ring without affecting the other systems. It also offers more options for recovery if a failure disrupts ring processing.

If system SYS1 were to fail and end its active participation in serializing access to global resources, it would still be part of the complex, but it would not be part of the ring. Figure 51 shows the ring that would continue processing after system SYS1 stopped serializing access to global resources.

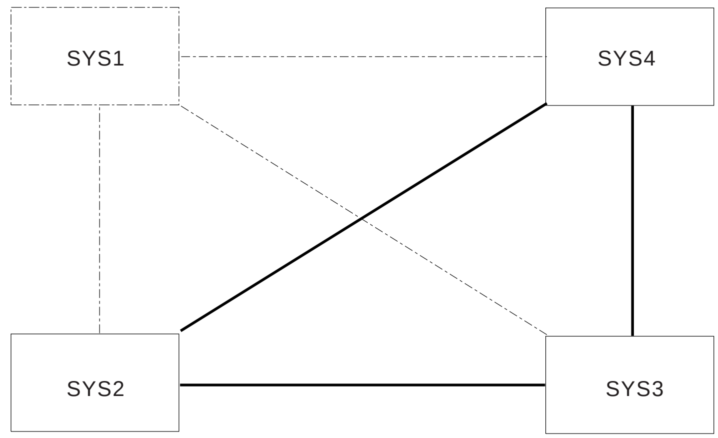


Figure 51. Three-System Ring — SYS1 Failed

Chapter 8, “Designing the Complex” on page 115 describes how to design the complex in detail. Chapter 9, “Operating the Complex” on page 145 describes how to plan operational procedures for the complex you design.

The concept of the global resource serialization ring is important because, regardless of the physical configuration of systems and links that make up the complex, global resource serialization uses a ring processing protocol to communicate information from one system to another. Once the ring is active, the primary means of communication is the ring system authority message (RSA-message).

The RSA-Message

The RSA-message contains information about requests for global resources (as well as control information). It passes from one system in the ring to another. No system can grant a request for a global resource until other systems in the ring know about the request; your installation, however, can control how many systems must know about the request before a system can grant access to a resource. (See “Processing a Request for a Resource” on page 111.) The RSA-message contains the information each system needs to protect the integrity of resources; different systems cannot grant exclusive access to the same resource to different requestors at the same time.

When a system receives a request for a global resource, the system suspends the requestor and, when the RSA message arrives, places the request in the RSA-message. Systems in the global resource serialization ring batch their requests for global resources. For example, a system might receive seven requests for global resources while waiting for the incoming RSA-message — the message it receives from the preceding system. It adds all seven requests to the outgoing RSA-message — the message that it sends on to the next system in the ring. Batching requests for resources minimizes the communication overhead for global resource serialization.

The order and direction of the RSA-message can change when systems enter or leave the ring. The amount of time that each system holds the RSA-message is called the **residency time**. Your installation sets the general limits for residency time. While it holds the RSA-message, each system processes the requests in the incoming RSA-message and adds its new requests to the outgoing RSA-message.

Processing a Request for a Resource

Global resource serialization processes requests for local resources and requests for global resources differently. When a task running on a system in the ring requests a local resource, that system handles the request on its own. Global resource serialization does not place a local resource request in the RSA-message.

When a task running on a system in the ring requests a global resource, however, the processing is very different because each system in the ring must keep track of all requests for global resources. How the ring processes a request for a global resource depends on whether or not your installation uses ring acceleration.

Request Processing without Ring Acceleration

Figure 52 summarizes the processing of a global resource request without ring acceleration. The steps include:

1 The originating system suspends the requesting task.

2 When the incoming RSA-message arrives, the system places the request in the outgoing RSA-message, then passes the RSA-message on to the next system in the ring.

3 The request in the RSA-message makes a cycle around the ring. Each system in the ring records the request.

4 When the RSA-message completes its cycle, the originating system recognizes that all systems know about the request. The originating system then actually processes the request; it grants access to the resource according to normal ENQ processing. That is, if the resource is available, the system grants the suspended task access to the resource and marks the task as ready to execute. If the resource is not available, the task continues to wait until it becomes available.

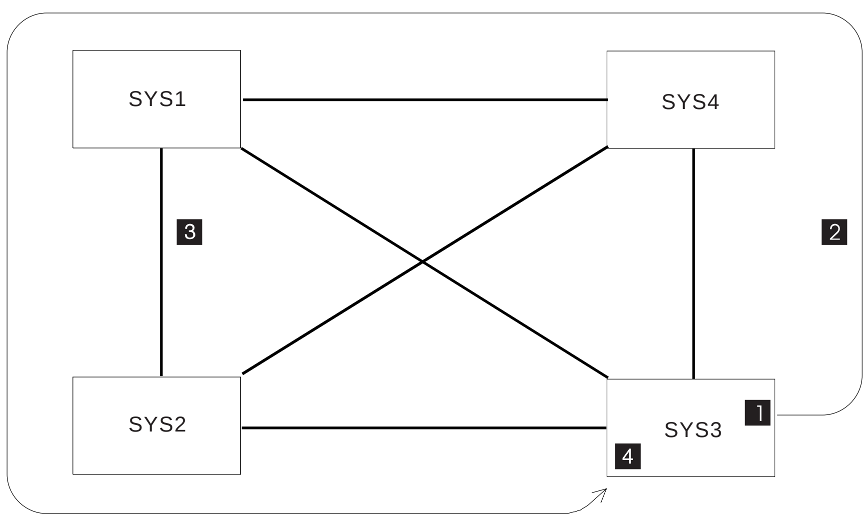


Figure 52. Global Resource Request Processing without Ring Acceleration

This processing ensures that each system in the ring has the same information about global resources at any particular time. The fact that each system has the same information ensures recovery from a failure that disrupts ring processing. Global resource serialization can maintain data integrity. Each system has accurate information about the state of all global resources granted at the time it last sent the RSA-message on to the next system in the ring. Thus, each system has the information it needs to:

1. Prevent different systems from allocating the same resource to different requestors
2. Allow the ring to continue processing without data integrity exposures even after multiple communication link or system failures

This processing, however, means that every task that requests access to a global resource is suspended for at least the time it requires for the RSA-message to complete its cycle around the ring. For installations that cannot tolerate this delay, global resource serialization provides an alternative ring processing technique called ring acceleration.

Request Processing with Ring Acceleration

Ring acceleration is available only when all systems in the ring are running MVS/SP Version 3 or higher. Ring acceleration also requires alternate links, except between systems in a sysplex, and IBM recommends that the complex be a fully-connected complex. An installation where the complex is the same as the sysplex does not need to perform any additional setup to use ring acceleration; multisystem sysplexes must be fully connected. To achieve full connectivity in a mixed complex, however, see Chapter 8, “Designing the Complex” on page 115 for details about how to define the necessary links.

Ring acceleration can significantly reduce the amount of time tasks spend waiting for global resources, especially in a large complex. It can, however, affect recovery. “Ring Acceleration (ACCELSYS)” on page 133 describes the factors involved in determining how your installation should use ring acceleration.

Using ring acceleration changes the processing of a global resource request. Figure 53 on page 113 summarizes the processing of a global resource request with ring acceleration. The steps include:

1 The originating system suspends the requesting task.

2 When the incoming RSA-message arrives, the system places the request in the outgoing RSA-message, then passes the RSA-message on to the next system in the ring.

3 Your installation chooses the number of systems that must see the RSA-message before a system sends a “shoulder-tap”, an acknowledgement that it has received the RSA-message, to the originating system. Assuming that the number of systems is two, the next system in the ring sends the shoulder-tap to the originating system.

4 When the originating system receives the shoulder-tap, the ring acceleration signal, it grants access to the resource according to normal ENQ processing. That is, if the resource is available, the system grants the suspended task access to the resource and marks the task as ready to execute. If the resource is not available, the task continues to wait until it becomes available.

5 The RSA-message continues on its cycle around the ring so that each system in the ring knows about the request. The task that requested the resource, however, does not need to wait for the cycle to complete before obtaining access to the resource.

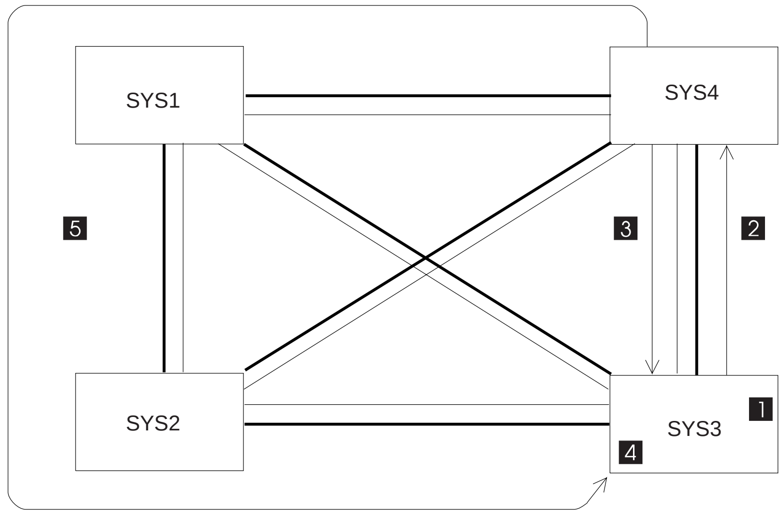


Figure 53. Global Resource Request Processing with Ring Acceleration

Chapter 8. Designing the Complex

In a sense, the decisions you make about how you want to process requests for various resources are the decisions that set your installation's goals for global resource serialization. The actual global resource serialization complex that you design is one of the tools you use to achieve these goals.

As stated earlier, a global resource serialization complex consists of all the systems that are able to share global resources. There are links between the systems that enable them to communicate, primarily by passing the RSA-message from one system to another. Each system in the complex indicates at IPL time that it is to be part of the complex.

Designing the complex involves answering these basic questions:
1. What resources does your installation want to share?
2. Which systems use these resources?

The resources your systems need to share determine the systems in the complex. The most likely candidates, of course, are those systems that are already serializing access to resources on shared DASD volumes and, especially, those systems where interlocks, contention, or data protection by job scheduling are causing significant problems. In addition, systems operating in a multisystem sysplex must also be in the same global resource serialization complex.

Note: "Systems" refers to the number of MVS operating systems, not the number of processors. For example:
- In a PR/SM environment, many systems can run in the same processor complex if they are in Logical Partitions (LPARs). The number of systems allowed varies by processor. See *PR/SM Planning Guide* to determine the number supported for your processor.
- Under VM/ESA multiple MVS systems can run as second-level systems in the same processor complex.

It is possible for a single installation to have two or more global resource serialization complexes, each operating independently. However, the independent complexes should not share resources. Also, there should be no common links made available to global resource serialization on any two complexes.

To avoid a data integrity exposure, ensure that no system outside the complex can access the same shared DASD as any system in the complex. If that is unavoidable, however, you must serialize the data on the shared DASD with the RESERVE macro. You need to decide how many of these systems to combine in one complex. The design of global resource serialization can support up to 32 systems. The actual number of systems your particular installation can reasonably configure into a complex depends on a number of factors. You should, for example, consider the operations and performance implications of a large ring complex. See *z/OS MVS Setting Up a Sysplex* for more information.

Note: Only **one** sysplex can exist in any global resource serialization complex.

The way you approach the task of designing a global resource serialization complex depends on your system environment. If you are operating a global resource serialization complex where all the systems are part of the same sysplex, see "Designing a Complex That Matches a Sysplex" on page 116. If you are operating a global resource serialization complex where not all of the systems in the complex are in the multisystem sysplex (a mixed complex), you have many explicit decisions to make. Section "Designing a Mixed Complex (Sysplex Does Not Match Complex)" on page 122 explains the setup procedures for other global resource serialization complex configurations. This section also describes concerns that may arise during migration from an existing global resource serialization complex to a sysplex.

Designing a Complex That Matches a Sysplex

Global resource serialization uses XCF signalling paths to communicate between systems in a sysplex. You do not need to define links for global resource serialization. See Figure 54.

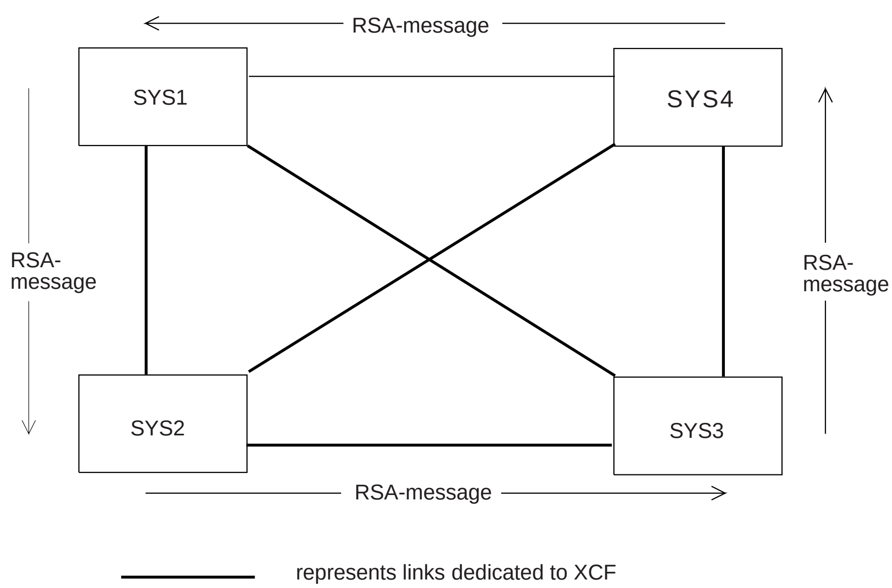


Figure 54. Links in a Sysplex

You must, however, define the global resource serialization processing options that your complex needs. For example, you must decide:

- The length of the residency time value, that is, the minimum length of time a system holds the RSA-message before sending it on to the next system in the ring
- The length of the tolerance interval, that is, the maximum length of time that global resource serialization is to wait for the incoming RSA-message before it signals a disruption
- Whether ring acceleration is to be used, and if so, the number of systems in the ring that need to know about global ENQ requests before they can be granted.

Use the information in "Processing Options in a Sysplex" on page 117 to make these decisions.

Sysplex Migration Reference

See *z/OS MVS Setting Up a Sysplex* for information concerning how to set up a sysplex.

Processing Options in a Sysplex

Processing options provide the information that global resource serialization needs about the systems in the complex. Some of this information comes from the system parameters specified at IPL time. These parameters are:

- SYSNAME=xxxxxxxx — identifies the system name. Each system must have a unique system name, which can be up to 8 characters. For simplicity, the four-character SMF SID is typically used.
- GRS=TRYJOIN — indicates that a system is to become part of the global resource serialization complex by joining an already existing complex, or by starting the complex if this is the first system IPLed into the complex. The operator does not need to be aware of the status of the other systems in the complex and generally is not prompted for START or JOIN at IPL. See "IPL" on page 151 for restrictions.
- GRSRNL=xx — identifies the GRSRNLxx parmlib member that holds the RNLs the system is to use. GRSRNL=EXCLUDE, however, specifies that no resource requests are to be treated as global ENQs, other than those ENQ macros coded with SCOPE=SYSTEMS,RNL=NO.

  Chapter 2, "Selecting the Data" on page 13 described how to use GRSRNLxx to define the RNLs. *z/OS MVS Initialization and Tuning Reference* contains complete information about how to code the GRSRNL system parameter.
- GRSCNF=xx — identifies the GRSCNFxx parmlib member that defines the complex. IBM supplies the GRSCNF00 parmlib member for your use. GRSCNF00 contains the default values shown in Figure 55.

```
GRSDEF
        RESMIL(10)
        TOLINT(180)
        ACCELSYS(99)
```

Figure 55. GRSCNF00 Parmlib Member

Because you are initializing a multisystem sysplex that matches the complex, you can use GRSCNF00 with the default values to define all the systems in your complex. Whether you use GRSCNF00 or supply your own parmlib member, you can use the same member on all systems in the sysplex.

Planning Aids

Table 7 on page 121 provides a worksheet you can use for defining a complex that matches the sysplex.

Reference Book

Once you have completed your plan, see *z/OS MVS Initialization and Tuning Reference* for information about how to specify the global resource serialization parmlib member and system parameters.

Residency Time Value (RESMIL)

Use the RESMIL option in GRSCNFxx to specify the residency time value. The residency time value is the minimum length of time in milliseconds the RSA-message resides at each system in the complex in addition to the processing time. The actual amount of time an RSA-message resides at a system varies.

Prior to MVS/ESA SP Version 4, the system holds the RSA-message until the RESMIL value expires. The system does not adjust the residency time to allow for other factors in the complex. Starting with MVS/ESA SP Version 4, the system holds the RSA-message for a variable length of time — based on the minimum length of time specified by RESMIL and a maximum value calculated by global resource serialization. The amount of time is that which the system calculates to be a good balance between quick response time and effective processor utilization. The residency time calculated by the system will never be less than the specified RESMIL value.

Starting with SP 5.1, the system further tunes the residency time by adjusting the time based on the number of systems in the ring. Rather than calculating the time within a fixed value range, the SP 5.1 system calculates the residency time within a variable range. Thus, in a ring composed of more than eight systems, the system tunes the RESMIL value to a shorter residency time than in a ring composed of fewer systems.

Also with SP 5.1 and higher, you can set the RESMIL option to OFF to specify that no residency time is required. In a ring made up of small systems, the amount of time used by I/O and other processing generally compensates for any additional residency time that RESMIL would have provided. By specifying OFF, you indicate that the minimum residency time is zero and that the system is not to do any tuning.

Choosing a RESMIL Value: The following topics discuss considerations when choosing a RESMIL value:

- "Residency Time Value (RESMIL)" on page 117 discusses how the RESMIL value can affect the performance of your complex. The default value for RESMIL in systems at and above MVS/ESA SP 5.1 and OS/390 R1 is 10 milliseconds. However, depending on your processor and workload configuration, this value might be too high for your installation.
- "Tuning the Complex" on page 169 discusses the importance of achieving an acceptable response time and how the RESMIL value can affect that response time. Charts are provided that show examples of what RESMIL value to specify to achieve the desired response time (Table 11 on page 174 and Table 12 on page 174).

Tolerance Interval (TOLINT)

Use the TOLINT option in GRSCNFxx to specify the tolerance interval. The tolerance interval is the length of time that global resource serialization is to wait for an overdue RSA-message before it signals a disruption. Determining an acceptable time-out value warrants the following considerations in a global resource serialization complex:

- The excessive spin time and recovery actions for each system
- The number of systems
- The speed of the systems
- Inter-system signalling configuration, and activity
- Paging of the global resource serialization common area storage for each system
- The RESMIL time for each system

When the sysplex matches the complex, IBM recommends that TOLINT be set to the default value of 180 seconds. Depending on your installation, this value can be raised or lowered. Keeping it set to a relatively high time-out value (180 seconds) will prevent premature global resource serialization disruptions in cases where there are unexpected but recoverable delays involving the ring.

If a system fails and is partitioned out of the sysplex, global resource serialization is notified of this condition and will commence a ring rebuild operation without waiting for the TOLINT value to expire.

Typically, the RSA-message should proceed quickly around the ring. A system that fails or is stopped temporarily, or a link that fails or temporarily slows down communication, can cause a significant delay of the RSA-message, such as,

- An MVS image recovering from a spin loop
- An MVS image is taking an SVC dump
- Delays in inter-system communications
- Shortages in real storage
- Auxiliary storage page-in delays

During a ring disruption, all tasks that request or free global resources are suspended because the RSA-message is halted and there is no communication between systems in the ring. As the ring disruption continues, more and more tasks are suspended, slowing the throughput of each system in the ring. The ring is then automatically rebuilt without the failed system or link. Once the ring has been rebuilt, global resource serialization will resume processing resource requests.

The value you set for TOLINT affects how rapidly global resource serialization detects an overdue RSA-message, and setting the value properly requires a basic trade-off:

- To detect a system failure or a link failure, the best TOLINT value is one that recognizes the condition almost immediately.
- To deal with a temporary delay, the best TOLINT value is one that does not detect the condition. There are many reasons for a system entering a temporary stop, such as a spin loop or taking an SDUMP to capture the contents of common storage. For a temporarily stopped system or a temporary link delay, the best TOLINT value is one that is large enough to allow normal RSA-message processing to resume without causing a ring disruption.

Thus, the best TOLINT value is one that allows global resource serialization to detect a system or link failure promptly but does not cause it to continuously detect temporary delays. If you specify RESTART(YES) and REJOIN(YES), setting a low TOLINT value has minimal effect because ring recovery is automatic. If your installation chooses not to use automatic restart and rejoin, set a higher value to avoid unnecessary ring disruptions that require operator intervention. The default value for TOLINT is three minutes. Depending on your installation, this value can be lowered. In other complexes, or when MVS is running in a PR/SM environment, a good value is between 40 and 60 seconds. If MVS is running as a guest under VM, set the set TOLINT value even higher.

Note: Systems in a multisystem sysplex will automatically rebuild a disrupted global resource serialization ring. A disabled system in a multisystem sysplex will automatically rejoin a disrupted global resource serialization ring once the disabled system has recovered.

Ring Acceleration (ACCELSYS)

Use the ACCELSYS option in GRSCNFxx to specify whether or not the complex is to use ring acceleration and, if so, how many systems must see the RSA-message before a system sends the shoulder-tap acknowledgment.

Without ring acceleration, every system in the ring must see each request for a global resource before it can be granted. While the RSA-message makes a complete cycle around the ring, the task that requested the global resource is suspended to guarantee the integrity of resources; no global resource request is granted until all systems know about it. It does, however, mean that every task that requests a global resource must wait for at least one RSA-message cycle.

Ring acceleration offers an alternative technique, which protects the integrity of resources while potentially providing a significant reduction in global resource request response time (the time a task is suspended while waiting for ring processing).

Request Processing: Using Figure 56, assume that a task on SYS1 requested access to a resource and that the RSA-message is moving as shown. Without ring acceleration, the task on SYS1 would wait until the RSA-message made a complete cycle around the ring. Only when SYS2, SYS3, and SYS4 all know about the request can SYS1 grant the resource to the requestor.

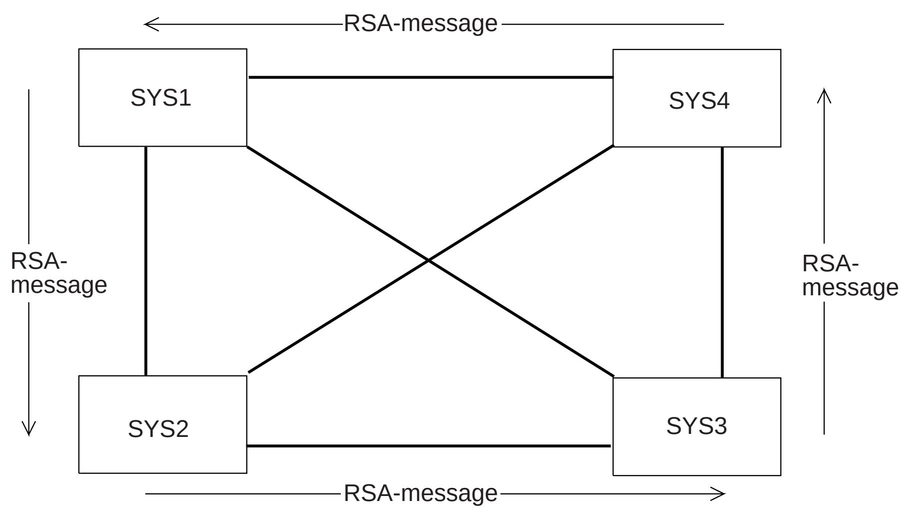


Figure 56. Ring Acceleration Configuration

In contrast, assume that GRSCNFxx contains ACCELSYS(2) to request ring acceleration. With ring acceleration, SYS1 still suspends the task that requested the resource, puts the request in the RSA-message, and sends the RSA-message on to the next system in the ring — SYS2 in this example.

SYS2, when it receives the RSA-message, uses the alternate link to send a shoulder-tap acknowledgment, the ring acceleration signal, to SYS1. SYS2 sends the signal because it is the second system to see the request, and ACCELSYS(2) means that two systems must see the request before it can be granted. After sending the shoulder-tap, SYS2 then processes the RSA-message. The RSA-message continues its cycle around the ring. All systems see and process the request, which preserves the integrity of the resource.

SYS1, as soon as it receives the ring acceleration signal, can grant the request. The task that requested the resource does not have to wait for the RSA-message to make a complete cycle around the ring. If the requested resource is available, the task can resume execution almost immediately.

Using ring acceleration can significantly reduce the amount of time that tasks must wait for access to global resources. On ACCELSYS, you specify the number of consecutive systems that must see the RSA-message before one of the systems sends the shoulder-tap to the originating system. If the complex shown in Figure 56 used a value of ACCELSYS(3), a resource requested on SYS1 would be granted once SYS1 received a shoulder-tap from SYS3.

Recovery: Using ring acceleration can further improve ring performance in large complexes, but it may introduce recovery considerations. When the sysplex matches the complex and ACCELSYS is set to 2, if two consecutive systems in the ring should fail, XCF may prompt the operator to either start or remove one of the systems that is stopped. Otherwise, one of the failed systems may hold the RSA-message and may have sent the shoulder tap to the other, which could have then granted access to resources prior to the system failure. The other systems in the ring would then not be aware that access had been granted to those resources.

ACCELSYS Recommendations: To minimize the chance of such a problem, avoid temporarily stopping more than one system at a time when you are using ring acceleration. See Chapter 9, “Operating the Complex” on page 145 for additional information about operating a global resource serialization complex.

To use ring acceleration, specify ACCELSYS on all systems. ACCELSYS(2) provides the maximum performance benefits. Global resource serialization rejects an ACCELSYS value that is less than 2 or greater than 99. Specifying a value greater than the number of systems in the complex turns ring acceleration off. The default is ACCELSYS(99), which turns ring acceleration off.

Specifying a different ACCELSYS value for different systems in a complex is allowed, but the system uses the highest ACCELSYS value specified to determine when to send the shoulder-tap acknowledgment. If the highest value is greater than the number of systems in the ring, the shoulder-tap acknowledgment does not take place. To ensure that shoulder-tap processing occurs, specify ACCELSYS(n) on all systems in the ring, making sure that the value of n is less then the number of systems in the ring.

Specifying Global Resource Serialization Tracing Options (CTRACE)

The CTRACE parameter in GRSCNFxx allows you to modify the default tracing options used by global resource serialization. Since the defaults provide adequate serviceability information, these should be changed only upon the recommendation of your IBM Service Representative.

Define the Complex to MVS

If necessary, use the worksheet shown in Table 7 to plan the content of GRSCNFxx.

Table 7. GRSCNF____ Definition (Sysplex Matches Complex)

Statement	Parameter	Comments
GRSDEF	RESMIL(______)	
	TOLINT(______)	
	ACCELSYS(_____)	
GRSDEF	MATCHSYS(________)	
	RESMIL(______)	
	TOLINT(______)	
	ACCELSYS(_____)	

Table 7. GRSCNF____ Definition (Sysplex Matches Complex) (continued)

Statement	Parameter	Comments
GRSDEF	MATCHSYS(________)	
	RESMIL(______)	
	TOLINT(______)	
	ACCELSYS(_____)	
GRSDEF	MATCHSYS(__________)	
	RESMIL(________)	
	TOLINT(________)	
	ACCELSYS(_______)	

Designing a Mixed Complex (Sysplex Does Not Match Complex)

As stated earlier, a global resource serialization complex consists of all the systems that are able to share global resources. There are links between the systems that enable them to communicate, primarily by passing the RSA-message from one system to another. Each system in the complex indicates at IPL time that it is to be part of the complex.

You need to decide how many of these systems to combine into one complex. The design of global resource serialization allows up to 32 systems per complex. However, the practical limit is much lower. The actual number of systems your particular installation can reasonably configure into a complex depends on a number of factors. You should, for example, consider the operations and performance implications of a very large complex.

Note: Only one sysplex can exist in any global resource serialization complex.

Once you have selected the systems that are to be part of the complex, you must then define the communication links that connect the systems. Use the information in “Choosing the Link Configuration” on page 123 to help you with this process. Since systems outside of a sysplex cannot communicate using XCF, you must provide communication links that global resource serialization can use. Use the information in “Choosing the Link Configuration” on page 123 to help you with this process.

Choosing the link configuration is one major part of designing a mixed complex; the other is defining the processing options that your complex needs. For example, you must decide:

- The length of the residency time value, that is, the minimum length of time a system is to hold the RSA-message before sending it on to the next system in the ring.
- The length of the tolerance interval, that is, the maximum length of time that global resource serialization is to wait for the incoming RSA-message before it signals a disruption.
- Whether or not the system can automatically rebuild a disrupted global resource serialization ring.
- Whether or not the system can automatically rejoin the ring after it has temporarily stopped.
- Whether or not to use ring acceleration, and if so, the number of systems in the ring that need to know about global resource requests before they can be granted.

Use the information in “Processing Options in a Mixed Complex” on page 128 to make these decisions.

Planning Aids

“Defining the Complex to MVS” on page 137 includes a blank configuration diagram and a worksheet for recording the design of your complex. The diagrams and worksheet can help you implement your plan.

Reference Book

Once you have completed your plan, see *z/OS MVS Initialization and Tuning Reference* for information about how to specify the global resource serialization parmlib member and system parameters.

Choosing the Link Configuration

Systems in the same XCF sysplex communicate with each other only through XCF links. However, global resource serialization links must be defined for communication between systems that cannot communicate with each other through XCF. These include links between all non-sysplex systems, as well as between sysplex systems and non-sysplex systems. See Figure 57 for an illustration. These links can be either a data link in an IBM 3088 Multisystem Channel

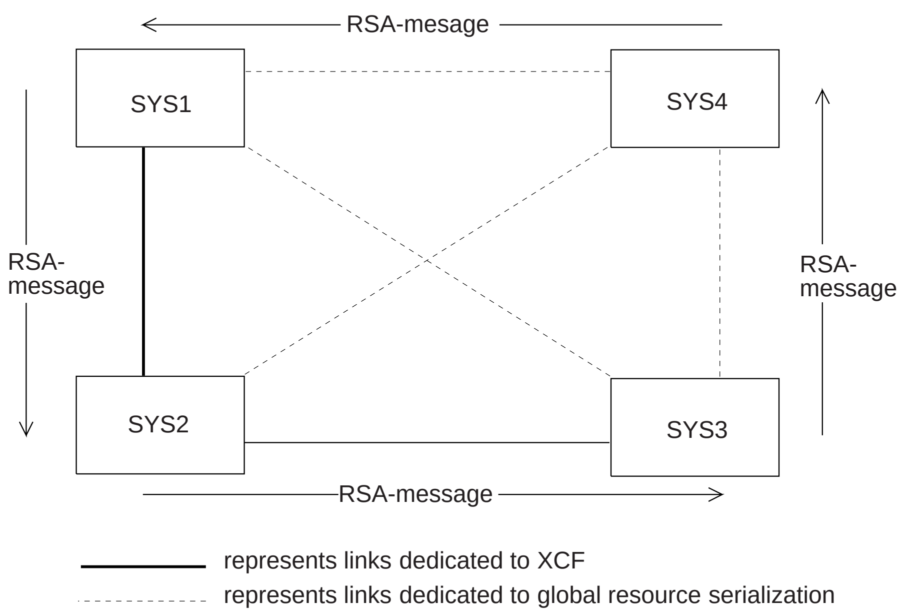


Figure 57. Links in a Mixed Complex

Communication Unit (MCCU) or a parallel CTC adapter. In ring mode, “link” or “CTC link” means either an IBM 3088 data link, a parallel CTC adapter, or an ESCON channel operating in CTC or basic mode.

If your hardware configuration includes an IBM 3088 Multisystem Channel Communication Unit, the number of available communication links is probably not a problem:

- Model A1 can connect two systems through up to 63 data links.
- Model 1 can connect up to four systems through up to 126 data links.
- Model 2 can connect up to eight systems through up to 252 data links.

Each data link is separately addressable and performs exactly the same function as a CTC adapter.

In contrast to the integrated CTC adapter, the IBM 3088 offers many advantages, summarized in the following table.

IBM 3088 MCCU	CTC Adapter
The 3088 allows as many data links as you need.	There can be only one CTC adapter per processor.
The 3088 can share its channel with other control units. Early channel disconnect allows multiple paired links on the same channel.	IBM recommends that a CTC adapter be the only device on its channel.
Channel cables can be up to 400 feet in length. Also, the channel connecting a processor to a 3088 can be extended with fiber optics (IBM 3044 Fiber Optic Channel Extender Link).	Channel cables can be up to 200 feet in length.
The 3088 is powered independently of the processors.	The CTC gets its power from the processor.
The 3088 has a data transfer rate of up to 4.5MB/second.	The CTC has a data transfer rate of 1.5MB/second.

IBM thus recommends that you use the IBM 3088 MCCU to provide channel-to-channel communication among the systems in a global resource serialization complex.

Link Placement

Global resource serialization requires fast communication between systems. Without channel interference, this communication normally requires only a few milliseconds. To achieve the optimum communication speed, place the 3088 on a 3-megabyte or faster data streaming block multiplexor channel.

Other data links used by other MVS subsystems can share the channel, but do not connect data links on the same channel as any devices that keep the channel busy for a long period of time. For example, some DASD control units, such as the IBM 3880, might be compatible while tape and terminal control units are not. The 3088, however, might monopolize the channel, causing delays in I/O operations to DASD.

Note: If one or more of the systems in the complex are running as VM guest systems, provide real CTC links (not virtual CTCs) and dedicate the CTC links to global resource serialization.

Other configuration recommendations are:

- Design a fully-connected complex — one where every system has a communication link to every other system. See “Level of Connectivity” on page 125 for more information.
- Provide at least one alternate (a second connection) for each communication link. Alternate links are required if you want to use ring acceleration to speed up the processing of global resource requests. See “Alternate Links” on page 127 for more information.
- Provide a backup IBM 3088. See “Backup Considerations” on page 128 for more information.

Following these recommendations ensures a complex that provides the best possible performance and availability. Configuration decisions have a significant effect on recovery planning.

Recovery

Any failure that disrupts ring processing requires recovery. Global resource serialization can both detect the failure and respond to it. Depending on options your installation selects, global resource serialization can automatically rebuild a disrupted ring. It can also automatically issue VARY commands to enable and disable communication links. These actions speed up recovery from a failure and reduce operator intervention in the recovery process. The primary causes of a failure that requires recovery are:

- A system fails because of a software problem, which can be either related to ring processing or independent of ring processing.
- A system fails because of a hardware problem.
- A CTC link fails. The failure can occur in the link itself or in any hardware or software component required in the communication path.
- Global resource serialization detects either a temporary problem on a system in the ring (such as when an operator stops a system) as a system failure or a temporary delay in communication as a communication link failure.

Whatever the cause of a break in ring processing, the result is a ring disruption; global resource serialization suspends the processing of requests for global resources until it recovers from the failure.

In designing your complex, plan a complex that can recover from a system or a CTC link failure, regardless of whether the failure is temporary or not.

After a system failure, there should be enough CTC links available to reconfigure a subset ring of **n-1** systems, where **n** is the number of systems in the original ring. That is, you want a complex where a system failure means that only the failed system must withdraw from the ring.

After a CTC link failure, there should be enough CTC links available to reconfigure the original ring. That is, you want a complex where the failure of a single link does not force any system to withdraw from the ring.

To design a complex that can recover effectively from failures, consider both the level of connectivity and the need for alternate CTC links. Alternate links are CTC links that global resource serialization can use for ring acceleration, which improves global resource request response time. Alternate links are available for use when there is a failure on a link that global resource serialization is using to pass the RSA-message around the ring, which improves recovery. Providing an additional 3088 for backup also has significant advantages.

Level of Connectivity

The number of CTC links available to the complex determines, to a great extent, the availability, ease of operation, and performance of the complex.

A **fully-connected complex** exists when every system in the complex has a communication link to every other system in the complex. Each system in a fully-connected n-system complex has **n-1** communication links, where **n** is the number of systems in the complex. For example, each system in a fully-connected four-system complex requires three link connections.

Note: Systems in a sysplex are fully connected with each other.

In contrast, a **partially-connected complex** is one where not every system has a communication link to every other system. That is, some systems in an **n**-system complex have fewer than **n-1** communication links. Systems operating outside of a multisystem sysplex or where the sysplex does not match the complex may be in a partially-connected complex. For example, some systems in a partially-connected four-system complex have less than three communication links. The level of connectivity of the complex affects the operation of the complex in two basic ways. One is the order in which one system starts the complex and other systems join the complex. A partially-connected complex of four or more systems requires coordination of IPLs so that global resource serialization can build a valid ring. The second effect is on recovery from a system or CTC link failure that cannot be repaired immediately. A partially-connected complex limits the reconfiguration options available to recover from the failure.

Figure 58 illustrates the problem of a system failure on a partially-connected complex. It shows an active four-system ring with five communication link connections.

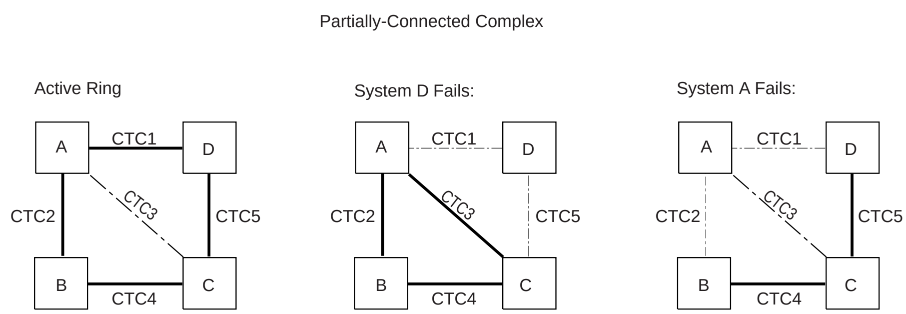


Figure 58. Recovery Problems with a Partially-Connected Complex

If system D fails, global resource serialization can automatically rebuild systems A, B, and C into a three-system ring using CTC2, CTC3, and CTC4, as shown in the figure. The three-system ring can resume processing requests for global resources. This four-system ring can recover just as quickly from a failure on system B.

If system A fails, however, the problem is entirely different because the complex is not fully connected. Global resource serialization cannot rebuild a three-system ring. It can automatically rebuild a two-system ring consisting of systems D and C (using CTC5) or a two-system ring consisting of systems B and C (using CTC4), and there is no way to predict which ring it would build. The same problem occurs if system C fails.

If the complex shown in the figure were fully connected, it would include a CTC link between system B and system D. With this fully-connected complex, global resource serialization can respond to a failure on any system by rebuilding a three-system ring that can quickly resume processing requests for global resources.

The distinction between a fully-connected complex and a partially-connected complex does not exist for a two-system complex or a three-system complex. For these complexes, the number of communication link connections required for full connectivity and the minimum number of communication link connections required are the same.

IBM recommends that you design a fully-connected global resource serialization complex, especially if you are operating a mixed complex that includes a multisystem sysplex. Even a fully-connected complex, however, might not meet the level of reliability or performance your installation requires. Designing a complex that includes alternate links offers significant advantages for both reliability and performance.

Alternate Links

Global resource serialization uses one link, the primary link, to send the RSA-message from one system in the ring to another. Alternate links provide additional connections. At IPL time, global resource serialization uses one link as the primary connection and marks any other links as alternates. Alternate links provide two very important benefits.

If alternate links exist, you can use ring acceleration during normal ring processing. Ring acceleration speeds up the process of granting requestors access to global resources. See "Ring Acceleration (ACCELSYS)" on page 133 for more information.

Alternate links also provide improved recovery. If the primary link fails during ring processing, a ring disruption occurs. If an alternate link is available, however, global resource serialization automatically selects an alternate link to replace the primary link, and ring processing can resume almost immediately. If global resource serialization was using the alternate link to send the ring acceleration signal, and no other link is available, the ring acceleration signal can no longer be sent between the two systems. This loss might affect performance, but the ring continues processing.

Figure 59 shows the problem of a link failure in a three-system complex. If CTC1 fails, system A and system B cannot communicate. Global resource serialization can rebuild a two-system ring, but the two-system ring omits either system A or system B. One of the two systems cannot continue to serialize access to global resources.

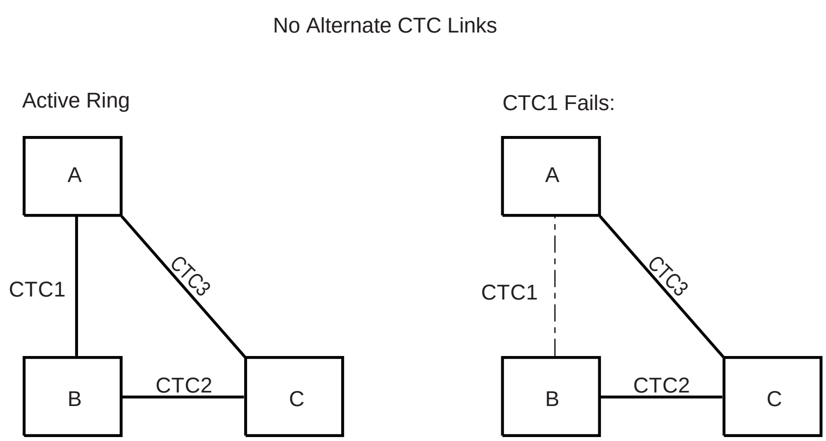


Figure 59. CTC Link Failure — No Alternate Available

Figure 60 shows how alternate links can solve this problem. If there is an alternate link between system A and system B, global resource serialization can use the alternate to rebuild the original three-system ring. The alternate link means that the two systems can continue to serialize access to global resources even when the primary link fails; global resource serialization uses the alternate in place of the primary, and ring processing continues.

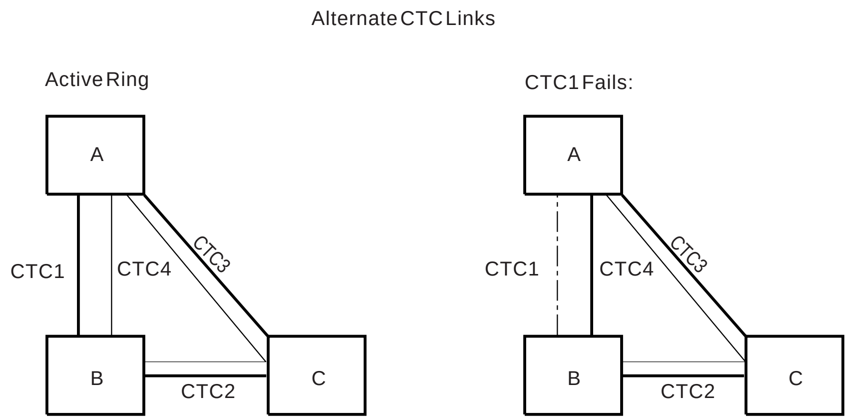


Figure 60. CTC Link Failure — Alternate Available

Because of the recovery and performance benefits, IBM recommends that you provide alternate links for the global resource serialization complex.

Backup Considerations

A fully-connected complex with alternate links provides the option of using ring acceleration as well as a very high level of reliability. It does not, however, remove the IBM 3088 as a potential single point of failure. Thus, IBM recommends that you provide an alternate 3088 to act as a backup. (Integrated CTC adapters can also act as backup connections between systems.)

In such a configuration, dedicate two data links from the primary 3088 and two data links from the alternate 3088 for each connection in your fully-connected complex. If a system runs on a processor that, like the 3090 Model 400E, can be partitioned, connect links from both 3088 units to both sides of the processor complex.

Processing Options in a Mixed Complex

Processing options provide the information that global resource serialization needs about the systems in the complex. Some of this information comes from the system parameters specified at IPL time. These parameters are:

- GRS=START, TRYJOIN, or JOIN — indicates whether the system is to start or join the complex.
- SYSNAME=name — identifies the name the system has in the global resource serialization complex.
- GRSCNF=xx — identifies the GRSCNFxx parmlib member that defines the complex.
- GRSRNL=xx — identifies the GRSRNLxx parmlib member that holds the RNLs the system is to use.

Chapter 2, “Selecting the Data” on page 13 described how to use GRSRNLxx to define the RNLs. This section describes how to use GRSCNFxx to define the processing options for the complex. You must create GRSCNF. Because there is no way of predicting the configuration of a particular installation’s links, IBM does not supply a default GRSCNFxx member for a mixed complex.

The information that you can specify in GRSCNFxx for each system is:

- The name of the system. See “System Name (MATCHSYS)” on page 129.

- The specific device numbers of all CTC links attached to the system and available to global resource serialization. See "CTC Link Device Numbers (CTC)".
- The minimum length of the RSA-message residency time. See "Residency Time Value (RESMIL)" on page 130.
- The length of the tolerance interval — the length of time that global resource serialization is to wait for an overdue RSA-message before it signals a disruption. See "Tolerance Interval (TOLINT)" on page 131.
- Whether or not the complex is to use ring acceleration and, if so, how many systems must see the RSA-message before a system sends the shoulder-tap acknowledgment. See "Ring Acceleration (ACCELSYS)" on page 133.
- Whether or not the system can automatically rebuild a disrupted ring. See "Automatically Rebuilding a Disrupted Ring (RESTART)" on page 135.
- Whether or not the system can automatically rejoin a ring after the system has been temporarily stopped. See "Automatically Rejoining the Ring (REJOIN)" on page 136.
- The tracing options you want available for CTRACE processing. See "Specifying Global Resource Serialization Tracing Options (CTRACE)" on page 136.

z/OS MVS Initialization and Tuning Reference contains complete syntactical information about how to create GRSCNFxx and how to specify the system parameters. Before you can create GRSCNFxx, however, you need to understand the options and what effect each option has on the complex.

System Name (MATCHSYS)

Global resource serialization matches the name specified on the SYSNAME system parameter at IPL time to a name specified on MATCHSYS to locate the information in GRSCNFxx for a particular system. Each system name must be unique within the complex. It is a good practice to use the same four-character name for MATCHSYS that you use to identify the system to SMF, that is, the same value you specify for the SMF SID parameter. Consistent use of the same system name makes identifying the system in various records and messages easier and provides a consistent identifier for the operators.

The syntax of the MATCHSYS parameter in GRSCNFxx allows you to specify MATCHSYS(*). Global resource serialization considers MATCHSYS(*) to be a match to any SYSNAME value. If an operator enters an erroneous value for SYSNAME, global resource serialization sees MATCHSYS(*) as a match and might build the complex incorrectly. To avoid this problem, identify each system explicitly by name in GRSCNFxx.

CTC Link Device Numbers (CTC)

In a mixed complex, use the CTC option in GRSCNFxx to specify the device numbers of all CTC links attached to the system and available to global resource serialization. Specifying CTC links that you might have included at system generation but not yet installed causes global resource serialization to issue an error message (ISG046E) during system initialization.

When you have more than one CTC link between systems, global resource serialization uses the last device number specified as the primary link. Thus, the order in which you specify the device numbers affects how global resource serialization chooses the primary and the alternate links. If two links are on-line and available when a system joins the ring, global resource serialization chooses the second CTC link specified as the primary link and marks the first as an alternate.

For example, if GRSCNFxx specifies CTC(860), followed by CTC(780), global resource serialization selects 780 as the primary and 860 as the alternate.

Residency Time Value (RESMIL)

Use the RESMIL option in GRSCNFxx to specify the residency time value. The residency time value is the minimum length of time in milliseconds the RSA-message spends in each system. The default value for an MVS/ESA SP 5.1 system is 10 milliseconds.

If processing the RSA-message takes longer than the RESMIL value, the system holds the RSA-message until processing is complete. An MVS/ESA SP Version 4 or later system adjusts the actual residency time to optimize processor use and enqueue response time. The actual residency time will never be less than the RESMIL value.

The RESMIL value you specify can further affect the performance of your complex. In general, a low value, which means that the RSA-message passes around the ring more frequently, improves ring performance. That is, a low RESMIL value:

- Increases ring capacity — the number of global resource requests the ring can process
- Decreases response time — the amount of time the ring requires to process a specific request for a global resource.

Thus, setting the RESMIL value is important to tuning your complex for efficient operation. Setting a low RESMIL value increases ring capacity and decreases response time, though it can slightly increase processor utilization. The RESMIL value, however is not the only factor that affects ring performance; the configuration and workload are also important.

Configuration Considerations: To set an optimal value for RESMIL, you must also consider the configuration:

- The transfer rate of the communication device
- The number of systems in the ring

To see how these factors relate, assume that you reduce by half the value of RESMIL on each system in a four-system ring. This action cuts the RSA-message cycle time roughly in half, thus approximately doubling ring capacity and cutting response time in half.

You can obtain a similar result by replacing a CTC adapter connection with an IBM 3088 link connection. The transmission rate of a 3088 data link is about three times as fast as the transmission rate of a CTC adapter. The faster communication speed reduces the RSA-message cycle time, thus increasing ring capacity and decreasing response time.

Adding a system to the ring, however, has the opposite effect; it decreases ring capacity and increases response time. The additional system adds time to the RSA-message cycle. If you are adding a system to the ring, decreasing the RESMIL value or switching to a faster communication device can maintain the existing ring capacity and response time.

Workload Considerations: The rate of global resource requests is the number of requests a system generates in a given time period. The rate depends on the workload. Thus, the workload on the systems in the ring also affects ring performance. TSO/E or a batch workload normally creates more global resource requests than a workload that is mostly CICS, or IMS.

The workload can also determine how important ring performance is. Ring performance is especially important to installations that:

- Run time-sensitive jobs that use global resources or jobs (like HSM back-out) that must complete in a predetermined amount of time
- Are experiencing resource contention problems
- Are planning to use the ring to serialize catalog access

Such installations need the lowest possible RESMIL value. See “Tuning the Complex” on page 169 for more information on performance.

Setting the RESMIL value differently according to the processor’s power does not affect the time (or processor utilization) a system spends processing global resource requests; a system, regardless of the RESMIL value, processes all requests in the incoming RSA-message before it sends the outgoing RSA-message. The RESMIL value affects only the time (or processor utilization) a system spends on ring processing. There is no benefit in trying to use the RESMIL value to adjust for differences in processor power; only the sum of RESMIL values is significant.

RESMIL Recommendations: You do not have to specify the same RESMIL value on all systems, but there is no reason to set different values. The only effect of specifying a large value for one system is to increase the RSA-message cycle time, which decreases ring capacity and increases response time. It is simpler to use the same RESMIL value for all systems.

For a complex that consists only of small systems (such as systems running on an IBM 4381 or only of large systems (such as systems running on an IBM 3090 Model 400E), set RESMIL to the lowest value that works for your complex.

For a complex that includes systems running on both large and small processors, there is a basic problem: the total percent of a small processor’s power spent on global resource serialization might be very high because it must process global resource requests generated on all systems.

Setting the RESMIL value differently according to the processor’s power does not affect the time (or processor utilization) a system spends processing global resource requests; a system, regardless of the RESMIL value, processes all requests in the incoming RSA-message before it sends the outgoing RSA-message. The RESMIL value affects only the time (or processor utilization) a system spends on ring processing. There is no benefit in trying to use the RESMIL value to adjust for differences in processor power; only the average value is significant.

Thus, use the workload on the large processor to select the RESMIL value and set the same value on all systems. If the workload on the large processor generates many requests for global resources, set RESMIL to a lower value on all systems. Otherwise, make no adjustment for processor power.

The same recommendation applies to a ring where each system runs a distinct workload. Use the workload on the system that generates the largest number of global resource requests as a base for setting RESMIL on all systems.

See “Tuning the Complex” on page 169 for a description of some techniques you can use to determine the best value for your complex.

Tolerance Interval (TOLINT)

Use the TOLINT option in GRSCNFxx to specify the tolerance interval. The tolerance interval is the length of time that global resource serialization is to wait for an overdue RSA-message before it signals a disruption. Determining an acceptable time-out value warrants the following considerations in a global resource serialization complex:

- The excessive spin time and recovery actions for each system
- The number of systems
- The speed of the systems
- Inter-system signalling configuration, and activity
- Paging of the global resource serialization common area storage for each system
- The RESMIL time for each system

Typically, the RSA-message should proceed quickly around the ring. A system that fails or is stopped temporarily, or a link that fails or temporarily slows down communication, can cause a significant delay of the RSA-message. Such as,

- An MVS image recovering from a spin loop
- An MVS image is taking an SVC dump
- Delays in inter-system communications
- Shortages in real storage
- Auxiliary storage page-in delays

During a ring disruption, all tasks that request or free global resources are suspended because the RSA-message is halted and there is no communication between systems in the ring. As the ring disruption continues, more and more tasks are suspended, slowing the throughput of each system in the ring.

A ring disruption requires recovery. Global resource serialization can recover automatically from most ring disruptions when you specify automatic restart and automatic rejoin. Specifying RESTART(YES) and REJOIN(YES) allows recovery without operator intervention; global resource serialization issues messages but does not usually require operator action. See “Automatically Rebuilding a Disrupted Ring (RESTART)” on page 135 and “Automatically Rejoining the Ring (REJOIN)” on page 136.

The value you set for TOLINT affects how rapidly global resource serialization detects an overdue RSA-message, and setting the value properly requires a basic trade-off:

- To detect a system failure or a link failure, the best TOLINT value is one that recognizes the condition almost immediately.
- To deal with a temporary delay, the best TOLINT value is one that does not detect the condition. There are many reasons for a system entering a temporary stop, such as a spin loop or taking an SDUMP to capture the contents of common storage. For a temporarily stopped system or a temporary link delay, the best TOLINT value is one that is large enough to allow normal RSA-message processing to resume without causing a ring disruption.

Thus, the best TOLINT value is one that allows global resource serialization to detect a system or link failure promptly but does not cause it to continuously detect temporary delays. If you specify RESTART(YES) and REJOIN(YES), setting a low TOLINT value has minimal effect because ring recovery is automatic. If your installation chooses not to use automatic restart and rejoin, set a higher value to avoid unnecessary ring disruptions that require operator intervention. The default value for TOLINT is three minutes. Depending on your installation, this value can be lowered. In other complexes, or when MVS is running in a PR/SM environment, a good value is between 40 and 60 seconds. If MVS is running as a guest under VM, set the TOLINT value even higher.

If your installation chooses not to use automatic restart and automatic rejoin, set a higher value. The higher value avoids unnecessary ring disruptions that require operator intervention.

The TOLINT value does not have to be the same for all systems, but it is a good idea to specify it consistently. If you set it to different values, the system with the smallest value is the first system to detect the disruption and initiate recovery.

Ring Acceleration (ACCELSYS)

Use the ACCELSYS option in GRSCNFxx to specify ring acceleration and the number of systems that must see a resource request before it is granted.

Without ring acceleration, every system in the ring must see each request for a global resource. While the RSA-message makes a complete cycle around the ring, the task that requested the global resource is suspended. This processing guarantees the integrity of resources; no global resource request is granted until all systems know about it. It does, however, mean that every task that requests a global resource must wait for at least one RSA-message cycle.

Ring acceleration offers an alternative technique, which protects the integrity of resources while potentially providing a significant reduction in global resource request response time (the time a task is suspended while waiting for ring processing).

Ring acceleration requires that all systems in the complex include MVS/SP Version 3 or later. It also requires alternate links, used to send the ring acceleration signal from one system to another. In addition, IBM recommends that the complex be a fully-connected complex. Using ring acceleration can significantly improve ring performance in large complexes; in two-system complexes, it provides minimal benefits.

Figure 61 shows an example of a complex that could use ring acceleration. It is a fully-connected four-system complex with primary links, shown as heavy lines, and alternate links, shown as light lines.

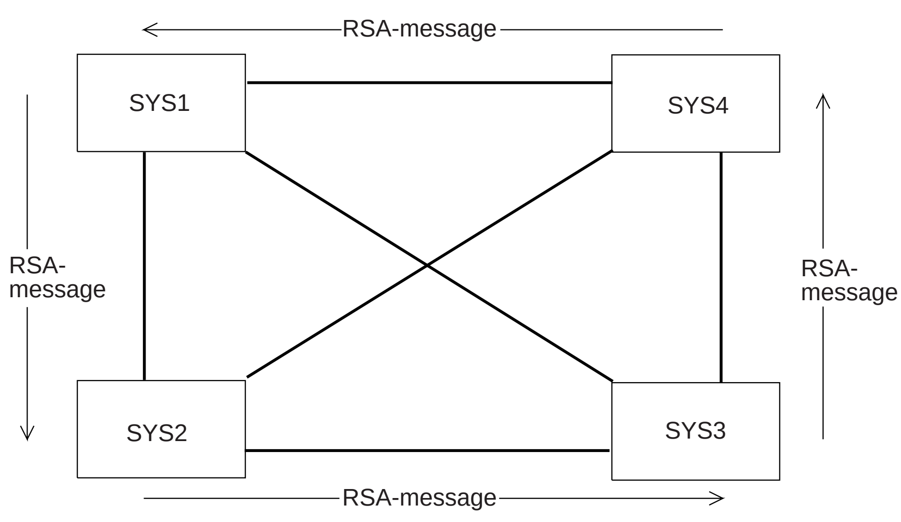


Figure 61. Ring Acceleration Configuration

Request Processing: Using Figure 61, assume that a task on SYS1 requested access to a resource and that the RSA-message is moving as shown. Without ring acceleration, the task on SYS1 would wait until the RSA-message made a complete cycle around the ring. Only when SYS2, SYS3, and SYS4 all know about the request can SYS1 grant the resource to the requestor.

In contrast, assume that GRSCNFxx contains ACCELSYS(2) to request ring acceleration. With ring acceleration, SYS1 still suspends the task that requested the resource, puts the request in the RSA-message, and sends the RSA-message on to the next system in the ring — SYS2 in this example.

SYS2, when it receives the RSA-message, uses the alternate link to send a shoulder-tap acknowledgment, the ring acceleration signal, to SYS1. SYS2 sends the signal because it is the second system to see the request, and ACCELSYS(2) means that two systems must see the request before it can be granted. After sending the shoulder-tap, SYS2 then processes the RSA-message. The RSA-message continues its cycle around the ring. All systems see and process the request, which preserves the integrity of the resource.

SYS1, as soon as it receives the ring acceleration signal, can grant the request. The task that requested the resource does not have to wait for the RSA-message to make a complete cycle around the ring. If the requested resource is available, the task can resume execution almost immediately.

Using ring acceleration can significantly reduce the amount of time that tasks must wait for access to global resources. On ACCELSYS, you specify the number of consecutive systems that must see the RSA-message before one of the systems sends the shoulder-tap to the originating system. If the complex shown earlier in Figure 61 used a value of ACCELSYS(3), a resource requested on SYS1 would be granted once SYS1 received a shoulder-tap from SYS3.

Recovery: Ring acceleration provides significant performance improvement, but it does introduce recovery considerations. The ACCELSYS value, as stated earlier, specifies the number of systems that must see the RSA-message before the originating system can grant a request. It also, in effect, specifies the number of consecutive systems that can fail before ring acceleration introduces a possible data integrity exposure.

For example, look again at the complex shown in Figure 61 and assume that ACCELSYS(2) is in effect. If any single system fails or is stopped temporarily, global resource serialization can safely rebuild the ring because at least one of the remaining systems has current resource information. If two non-consecutive systems, like SYS1 and SYS3, fail or are stopped temporarily, rebuilding the ring safely is still possible because either SYS2 or SYS4 has current resource information.

If, however, two consecutive systems, like SYS1 and SYS2, fail, and one of the failed systems held the RSA-message, then rebuilding the ring safely is not possible. There is a potential data integrity exposure because the failed systems are the systems that have current resource information. For example, assume that SYS2 held the RSA-message and sent the shoulder-tap to SYS1. SYS1, after receiving the shoulder-tap, granted access to one or more resources. If both systems then fail or are stopped temporarily, the active systems (SYS3 and SYS4) do not know about the resources granted on SYS1 and, if the ring were rebuilt, might grant other tasks access to these same resources.

In this situation, global resource serialization does not automatically rebuild the ring. Instead, it issues a unique operator message **ISG080E** . The operator must follow normal installation procedures to resolve any data integrity exposure and then issue a restart command to rebuild the ring.

ACCELSYS Recommendations: To minimize the chance of such a problem, avoid temporarily stopping more than one system at a time. If your operators regularly issue VARY GRS(sysname),QUIESCE for a system before stopping it, you can avoid any recovery problems related to temporarily stopped systems. See Chapter 9, “Operating the Complex” on page 145 for additional information about operating a global resource serialization complex.

To use ring acceleration, specify ACCELSYS on all systems. ACCELSYS(2) provides the maximum performance benefits. Global resource serialization rejects an ACCELSYS value that is less than 2 or greater than 99. The operator must re-IPL with a valid value, or specify GRS=NONE to continue with the IPL. Specifying a value greater than the number of systems in the complex turns ring acceleration off. The default is ACCELSYS(99), which turns ring acceleration off. You can change the ACCELSYS value to tune enqueue response time. See “ACCELSYS Value” on page 174 for more information.

Automatically Rebuilding a Disrupted Ring (RESTART)

Use the RESTART option in GRSCNFxx to indicate whether or not the system can automatically rebuild the ring when it detects an error that disrupts global resource serialization processing.

Specifying RESTART(YES) indicates that the system can automatically rebuild the ring when either one of the following conditions is true:

1. The system can communicate with more than half of all systems that were in the ring (including itself).
2. The system can communicate with exactly one half of all systems that were in the ring; all the systems with which it cannot communicate have the RESTART(NO) option specified.

Having a system rather than the operator initiate recovery has several advantages:

- It can speed up the recovery process significantly.
- It reduces operator intervention in recovery.
- It avoids the possibility of split rings, which can occur when more than one operator tries to restart the ring at the same time, causing the ring to split into multiple independent rings. See “Split Rings” on page 161.

Thus, specify RESTART(YES) whenever possible:

- In two-system mixed complexes, specify RESTART(YES) on one system and RESTART(NO) on the other. Global resource serialization can automatically rebuild a one-system ring if the link fails or if the RESTART(NO) system fails. If you specify RESTART(YES) on both systems, global resource serialization does not restart either system if the link fails.

  Specifying RESTART in this way means that an operator must rebuild a disrupted ring only when:
  - The primary link fails and there is no alternate available
  - The RESTART(YES) system itself fails.

  If one system is more critical than the other, specify RESTART(YES) on the critical system and RESTART(NO) on the on the other; otherwise, arbitrarily choose one system as the RESTART(YES) system.

- In complexes of three or more systems, specify RESTART(YES) for all systems.

Notes:

1. An installation that specifies both RESTART(YES) and REJOIN(YES) can reduce the need for operator intervention in recovery from a ring disruption.
2. RESTART is forced to YES on systems in a sysplex.

Automatically Rejoining the Ring (REJOIN)

Use the REJOIN option in GRSCNFxx to indicate whether or not a system that has been temporarily stopped can automatically rejoin the ring when the system resumes processing. A system that stops temporarily causes a ring disruption; the ring is rebuilt without the stopped system. REJOIN(YES) allows the system to automatically rejoin the ring when it resumes processing; no operator intervention is required. REJOIN(NO) means that the operator must bring the system back into the ring when the system resumes processing.

IBM recommends that you always specify REJOIN(YES) to avoid the problems of operator intervention and operator delay during recovery. REJOIN(YES) does not cause any potential ring processing problems or data integrity exposures. When the automatic rejoin does not succeed, global resource serialization issues messages, and the operator can then intervene to bring the system back into the ring. In general, the automatic rejoin succeeds when there is at least one active system in the ring and an available link between the active system and the rejoining system.

Specify REJOIN(NO) only when your installation needs absolute control over the process of rebuilding a disrupted ring.

Notes:

1. An installation that specifies both RESTART(YES) and REJOIN(YES) can reduce the need for operator intervention in recovery from a ring disruption.
2. REJOIN is forced to YES on systems in a sysplex.
3. On systems running MVS Version 2, REJOIN(YES) cannot be specified with RESTART(NO).

Specifying Global Resource Serialization Tracing Options (CTRACE)

Use the CTRACE parameter in GRSCNFxx to specify the CTRACE options you want for your installation. For more information about global resource serialization component trace, see *z/OS MVS Diagnosis: Tools and Service Aids*. For information about how to specify the options you want, see *z/OS MVS Initialization and Tuning Reference*.

The CTRACE parameter in GRSCNFxx allows you to modify the default tracing options used by global resource serialization. Since the defaults provide adequate serviceability information, you should change them only upon the recommendation of your IBM service representative.

The CTRACE parameter in GRSCNFxx is available only in systems running MVS/SP Version 4 or later.

Minimum Options (MINOPS): Minimum options (MINOPS) are defined for GRS=RING and GRS=NONE so that exceptional events will be traced at all times, regardless of the options specified. CTRACE will permit the trace state to be ON (with both the specified and minimum options in effect) or MIN (only the minimum options in effect). The trace will never be OFF. When viewing the trace data using the IPCS CTRACE subcommand, filtering options will be provided to limit the scope of the data displayed.

Defining the Complex to MVS

A diagram consisting of system blocks and CTC link connection lines is a useful way to represent the configuration of a global resource serialization complex. To make the block diagram also useful as input to the process of defining your complex to MVS, expand the basic diagram to include the information that global resource serialization needs about the systems in the complex.

Figure 62 shows one way to expand the basic block diagram to combine the information MVS needs about your complex with the block diagram design of your complex. The complex shown in the figure consists of 4 systems and 24 CTC links. It is a fully-connected complex with alternate links. The configuration includes a primary IBM 3088 MCCU (3088-P) and a backup 3088 (3088-B). Figure 63 on page 139 is a blank configuration diagram for your use.

To define your complex to MVS, you use the GRSCNFxx parmlib member. You can create a single member that defines all systems in the complex and copy it to the parmlibs of all systems, or you can create a parmlib member for each system that defines only that system. For more efficient testing and control, it is better to define the entire complex in a single member, then copy that member to the parmlib of each system.

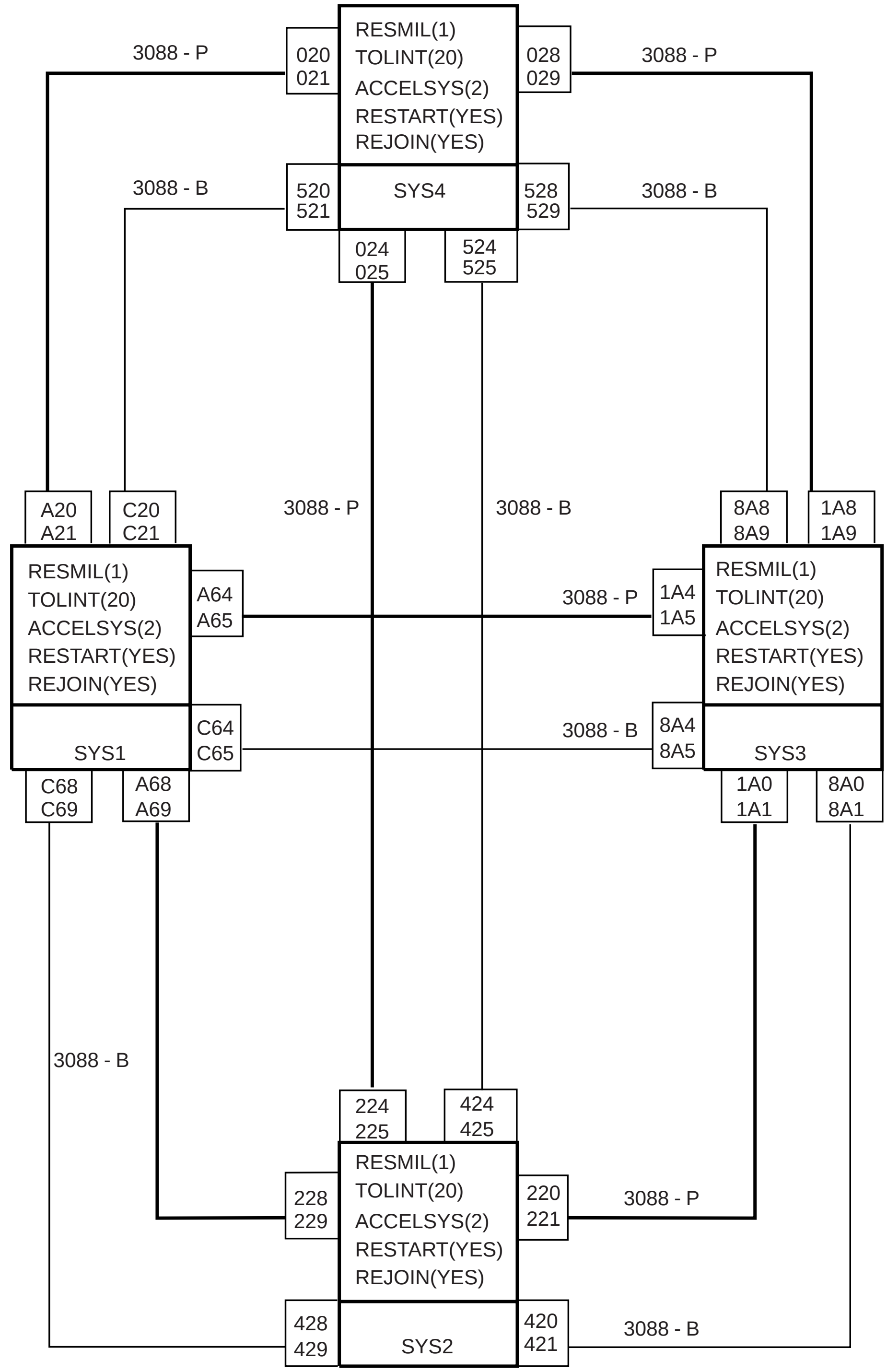


Figure 62. Sample Complex Design and Definition Diagram

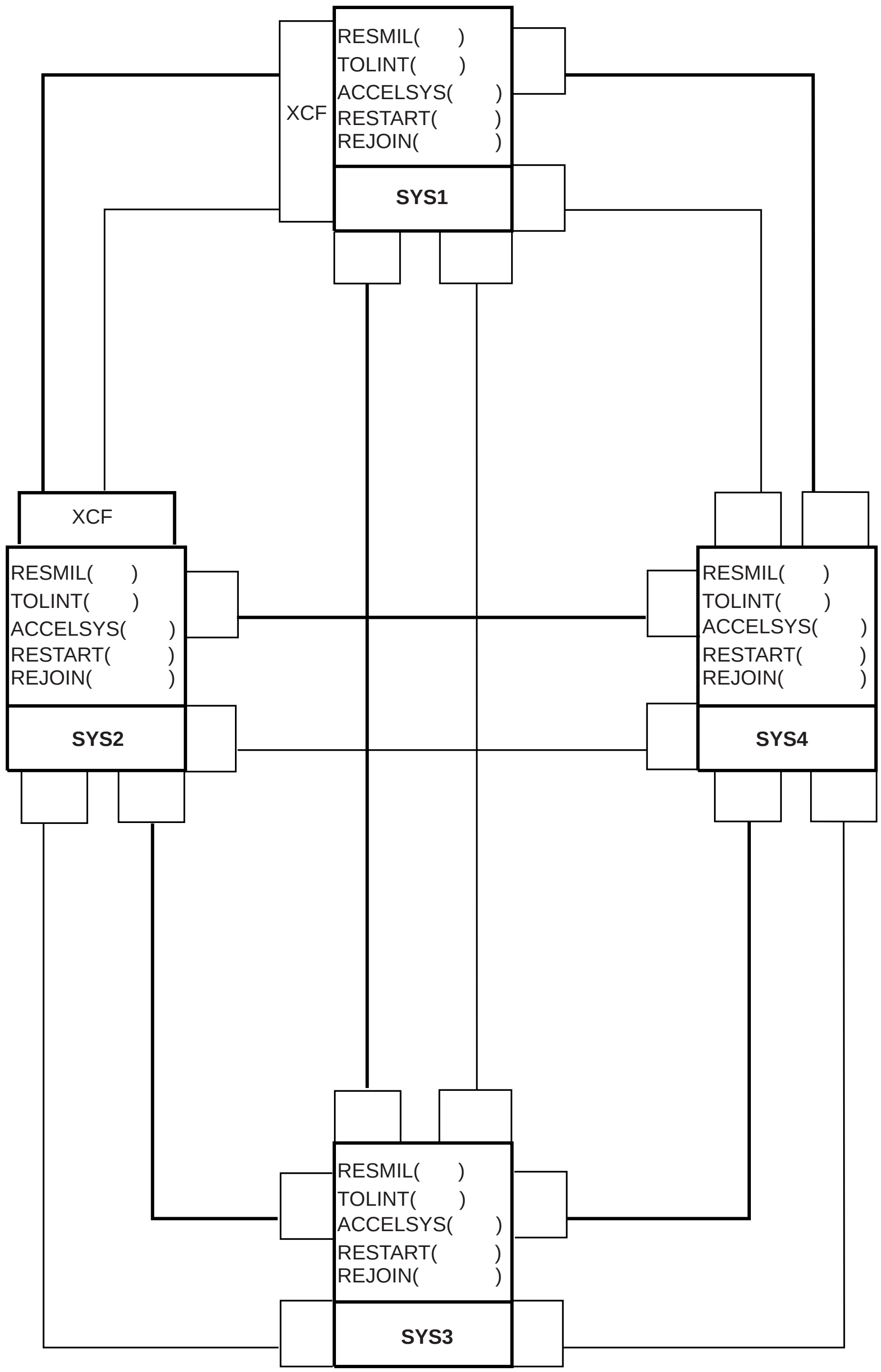


Figure 63. Sample Design and Definition Diagram for a Mixed Complex

GRSCNFxx Worksheet

One way to describe the design of your complex in a format you can use to actually create GRSCNFxx is to use the GRSCNFxx worksheet. Table 8 on page 140 shows a completed worksheet for the complex shown in Figure 62. Table 9 on page 141 is a blank worksheet for your use as you plan for systems that are not part of a sysplex. Table 7 on page 121 is a blank worksheet for your use as you plan a complex that matches the sysplex.

Table 8. Sample Complex Definition Plan

Statement	Parameter	Comments
GRSDEF	MATCHSYS(SYS1)	Matches SYSNAME=SYS1 system parameter
	RESMIL(1)	RSA-message residency = 1 millisecond
	TOLINT(20)	Tolerance interval = 20 seconds
	ACCELSYS(2)	Ring acceleration definition
	CTC(C68)	3088-B link to SYS2
	CTC(C69)	3088-B link to SYS2
	CTC(C64)	3088-B link to SYS3
	CTC(C65)	3088-B link to SYS3
	CTC(C20)	3088-B link to SYS4
	CTC(C21)	3088-B link to SYS4
	CTC(A68)	3088-P link to SYS2
	CTC(A69)	3088-P link to SYS2
	CTC(A64)	3088-P link to SYS3
	CTC(A65)	3088-P link to SYS3
	CTC(A20)	3088-P link to SYS4
	CTC(A21)	3088-P link to SYS4
	RESTART(YES)	Can rebuild disrupted ring automatically
	REJOIN(YES)	Can rejoin ring after temporary stop
GRSDEF	MATCHSYS(SYS2)	Matches SYSNAME=SYS2 system parameter
	RESMIL(1)	RSA-message residency = 1 millisecond
	TOLINT(20)	Tolerance interval = 20 seconds
	ACCELSYS(2)	Ring acceleration definition
	CTC(428)	3088-B link to SYS1
	CTC(429)	3088-B link to SYS1
	CTC(420)	3088-B link to SYS3
	CTC(421)	3088-B link to SYS3
	CTC(424)	3088-B link to SYS4
	CTC(425)	3088-B link to SYS4
	CTC(228)	3088-P link to SYS1
	CTC(229)	3088-P link to SYS1
	CTC(220)	3088-P link to SYS3
	CTC(221)	3088-P link to SYS3
	CTC(224)	3088-P link to SYS4
	CTC(225)	3088-P link to SYS4
	RESTART(YES)	Can rebuild disrupted ring automatically
	REJOIN(YES)	Can rejoin ring after temporary stop

Table 8. Sample Complex Definition Plan (continued)

Statement	Parameter	Comments
GRSDEF	MATCHSYS(SYS3)	Matches SYSNAME=SYS3 system parameter
	RESMIL(1)	RSA-message residency = 1 millisecond
	TOLINT(20)	Tolerance interval = 20 seconds
	ACCELSYS(2)	Ring acceleration definition
	CTC(8A4)	3088-B link to SYS1
	CTC(8A5)	3088-B link to SYS1
	CTC(8A0)	3088-B link to SYS2
	CTC(8A1)	3088-B link to SYS2
	CTC(8A8)	3088-B link to SYS4
	CTC(8A9)	3088-B link to SYS4
	CTC(1A4)	3088-P link to SYS1
	CTC(1A5)	3088-P link to SYS1
	CTC(1A0)	3088-P link to SYS2
	CTC(1A1)	3088-P link to SYS2
	CTC(1A8)	3088-P link to SYS4
	CTC(1A9)	3088-P link to SYS4
	RESTART(YES)	Can rebuild disrupted ring automatically
	REJOIN(YES)	Can rejoin ring after temporary stop
GRSDEF	MATCHSYS(SYS4)	Matches SYSNAME=SYS4 system parameter
	RESMIL(1)	RSA-message residency = 1 millisecond
	TOLINT(20)	Tolerance interval = 20 seconds
	ACCELSYS(2)	Ring acceleration definition
	CTC(520)	3088-B link to SYS1
	CTC(521)	3088-B link to SYS1
	CTC(524)	3088-B link to SYS2
	CTC(525)	3088-B link to SYS2
	CTC(528)	3088-B link to SYS3
	CTC(529)	3088-B link to SYS3
	CTC(020)	3088-P link to SYS1
	CTC(021)	3088-P link to SYS1
	CTC(024)	3088-P link to SYS2
	CTC(025)	3088-P link to SYS2
	CTC(028)	3088-P link to SYS3
	CTC(029)	3088-P link to SYS3
	RESTART(YES)	Can rebuild disrupted ring automatically
	REJOIN(YES)	Can rejoin ring after temporary stop

Table 9. GRSCNF____ Definition (Mixed Complex)

Statement	Parameter	Comments
GRSDEF	MATCHSYS(_________)	
	RESMIL(______)	
	TOLINT(______)	
	ACCELSYS(_____)	
	CTC(______)	

Table 9. GRSCNF____ Definition (Mixed Complex) (continued)

Statement	Parameter	Comments
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	RESTART(YES│NO)	
	REJOIN(YES│NO)	
GRSDEF	MATCHSYS(________)	
	RESMIL(______)	
	TOLINT(______)	
	ACCELSYS(_____)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	RESTART(YES│NO)	
	REJOIN(YES│NO)	

Table 9. GRSCNF____ Definition (Mixed Complex) (continued)

Statement	Parameter	Comments
GRSDEF	MATCHSYS(________)	
	RESMIL(______)	
	TOLINT(______)	
	ACCELSYS(_____)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	CTC(______)	
	RESTART(YES|NO)	
	REJOIN(YES|NO)	
GRSDEF	MATCHSYS(__________)	
	RESMIL(________)	
	TOLINT(________)	
	ACCELSYS(_______)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	CTC(________)	
	RESTART(YES|NO)	
	REJOIN(YES|NO)	

Chapter 9. Operating the Complex

As shown in Chapter 8, “Designing the Complex”, the design of the global resource serialization complex is a critical factor in the successful operation of the complex. However, the procedures you provide for the operators of the systems in the complex are also important.

Educate the operators and prepare operator procedures for operating the global resource serialization complex. These procedures, often called a runbook or an operations workbook, describe how your operators build and operate the complex. When the sysplex matches the complex, there is little need for any operator action. When you are operating a mixed complex, however, you will need to provide explicit instructions tailored to your installation’s needs.

Reference Books

As you read this chapter and as you develop your operator procedures, consult *z/OS MVS System Messages, Vol 9 (IGF-IWM)* for the exact text and responses to global resource serialization messages. Also, *z/OS MVS System Commands* contains a complete description of how to use the VARY and DISPLAY commands with global resource serialization.

See *z/OS MVS Recovery and Reconfiguration Guide* for a description of how to plan your recovery procedures.

For sysplex-related concerns, see *z/OS MVS Setting Up a Sysplex*.

Your operating environment determines how you plan for operation. If all of the systems in your global resource serialization complex belong to the same sysplex, see “Operating a Complex That Matches a Sysplex”. If you are operating a mixed complex (at least one system in your global resource serialization complex is not a part of the sysplex), then you must make precise, detailed plans for operations — how your operators build the complex, keep an eye on its normal operation, and respond to the problems that automatic recovery does not handle. See “Operating a Mixed Complex (Complex Does Not Match Sysplex)” on page 150 for those considerations.

Operating a Complex That Matches a Sysplex

In general, your operational planning focuses on three areas: building the complex, normal operations, and recovery operations. The design of your complex affects all three areas. See *z/OS MVS Recovery and Reconfiguration Guide* for information about planning your recovery operations.

In a sysplex, global resource serialization uses XCF signalling paths as communication links.

Building the Complex

The process of building a global resource serialization complex can have two phases: a configuration check and the IPL of the systems.

Configuration Check

Before an operator actually IPLs a system that is to start or join a global resource serialization complex, ensure that the operator verifies that the shared resource (such as DASD) connections are correct.

If the shared resource connections are incorrect, a serious data integrity exposure could occur. This exposure occurs when systems in the complex are serializing access to a global resource by means of an ENQ macro with a scope of SYSTEMS. For example, if the RESERVE conversion RNL for the complex contains an entry for a resource, this entry causes global resource serialization on each system in the complex to suppress the reserve for that resource. If a system outside the complex can use a reserve to access the same resource at the same time, the resource could be damaged.

IPL

There are three system parameters (GRS, GRSCNF, and GRSRNL) that indicate to MVS at IPL time that a system is to be part of a global resource serialization complex. The GRS and GRSCNF parameters remain in effect for the duration of the IPL, or until they are changed using the SETGRS command. You can change the RNLs without having to reIPL the entire complex. Use the SET GRSRNL command to accomplish this change. See “Changing the RNLs for a Ring” on page 148 for more information.

As with all system parameters, there are several ways you can specify the global resource serialization parameters. To minimize operator intervention during IPL, it is generally best to specify GRS, GRSRNL, and GRSCNF in IEASYSxx or take the default values.

You can specify GRS=TRYJOIN in IEASYSxx on each system in the sysplex. If a system is IPLed and there is no complex, that system will start one. If a complex exists, the system joins the complex. The system that starts the complex builds a one-system ring and issues a message stating that a complex is active. As each additional system IPLs, an active system processes the request to join the complex. Global resource serialization writes messages to the system log on the joining system that identify the system that is assisting the joining system.

Global resource serialization also writes messages to the system logs on all systems in the complex to indicate that a new system is joining the ring. These messages indicate that the IPLs are proceeding normally and that the global resource serialization ring can process requests for global resources.

Normal Operations in a Sysplex

Once the complex is built, it requires little, if any, operator intervention. If a problem occurs, either global resource serialization or some other system component will detect the problem and issue messages that describe it before the operator could notice it.

For example, some of the error messages that global resource serialization issues indicate damage to resources or to the resource control blocks. These messages are ISG031E, ISG032E, ISG033E, ISG034E and ISG035E. The problem that causes any of these messages can also cause the job requesting the resource to terminate abnormally. If the damage is extensive, the problem can cause multiple jobs to terminate abnormally, requiring the system to IPL again to restore the control blocks. This problem is, of course, only one example of a problem that can force a system in the ring to IPL again.

During normal processing, operators can use system commands to monitor and control global resource serialization. The system commands related to global resource serialization are:

- DISPLAY GRS, which displays the status of each system in the complex
- VARY XCF,sysname,OFFLINE, which removes a system from the sysplex. (Any action that removes a system from the sysplex also removes it from the global resource serialization complex.) See *z/OS MVS Setting Up a Sysplex* for more information.
- SET GRSRNL, which changes the RNLs dynamically.

Displaying Ring Status

The DISPLAY GRS (D GRS) command shows the state of each system in the complex. Note that D GRS shows system status only as it relates to the global resource serialization ring. D GRS does not reflect how well a system is running.

You can also use D GRS to display the local and global resources requested by the systems in the ring, contention information, the contents of the RNLs, and jobs that are delaying or suspended by a SET GRSRNL command. These uses are described in *z/OS MVS System Commands*.

You can issue D GRS from any system in the ring and at any time after the ring has been started. The D GRS display shows the status of the ring from that system's point of view; thus, the displays issued from different systems might show different results. Figure 64 shows an example of the information D GRS produces and explains the values that can appear in each field.

```
18.40.07  ISG343I  18:40:06  GRS STATUS 340
SYSTEM    STATE               SYSTEM    STATE
 SYS2      ACTIVE              SYS1      ACTIVE
 SYS3      QUIESCED            SYS4      QUIESCED
```

SYSTEM The name of the system.

STATE The state of the system at the time when the command was issued.

ACTIVE The system is part of the ring and is actively participating in global resource serialization. ACTIVE is the normal condition.

QUIESCED The system is temporarily suspended from the ring, in response to a ring disruption. The system does not have current information about global resources and is not currently processing global resource requests. Users of global resources retain ownership, but any users who try to obtain or free a global resource are suspended. The system will restart and become active as soon as it is able.

INACTIVE The system is not part of the ring. INACTIVE appears when a ring disruption has occurred. The system has current information about global resources but is not currently processing global resource requests. Users of global resources retain ownership, but any users who try to obtain or release a global resource are suspended. Multiple systems can be INACTIVE, and an inactive system can restart the ring. A system will restart the ring as soon as possible.

JOINING The system is joining the ring as part of its IPL process.

RESTARTING The system is re-entering the ring after a ring disruption.

ACTIVE+VARY
The system is executing an internal command.

ACTIVE+WAIT
The system is waiting to process an internal command.

MIGRATING The system is in the process of migrating from a ring to a star, as a result of issuing a SETGRS command. The system suspends all tasks from obtaining global resources.

Note: GQSCAN does not work during migration from a ring complex to a star complex.

Figure 64. D GRS Explanation (Complex Matches Sysplex)

As a part of your planning, decide what to do if a system remains quiesced or inactive for an extended period of time. See *z/OS MVS Recovery and Reconfiguration Guide* to determine what recovery operations you should perform.

Changing the RNLs for a Ring

You can dynamically change the RNLs that global resource serialization uses, as long as the sysplex matches the complex. If your complex has any systems that are not in the sysplex, the change will not take effect. In addition, any single system complex running MVS/ESA SP Version 4 or later can dynamically change its RNLs.

To change the RNLs currently being used by global resource serialization, set up the GRSRNLxx parmlib members with the new RNLs. Next, issue the SET GRSRNL command on a system that has access to those members. The new RNLs are then communicated to all systems in the complex. Keep in mind that you can not use SET GRSRNL=EXCLUDE or issue SET GRSRNL=xx in a complex already using GRSRNL=EXCLUDE. See Chapter 2, "Selecting the Data" on page 13 for details.

Note: Even though only one system needs the updated parmlib members to start the change, be sure to copy the updated GRSRNLxx parmlib members to each system's parmlib. Any system that needs to can then IPL again into the same complex. Otherwise, the change will be in effect only for the duration of the IPL.

Global resource serialization ensures that the integrity of all resources is maintained throughout the RNL change. In particular, before an RNL change can complete, special processing may be performed if any jobs are using the resources that are different in the old and new RNLs. These resources are known as *affected* resources. Jobs issuing new requests for these resources are suspended until the RNL change is complete. These are known as *suspended jobs*. The following message is issued on each system in the complex that has suspended one or more jobs:

```
ISG210E RNL CHANGE WAS INITIATED BY SYSTEM sysname
        SOME JOBS ARE BEING SUSPENDED UNTIL RNL CHANGE COMPLETES.
```

If any job currently holds one or more of the affected resources, the change is delayed until all of the affected resources are freed. Jobs holding an affected resource (and thereby delaying the RNL change) are *delaying jobs*. When jobs are holding affected resources and delaying the change, the following messages are issued on whichever console originated the RNL change:

```
ISG219E RNL CHANGE WAITING FOR RESOURCES TO BE FREED.
        TO LIST DELAYING JOBS, USE ROUTE SYSNAME,DISPLAY GRS,DELAY.
        TO LIST SUSPENDED JOBS, USE ROUTE SYSNAME,DISPLAY GRS,SUSPEND.
ISG220D REPLY C TO CANCEL RNL CHANGE COMMAND, OR S FOR SUMMARY OF RNL
        CHANGE PROGRESS.
```

The DISPLAY GRS,DELAY (D GRS,DELAY) operator command lists the jobs that hold affected resources and are causing the change to be delayed. The jobs listed might release the affected resources normally, or they can be cancelled at the discretion of the installation. Once these jobs release the affected resources, the RNL change completes.

The DISPLAY GRS,SUSPEND (D GRS,SUSPEND) operator command lists the jobs that are being suspended due to the RNL change. The jobs listed will remain suspended until the RNL change completes, or until the RNL change is cancelled.

Replying to message ISG220D with an S produces a summary of the RNL change progress. This summary indicates the number of jobs on each system that are delaying or are suspended by the RNL change. Replying to message ISG220D with a C causes the RNL change to be cancelled.

If the operator chooses not to respond to message ISG220D with a C, the change will take place when all delaying jobs release the affected resources.

There may be instances where the operator must either cancel the RNL change command or cancel jobs that hold the affected resources:

1. A job that is not cancellable is holding affected resources for a long time.
2. A job holding an affected resource cannot DEQ that resource because it is suspended by global resource serialization pending a new ENQ for another

affected resource, or else the job is waiting for some other work in the system that has issued an ENQ for an affected resource and has become suspended.

3. A job that is suspended by the RNL change is considered more important than the RNL change.

See *z/OS MVS System Commands* for more information about the DISPLAY GRS and SET GRSRNL commands.

Operating a Mixed Complex (Complex Does Not Match Sysplex)

In general, the messages, and thus your operational planning, focus on three areas: building the complex, normal operations, and recovery operations. The design of your complex affects all three areas. See *z/OS MVS Recovery and Reconfiguration Guide* for information about planning your recovery operations. Chapter 8, "Designing the Complex" on page 115 describes these design considerations in detail, but the following list summarizes the most important recommendations:

- Use IBM 3088 data links or an ESCON channel operating in basic mode, rather than CTC adapters, to connect the systems.
- Design a fully-connected complex, one where each system has at least one link to every other system.

  Note: You can, of course, operate a complex that is not fully connected. However, a minimal configuration can create availability, operations, and performance problems.
- Provide alternate links for each connection. Alternate links make recovery from a ring disruption easier. In addition, MVS/ESA SP Versions 3 and above can use the alternate link to send the ring acceleration signal.
- Provide a backup IBM 3088 to increase availability and eliminate the 3088 as a single point of failure.
- In GRSCNFxx, specify RESTART(YES) and REJOIN(YES) to minimize operator intervention during recovery.
- Tune the TOLINT value to meet your installation's needs. The TOLINT value determines the maximum length of time required to detect a ring disruption.
- On any pre-MVS/ESA SP Version 4 system, tune the RESMIL value to meet your installation's needs. The RESMIL value determines the minimum length of time the RSA-message spends in each system. MVS/ESA SP Version 4 and later systems tune the RSA-message residency time automatically.

Figure 65 on page 151 shows a sample configuration diagram of a four-system mixed complex. The system is fully-connected, and there are alternate links for all connections. Examples throughout this chapter use this configuration.

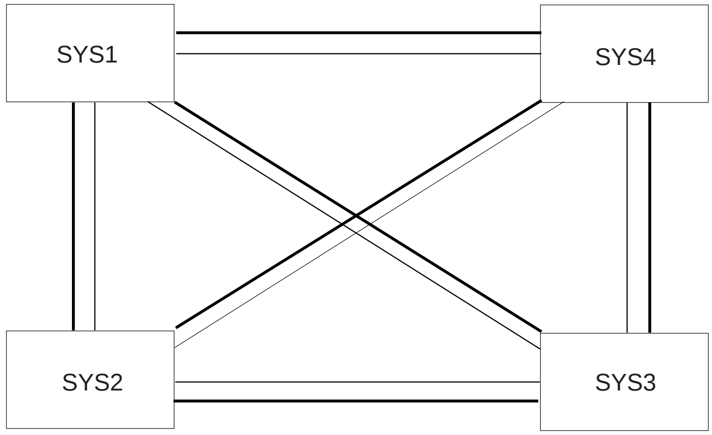


Figure 65. Sample Configuration

Building the Complex

The process of building a global resource serialization complex can have two phases: a configuration check and the IPL of the systems.

Configuration Check

Before an operator actually IPLs a system that is to start or join a global resource serialization complex, ensure that the operator verifies that the CTC link connections and the shared resource (such as DASD) connections are correct.

If the shared resource connections are incorrect, a serious data integrity exposure could occur. This exposure occurs when systems in the complex are serializing access to a global resource by means of an ENQ macro with a scope of SYSTEMS. For example, if the RESERVE conversion RNL for the complex contains an entry for a resource, this entry causes global resource serialization on each system in the complex to suppress the reserve for that resource. If a system outside the complex can use a reserve to access the same resource at the same time, the resource could be damaged.

IPL

There are three system parameters (GRS, GRSCNF, and GRSRNL) that indicate to MVS at IPL time that a system is to be part of a global resource serialization complex. In a mixed complex, these parameters remain in effect for the duration of the IPL; the only way to change a value is to IPL the system again. See “Transitions to and from a Mixed Complex” on page 163 for information about the effects of changing from a mixed complex to a complex matches sysplex environment.

As with all system parameters, there are several ways you can specify the global resource serialization parameters. To minimize operator intervention during IPL, it is generally best to specify GRS, GRSRNL, and GRSCNF in IEASYSxx. However, the best way to specify the GRS= system parameter is a less clear-cut choice:

1. If the same system always starts the complex, you can place GRS=START in IEASYSxx for that system and place GRS=JOIN explicitly or by default in IEASYSxx for the other systems.
2. You can tell the operators to enter GRS=START or GRS=JOIN at the console during IPL.

3. You can place GRS=JOIN either explicitly or by default in IEASYSxx for all of the systems. When you make this choice, the system that actually is to start the complex IPLs with GRS=JOIN. Global resource serialization issues a message stating that there is no active complex, followed by a prompting message. The operator can then respond START to the prompting message, but the system-operator interaction requires extra time.
4. You can specify GRS=TRYJOIN in IEASYSxx for all of the systems that are operating MVS/ESA SP Version 4 or later. If a global resource serialization complex exists, the system joins the complex. If the complex does exists, the system joins the existing complex. If the system does not find any active global resource serialization complex systems, the system will start the complex.

It is both neater and more efficient to have the operator of the system that is to start the mixed complex explicitly override the default by entering GRS=START in response to the SPECIFY SYSTEM PARAMETERS message. This procedure, which IBM recommends, is especially useful when different systems might start the complex at different times. One operator explicitly specifies GRS=START; the others use the default GRS=JOIN in IEASYSxx.

Whatever way you choose to specify GRS=START, the effect is the same. The system that starts the complex builds a one-system ring and issues a message stating that a complex is active. As each additional system IPLs with GRS=JOIN, an active system processes the request to join the complex. When a system IPLs with GRS=JOIN, global resource serialization issues messages on the joining system that identify the system that is assisting the joining system. Global resource serialization also issues messages on all systems in the complex to indicate that a new system is joining the ring. These messages indicate that the IPLs are proceeding normally and that the global resource serialization ring can process requests for global resources.

One major reason for having the systems IPL explicitly with GRS=START for the starting system and GRS=JOIN for any joining system is to make sure that two potentially critical messages appear only in abnormal situations. These messages are:

`ISG005I GRS START OPTION INVALID - SYSTEM sysname EXISTS IN A GRS COMPLEX`

This message, followed by a prompting message, can occur when the system IPLs with GRS=START after another system has already started the complex. It thus might be a “normal” or expected message, and the operator can respond JOIN to the prompting message. However, it can also occur when there is a serious problem, such as a combination of errors having created multiple independent complexes using incorrectly-connected CTC links or duplications of the same system name.

`ISG006I GRS JOIN OPTION INVALID - NO ACTIVE GRS SYSTEM`

This message, also followed by a prompting message, can occur when the system IPLs with GRS=JOIN before another system has started the complex. It thus might be a “normal” or expected message, and the operator can respond START to the prompting message. However, this message can also occur when there are some very serious problems, such as a combination of errors having created either multiple independent complexes using incorrectly-connected CTC links.

If systems IPL explicitly with GRS=START or GRS=JOIN, the operator can treat each occurrence of either of these messages as a potentially serious error rather than something that is usually normal. There is no chance the operator can think the serious error is a normal condition.

Normal Operations in a Mixed Complex

Once the complex is built, it requires little, if any, operator intervention unless a problem disrupts ring processing or the ring requires reconfiguration for some other reason. If a problem occurs that is not related to ring processing, either global resource serialization or some other system component will detect the problem and issue messages that describe it before the operator could notice it.

For example, some of the error messages that global resource serialization issues indicate damage to resources or to the resource control blocks, rather than a problem with ring processing. These messages are ISG031E, ISG032E, ISG033E, ISG034E and ISG035E. The problem that causes any of these messages can also cause the job requesting the resource to terminate abnormally. If the damage is extensive, the problem can cause multiple jobs to terminate abnormally, requiring the system to IPL again to restore the control blocks. This problem is, of course, only one example of a problem not directly related to ring processing that can force a system in the ring to IPL again.

During normal processing, as well as during recovery from a ring disruption, operators use system commands to monitor and control global resource serialization. The system commands related to ring processing are:

- DISPLAY GRS, which displays the status of each system in the complex. D GRS is the operator's primary way of checking ring processing and determining the source of problems. See "Displaying Ring Status".
- VARY GRS with the QUIESCE operand, which allows the operator to remove a system from the ring. See "Quiescing a System" on page 156.
- VARY GRS with the PURGE operand, which allows the operator to remove a system from the complex. See "Purging a System" on page 158.
- VARY GRS with the RESTART operand, which allows the operator to restart a quiesced system or an inactive system. See "Restarting a System" on page 160.
- VARY *devnum*, which allows the operator to bring a link online or take a link offline. See "Controlling CTC Links" on page 162.
- VARY CTC,OFFLINE,FORCE, which permanently removes a CTC from use by global resource serialization and releases it for other uses. See "Migrating an Existing Complex into a Sysplex" on page 165 for an example of how and when to use this command.

It is a good practice, whenever possible, to issue all VARY commands for the ring from the same system; this practice simplifies operations procedures, especially during recovery.

If your mixed complex contains systems in an XCF multisystem sysplex, additional system commands for those systems related to ring processing are:

- VARY XCF,sysname,OFFLINE, which removes a system from the sysplex. (Any action that removes a system from the sysplex also removes it from the global resource serialization complex.) See *z/OS MVS Setting Up a Sysplex* for more information.

Displaying Ring Status

The DISPLAY GRS (D GRS) command shows the state of each system in the complex and the status of the links that connect the systems. Note that D GRS shows system status only as it relates to the global resource serialization ring. D GRS does not reflect how well a system is running generally; for example, MVS on a system shown as QUIESCED or INACTIVE in the global resource serialization complex might run successfully for quite a while.

You can also use D GRS to display the local and global resources requested by the systems in the ring, contention information, or the contents of the RNLs. These uses are described in *z/OS MVS System Commands*.

You can issue D GRS from any system in the ring and at any time after the ring has been started. The D GRS display shows the status of the ring from that system's point of view; thus, the displays issued from different systems might show different results. Figure 66 shows an example of the information D GRS produces and explains the values that can appear in each field.

D GRS is most useful, however, when a ring failure has occurred. The information displayed can help the operator to make informed decisions about the cause of an error and the correct response to the problem. Note that D GRS does not diagnose a problem; it simply reports status. Figure 67 on page 156 shows how an operator can use D GRS to determine the cause of a problem with ring processing.

```
18.40.07  ISG343I  18:40:06  GRS STATUS 340
SYSTEM    STATE       COMM    SYSTEM    STATE      COMM
SYS2      ACTIVE              SYS1      ACTIVE     YES
SYS3      QUIESCED    YES     SYS4      QUIESCED   NO

LINK      STATUS      TARGET  LINK      STATUS     TARGET
 220       ALTERNATE   SYS3    420      ALTERNATE   SYS3
 221       ALTERNATE   SYS3    421      ALTERNATE   SYS3
 224       QUIET       SYS4    424      QUIET       SYS4
 225       QUIET       SYS4    425      QUIET       SYS4
 228       ALTERNATE   SYS1    428      ALTERNATE   SYS1
 229       IN-USE      SYS1    429      ALTERNATE   SYS1
```

Figure 66. D GRS Explanation (Mixed Complex)

SYSTEM The name of the system.

STATE The state of the system at the time when the command was issued. There are seven possible states:

- **ACTIVE** The system is part of the ring and is actively participating in global resource serialization. ACTIVE is the normal condition. The system accepts all commands related to ring processing.
- **QUIESCED** The system is temporarily suspended from the ring, in response to either a ring disruption or operator command. The system does not have current information about global resources and is not currently processing global resource requests. Users of global resources retain ownership, but any users who try to obtain or free a global resource are suspended. The system remains quiesced, and the users remain suspended, until the system is restarted. **Note:** Access to local resources is not affected, but an attempt to cancel a job might not succeed if a global resource is involved.
- **INACTIVE** The system is not part of the ring. INACTIVE appears when a ring disruption has occurred. The system has current information about global resources but is not currently processing global resource requests. Users of global resources retain

ownership, but any users who try to obtain or release a global resource are suspended. Multiple systems can be INACTIVE, and an inactive system can restart the ring. An inactive system remains inactive until any system in the complex is restarted. **Note:** Access to local resources is not affected, but an attempt to cancel a job might not succeed if a global resource is involved.

JOINING The system is joining the ring as part of its IPL process.

RESTARTING The system is re-entering the ring as a result of a RESTART command.

ACTIVE+VARY
The system is executing a VARY GRS command.

ACTIVE+WAIT
A VARY GRS command was issued, but it is waiting because another VARY GRS command is now executing. When ACTIVE+WAIT appears, another system normally shows ACTIVE+VARY.

COMM An indication of whether or not the system has responded to a request for status. YES indicates that the system shown can communicate with the system issuing D GRS. NO indicates that there is no communication link, the system is temporarily stopped, or the system has failed. If NO appears, the state shown for the system might not be accurate. The field is blank for the system that issued D GRS.

LINK The address of each CTC data link defined for global resource serialization on the system.

STATUS The status of the link. There are four possible states:

IN-USE The link is a primary link now being used to send the RSA-message from one system to another. IN-USE appears only for a link that connects active systems.

ALTERNATE The link is an alternate. If a primary link fails, an alternate link can automatically replace it. An alternate link might be used to send the ring acceleration signal, which D GRS does not report; if an alternate link used for ring acceleration replaces a failed primary link, it can no longer send the ring acceleration signal.

DISABLED The link is not physically connected or was taken offline because of an error.

QUIET The link does not have any apparent problems, but the system it connects to did not respond to the request for status.

TARGET The name of the system that last responded from the other side of the link. The field is blank when the link has been disabled since the IPL of the system or when the system did not respond to the request for status.

The COMM field for system SYS2 is blank; the D GRS command was issued on

```
18.40.07  ISG020I  18:40:06  GRS STATUS 340
SYSTEM    STATE       COMM    SYSTEM    STATE      COMM
 SYS2      ACTIVE              SYS1      ACTIVE     YES
 SYS3      QUIESCED    YES     SYS4      QUIESCED   NO

LINK      STATUS      TARGET  LINK      STATUS     TARGET
 220       ALTERNATE   SYS3    420      ALTERNATE   SYS3
 221       ALTERNATE   SYS3    421      ALTERNATE   SYS3
 224       QUIET       SYS4    424      QUIET       SYS4
 225       QUIET       SYS4    425      QUIET       SYS4
 228       ALTERNATE   SYS1    428      ALTERNATE   SYS1
 229       IN-USE      SYS1    429      ALTERNATE   SYS1
```

Figure 67. Using D GRS to Analyze a Problem

system SYS2. The display shows the following:

1. System SYS2 and system SYS1 are active; they are processing global resource requests.
2. System SYS2 and system SYS1 are using link 229 to send the RSA-message. Link 229 is a primary link; its status is IN-USE.
3. All other links between system SYS2 and system SYS1 (228, 428, 429) are shown as ALTERNATE. One of these links might be sending the ring acceleration shoulder-tap.
4. The status of system SYS3 is QUIESCED. It is not part of the ring and is not processing global resource requests. YES appears in the COMM field for system SYS3, indicating that system SYS3 responded to the request for status. MVS is still active on system SYS3.
5. Because system SYS3 is quiesced, all of its links to system SYS2 (220, 221, 420, 421) are marked as ALTERNATE.
6. The status of system SYS4 is QUIESCED. Like system SYS3, it is not part of the ring and is not processing global resource requests. NO appears in the COMM field for system SYS4, indicating that system SYS4 (unlike system SYS3) did not respond to the request for status. Also, all links between system SYS4 and system SYS2 (224, 225, 424, 425) are marked as QUIET. System SYS4 is the source of the problem.

   D GRS can report a problem but it cannot diagnose the reason for the problem. Possible reasons for the problem shown in this example are:

   a. System SYS4 is temporarily stopped. Perhaps the system has stopped to take a dump, or MVS might be in a spin loop.
   b. System SYS4 has failed.
   c. All links have failed on the system SYS4 side. This possibility is unlikely; an I/O error on a link is normally detected by both systems (SYS2 and SYS4 in this case), and the status of a failed link normally appears as DISABLED.

Quiescing a System

In the context of ring processing, quiescing a system means removing it from the ring. The system can continue to run, but it cannot access or free global resources. Quiescing a system is normally done as the first step in removing a system from the complex.

To quiesce a system, the operator on the system to be quiesced (or on any active system that can communicate with the system to be quiesced) can issue the VARY

GRS(sysname),QUIESCE command. A quiesced system is no longer part of the ring; it is, however, still known to the other systems in the ring.

Quiescing a system can slow down performance because no global resources are released:

- On the quiesced system, any task that controls any global resources retains control of those resources, and any task that is waiting for a global resource continues to wait.

  Programs on the quiesced system do continue to process, but only until they need to access or free a global resource. For example, a program that had exclusive control of a global resource can finish with the resource; however, the quiesced system cannot completely process the DEQ for the resource or tell the active systems that the resource is now available.
- On the active systems, any task that needs a global resource held by a task on the quiesced system continues to wait. This condition continues until the quiesced system either rejoins the ring or is purged from the ring.

Thus, quiescing a system is an action that you should take very seldom and for as short a time as possible. It might, for example, be part of the process of physical reconfiguration. When it is necessary to quiesce a system, the operator must first bring work on the system to an orderly shutdown. This procedure minimizes ring performance problems and data integrity exposures if the system is to be purged from the ring.

Global resource serialization, in response to the VARY GRS(sysname),QUIESCE command, places the target system in a quiesced state and forms a new ring without the quiesced system. The operators can use the global resource serialization messages (ISG011I and ISG013I) and, if necessary, D GRS, to verify that the system is now quiesced.

Global resource serialization can build a new ring without the quiesced system only when the links needed for the new ring are available. When the complex is fully-connected and alternate links are available, rebuilding the ring without the quiesced system is not a problem. If a link that it needs to build a new ring without the quiesced system is missing, global resource serialization rejects the VARY GRS(sysname),QUIESCE command. After enabling the required links, the operator can enter the command again. Once the system is quiesced, it can either rejoin the ring, which does not require a reIPL, or be purged from the ring.

Quiesce Messages

The global resource serialization messages related to quiescing a system include ISG011I, ISG012I, ISG013I, ISG014I, and ISG015I.

Example — Quiescing a System: Using the four-system complex shown earlier in Figure 65 on page 151, assume that it is necessary to stop SYS4 temporarily.

On SYS4, the operator would take the following steps:

1. Bring the work to an orderly shutdown by taking such actions as stopping the subsystems and terminating jobs.
2. Issue VARY GRS(*),QUIESCE or VARY GRS(SYS4),QUIESCE. (An operator on any active system could also issue the second command.)

   On SYS4, the following message appears:

```
ISG012I QUIESCE REQUEST PASSED TO SYSTEM SYS2
```

This message indicates that global resource serialization has accepted the command and that SYS2 will assist in the quiesce process. SYS2 is the assisting system, and SYS4 is the target system. (This message appears only when the operator on the target system issues the VARY command.)

On SYS2 and SYS4, the following message indicates that global resource serialization has started to quiesce the target system (SYS4):

```
ISG011I SYSTEM SYS4 - QUIESCING GLOBAL RESOURCE SERIALIZATION
```

On all systems, the following message appears after the system has been successfully quiesced.

```
ISG013I SYSTEM SYS4 - QUIESCED GLOBAL RESOURCE SERIALIZATION
```

3. Once the quiesce is successful, the operator on SYS4 can stop the system.

Issuing D GRS would show the state of SYS4 as QUIESCED. The COMM field would show YES, indicating that communication still existed, and all links to SYS4 would appear as ALTERNATE.

Purging a System

To purge a system, the operator on any active system issues the VARY GRS(sysname),PURGE command. Purging a system is normally needed when:

- The operator must remove the system from the ring for a long period of time (perhaps for preventive maintenance).
- The system is no longer needed in the ring (perhaps because of a configuration change).
- The system has failed and must reIPL.

In response to the purge command, each active system in the ring deletes all information related to the target system, including its requests for global resources, its control of global resources, and any appearance of its system name. In short, global resource serialization removes all indications that the purged system was ever a part of the complex.

If users on the purged system held global resources, these resources are freed. Message ISG018I, issued to SYSLOG, describes these resources. Your installation must plan in advance to investigate the state of resources as part of the process of removing a system from the complex.

The purged system must reIPL with GRS=JOIN to rejoin the ring. Also, a system that has been part of an active ring cannot reIPL with GRS=JOIN unless it has first been purged. Until the system is purged, global resource serialization knows about it and rejects its attempt to rejoin the ring because it detects a duplicate system name.

Because purging the system does not stop MVS, stop the system before purging it so that the system cannot continue to access shared resources. This procedure prevents a potential data integrity exposure. For example, assume that a job on a purged system, SYS1, was updating a resource and did not complete before SYS1 was purged. Purging SYS1 frees the resource and makes it available to other requestors, but, unless SYS1 is stopped, the job on SYS1 can continue to update the resource.

As of MVS/SP Version 3, the target system — the system to be purged — can be an active system or a quiesced system. (On earlier levels of MVS, the target system must be a quiesced system.) When the target system is an active system, global resource serialization issues a message to remind the operator that the system is active; that is, the operator must bring the work to an orderly shutdown before proceeding. See “Example — Purging an Active System” for an example of purging an active system. See “Example — Purging a Quiesced System” for an example of purging a quiesced system.

Example — Purging an Active System: Using the four-system complex shown earlier in Figure 65 on page 151, assume that it is necessary to purge SYS1 from the ring. SYS1 is an active system. The operator on SYS2 issues the purge command; thus, SYS2 is the assisting system. The required steps are:

On SYS1, the operator, to avoid potential data integrity exposures, must bring the workload to an orderly shutdown by taking such actions as stopping the subsystems and terminating jobs.

On SYS2, the operator then issues VARY GRS(SYS1),PURGE. The following messages appear:

```
ISG100E SYSTEM SYS1 IS STILL AN ACTIVE GRS SYSTEM
ISG101D CONFIRM PURGE FOR ACTIVE SYSTEM SYS1 - REPLY NO OR YES
```

In this example, the operator can safely reply YES. These messages remind the operator that SYS1 is still active; purging it from the ring might create a data integrity exposure.

On SYS2, the operator replies YES to message ISG101D.

On all active systems, the following messages appear:

```
ISG011I SYSTEM SYS1 - QUIESCING GLOBAL RESOURCE SERIALIZATION
ISG013I SYSTEM SYS1 - QUIESCED GLOBAL RESOURCE SERIALIZATION
ISG011I SYSTEM SYS1 - BEING PURGED FROM GRS COMPLEX
ISG013I SYSTEM SYS1 - PURGED FROM GRS COMPLEX
```

On SYS1, the operator must stop the system. At this point, SYS1 is no longer known to global resource serialization. The ring consists of SYS2, SYS3, and SYS4. To rejoin the ring, SYS1 must reIPL with GRS=JOIN.

While purging SYS1, global resource serialization might detect a potential data integrity exposure. After purging an active system, the operator should follow the installation’s procedures for resolving a data integrity exposure, such as contacting the system programmer responsible for investigating the state of resources. More information about the problem normally appears in SYSLOG, where the following message appears to describe any resources that might have been damaged by purging the system:

```
ISG018I REQUESTORS FROM SYSTEM SYS1 HAVE BEEN PURGED FROM RESOURCES
         NAMED xxxx,yyyy
```

Example — Purging a Quiesced System: Using the four-system complex shown earlier in Figure 65 on page 151, assume that it is necessary to purge SYS1 from the ring. SYS1 is a quiesced system. The operator on SYS2 issues the purge command; thus, SYS2 is the assisting system. The required steps are:

On SYS2, the operator issues VARY GRS(SYS1), PURGE. The following messages appear:

```
ISG016I SYSTEM SYS1 OWNS OR IS WAITING FOR GLOBAL RESOURCES
ISG017D CONFIRM PURGE REQUEST FOR SYSTEM SYS1 - REPLY NO OR YES
```

These messages indicate that users on SYS1 still own, or are waiting for, global resources. The operator on SYS2 should reply NO unless the operator knows the work on SYS1 has been shut down. The operator on SYS1 must shut the work down. Replying YES to message ISG017D might create a data integrity exposure. When the work on SYS1 has been shut down, the operator on SYS2 can reissue the VARY GRS(SYS1), PURGE command.

On SYS2, the following message appears:

```
ISG011I SYSTEM SYS1 - BEING PURGED FROM GRS COMPLEX
```

On all active systems, the following message appears:

```
ISG013I SYSTEM SYS1 - PURGED FROM GRS COMPLEX
```

On SYS1, the operator must stop the system. At this point, SYS1 is no longer known to global resource serialization. The ring consists of SYS2, SYS3, and SYS4. To rejoin the ring, SYS1 must reIPL with GRS=JOIN.

While purging SYS1, global resource serialization detected a potential data integrity exposure, indicated by message ISG016I. When this message appears, the operator should follow the installation's procedures for resolving the problem, such as contacting the system programmer responsible for investigating the state of resources. More information about the problem normally appears in SYSLOG, where the following message appears to describe any resources that might have been damaged by purging the system:

```
ISG018I REQUESTORS FROM SYSTEM SYS1 HAVE BEEN PURGED FROM RESOURCES
          NAMED xxxx,yyyy
```

Restarting a System

Specifying the automatic recovery options, RESTART and REJOIN, means that operators seldom need to intervene to restart a system. When necessary, the operator on any system in the complex can issue the VARY GRS(sysname),RESTART command to bring the target system back into the ring. The target system can be either an inactive system or a quiesced system.

Restarting a system is the opposite of quiescing a system. VARY GRS(sysname),QUIESCE suspends global resource serialization and removes the target system from the ring. VARY GRS(sysname),RESTART resumes global resource serialization and brings the system back into the ring. The restarted system, because it is now part of the ring, can release any resources already freed by users and resume processing requests for global resources.

The VARY GRS(sysname),RESTART command can bring back into the ring a system that the operator had quiesced or a system that had become inactive or quiesced as a result of a ring disruption. After issuing the command, the operator can use D GRS to verify that the target system is now part of the ring.

There are three ways to issue the command:

1. VARY GRS(sysname),RESTART — issued from any active system to bring the named system back into the ring.
2. VARY GRS(*),RESTART — issued on the system to be restarted to bring that system back into the ring.

Issuing the first or second form of the command when all systems are inactive makes the specified system active, while all others become quiesced. The active system can then bring the other systems back into the ring.

3. VARY GRS(ALL),RESTART — issued on any inactive system to restart the ring. Ensure that operators:
   - Allow automatic recovery processing to complete before issuing this command.
   - Issue this command only when there is no active system in the ring and at least one inactive system.
   - Issue this command only once during the process of recovery from a ring disruption.

   The command changes the state of all inactive systems from inactive to active. The command will not bring back systems that were quiesced before the ring disruption, such as those that the operator quiesced specifically.

Issuing any form of the command when all systems are quiesced invokes the reactivate function, which is designed for very unusual recovery situations.

To avoid the possibility of split rings, ensure that the operators issue VARY GRS(ALL),RESTART with extreme care.

Split Rings: Split rings can occur when more than one operator tries to restart the ring at the same time, causing the ring to split into multiple independent rings, each able to grant access to global resources at the same time. Split rings create a severe data integrity exposure. Actions you can take to avoid split rings include:
- Ensure that an operator issues VARY GRS(ALL),RESTART only from an inactive system.
- Ensure that only one operator issues VARY GRS(ALL), RESTART
- Provide alternate links.
- Specify RESTART(YES) whenever possible, which allows automatic restart and reduces operator intervention in recovery from a ring disruption.

An operator trying to restart the ring should always issue VARY GRS(ALL),RESTART to restart all of the systems rather than VARY GRS(sysname),RESTART or VARY GRS(*),RESTART to restart a specific system. When the operator issues VARY GRS(ALL),RESTART, global resource serialization issues the following messages:

```
ISG026I SYSTEM SYS2 MAY CREATE A SPLIT RING IF ANY OTHER GRS SYSTEM
          IS ACTIVE. VERIFY THAT NO GRS SYSTEM IS ACTIVE BEFORE
          CONFIRMING RESTART
  ISG027D CONFIRM RESTART RING FOR SYSTEM SYS2 - REPLY NO OR YES
```

Before replying to message ISG027D, the operator must issue D GRS and/or check with the other operators to verify that there are no active systems. If all other systems are inactive, the operator can safely reply YES to continue the restart. If any system is active, the operator must reply NO to avoid split rings.

For example, consider the two-system complex shown in Figure 68 on page 162. SYS1 is active, SYS2 is quiesced, and the communication link has failed. If the operator issues a restart command on SYS2, message ISG026I appears to warn the operator that split rings might occur, followed by a prompting message. If the operator replies YES to the prompt, SYS2 will create a ring of one system. Because SYS1 is also active and there is no communication, there are two one-system rings. Both rings can grant access to the same global resources, and neither system can rejoin the ring created by the other without an IPL. Note that global resource serialization does not force the reIPL; it is, however, required to resolve the data integrity exposure.

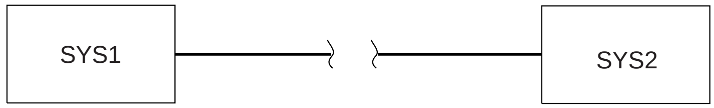


Figure 68. Two-System Ring with Link Failure

There are several ways to avoid split rings in this situation:

1. If the configuration includes an alternate link, and the alternate link has not failed, the problem does not occur; global resource serialization could use the alternate link and resume processing almost immediately.
2. If the operator issues the restart command on the active system, split rings do not occur. Instead, the following message appears:
   ```
   ISG014I VARY GRS RESTART REQUEST FOR SYSTEM SYS1 REJECTED -
            SYSTEM NOT RESPONDING
   ```
3. If the operator replies NO to the prompt following message ISG027D, split rings do not occur.

In the last two cases, message ISG026I or message ISG014I alert the operator to the actual problem; SYS1 and SYS2 cannot communicate. The operator could then respond correctly — fix the link problem, then reissue the VARY GRS(SYS2),RESTART command for the quiesced system.

Example — Restarting a System: Using the four-system complex shown in Figure 65 on page 151, assume that SYS4 has been quiesced but is now ready to rejoin the ring. An operator on any active system could restart SYS4, but assume that the operator on SYS2 is to handle the restart.

On SYS2, the operator issues VARY GRS(SYS4),RESTART.

On SYS2 and SYS4, the following message appears to indicate that the process of restarting SYS4 has begun:

```
ISG011I SYSTEM SYS4 - RESTARTING GLOBAL RESOURCE SERIALIZATION
```

On all active systems, the following message appears to indicate that SYS4 is now part of the active global resource serialization ring:

```
ISG013I SYSTEM SYS4 - RESTARTED GLOBAL RESOURCE SERIALIZATION
```

If the operator on SYS4 issued the restart command, global resource serialization would pass the command to an active system for processing. If the system selected was SYS2, the following message would appear on SYS4:

```
ISG012I RESTART REQUEST PASSED TO SYSTEM SYS2
```

Controlling CTC Links

To bring a CTC link online or take a CTC link offline, use the VARY command. All links that you want global resource serialization to use must be defined in the GRSCNFxx member.

To bring a defined link online, issue VARY devnum,ONLINE. In response to this command, the link comes online, and global resource serialization changes its status from DISABLED to ALTERNATE. It is then available to send the ring acceleration signal or to act as a backup for a primary link.

To take a defined link offline, issue VARY devnum,OFFLINE. In response to this command, the link goes offline, and global resource serialization changes its status from ALTERNATE to DISABLED. The specified link must be an alternate link; if an operator tries to take the primary link offline, global resource serialization rejects the command.

Transitions to and from a Mixed Complex

During normal operations, the actual operating environment may alternate between a mixed complex and a complex that matches a sysplex as systems join and are purged from the complex. For example, in a three system mixed complex where two systems are in the same sysplex, removing the non-sysplex system (by issuing VARY GRS PURGE) creates the complex equal sysplex environment.

Even in this transitional complex equal sysplex environment, many of the operational benefits described in “Operating a Complex That Matches a Sysplex” on page 145 will exist. For example, all systems have automatic rebuild and rejoin characteristics, so the VARY GRS commands are not supported in this environment. In addition, you can issue the SET GRSRNL command to change the RNLs of the systems that are part of a sysplex, and then IPL the other systems with the updated RNLs.

When the non-sysplex system is re-IPLed into the complex, the operating environment becomes mixed again.

Chapter 10. Installing and Tuning the Complex

There are many possible ways to install a global resource serialization complex.

Installing the Complex

You may decide to bring all of your systems down and reIPL them into a multisystem sysplex that matches the complex. You may choose to start a complex with a single system enabled for a sysplex and continue to use RESERVE/DEQ or job scheduling to serialize shared resources until you bring your remaining systems into the complex and sysplex. If you are planning your installation's first global resource serialization complex, the best approach is to plan to create a sysplex that matches the complex. See "Installing the Complex" for a list of considerations. *z/OS MVS Setting Up a Sysplex* provides detailed information on installing a sysplex.

However, if your installation is already using a global resource serialization complex, you may want to plan on moving one system at a time into a sysplex. See "Migrating an Existing Complex into a Sysplex" for a detailed migration plan.

You will also want to evaluate the performance of the complex as you progress and take actions that will minimize the performance cost of the availability benefits that a global resource serialization complex provides; see "Tuning the Complex" on page 169.

Installing a New Complex

How you actually install the global resource serialization complex depends — like every other decision related to global resource serialization — on the needs of your installation. Here are some installation considerations:

- Identify the resources that you must include in the RNLs to get benefits from the complex as quickly as possible.
- Define the long-term resource processing goals for your installation.
- Evaluate the data set naming conventions at your installation and begin making any changes required to make better use of global resource serialization.
- Evaluate the possibility of modifying existing applications to use global resource serialization more effectively.
- Determine how global resource serialization will affect the design of future applications.
- Prepare the initial educational and procedural material for the system operators.
- Leave the RESERVE conversion RNL empty if you plan to continue using RESERVE/DEQ for data set serialization until the complex matches the sysplex.
- Complete any shared DASD changes required to ensure that the complex does not share DASD volumes with systems outside the complex.

Migrating an Existing Complex into a Sysplex

You can migrate an existing global resource serialization complex into a sysplex one system at a time. There are two ways you can accomplish the migration. The easier way is to add communication links for XCF to use in addition to the links already dedicated to global resource serialization. Providing the extra links allows you to keep your complex operational in the event that you encounter an unexpected situation and need to revert to the previous environment. Once your operating environment is stable after the migration, however, you can release the links that were dedicated to global resource serialization, freeing them for other uses.

Another way to migrate the systems in a complex into a sysplex requires releasing a link that is dedicated to global resource serialization and using that link for XCF, as well as providing every pair of systems in the complex with one additional link, also for XCF. The additional link between each pair of systems leaves one link dedicated to global resource serialization, enabling you to return to the previous environment with at least minimal link connections still dedicated to global resource serialization if an unexpected situation should make it necessary.

Note: You must use the VARY ctc,OFFLINE,FORCE command to release a CTC dedicated to global resource serialization before XCF can use the CTC.

The following example illustrates this migration technique. Figure 69 represents a fully-connected global resource serialization complex before migration described in the example begins.

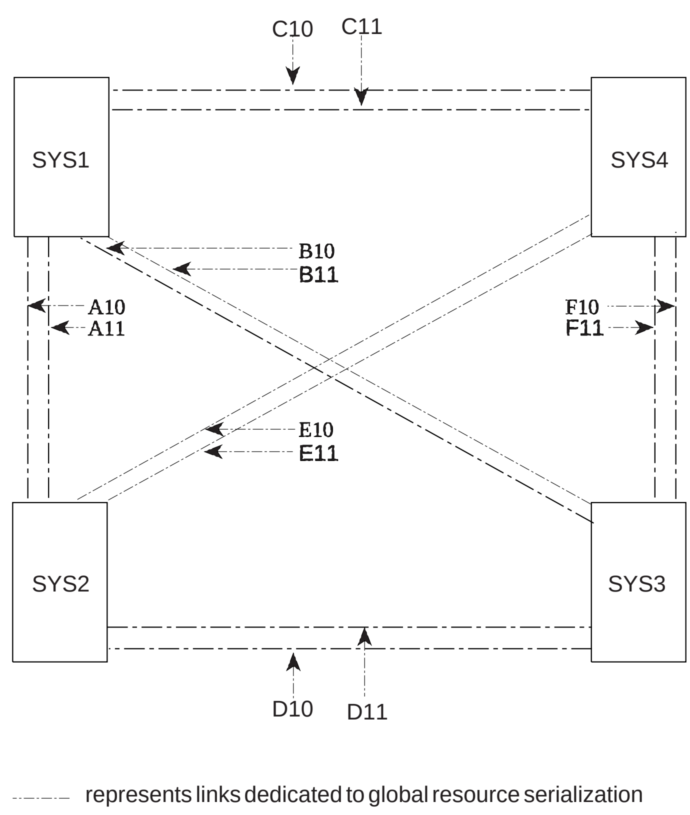


Figure 69. Global Resource Serialization Complex before Migration

The systems are migrating to MVS/SP Version 4 sequentially, beginning with SYS1.

1. **Migrating SYS1 into the sysplex**
   - All links remain dedicated to global resource serialization
   - ReIPL SYS1 into the sysplex.
2. **Migrating SYS2 into the sysplex**
   - Remove one link (A11 in this example) from use by global resource serialization and make it available to XCF.

- On SYS1, issue the VARY A11,OFFLINE,FORCE command so global resource serialization can no longer use the link. (Respond *free* to message ISG186D.)
- On SYS1, issue the VARY A11,ONLINE command to make the link available to XCF.
- On SYS1, issue the SETXCF START,PATHIN,DEVICE=(A11) command to let XCF begin using the link.

- Make another link (A12 in this example) available to XCF.
  - On SYS1, issue the SETXCF START,PATHOUT,DEVICE=(A12) command to let XCF begin using this new link.
- ReIPL SYS2 into the sysplex, specifying that XCF on SYS2 use links A11 and A12.

3. **Migrating SYS3 into the sysplex**
   - Remove one link (B11) between SYS1 and SYS3 from use by global resource serialization and make it available to XCF.
     - On SYS1, issue the VARY B11,OFFLINE,FORCE command so global resource serialization can no longer use the link. (Respond *free* to message ISG186D.)
     - On SYS1, issue the VARY B11,ONLINE command to make the link available to XCF.
     - On SYS1, issue the SETXCF START,PATHIN,DEVICE=(B11) command to let XCF begin using the link.
   - Make another link (B12 in this example) between SYS1 and SYS3 available to XCF.
     - On SYS1, issue the SETXCF START,PATHOUT,DEVICE=(B12) command to let XCF begin using this new link.
   - Remove one link (D11) between SYS2 and SYS3 from use by global resource serialization and make it available to XCF.
     - On SYS2, issue the VARY D11,OFFLINE,FORCE command so global resource serialization can no longer use the link. (Respond *free* to message ISG186D.)
     - On SYS2, issue the VARY D11,ONLINE command to make the link available to XCF.
     - On SYS2, issue the SETXCF START,PATHIN,DEVICE=(D11) command to let XCF begin using the link.
   - Make another link (D12) between SYS1 and SYS3 available to XCF.
     - On SYS2, issue the SETXCF START,PATHOUT,DEVICE=(D12) command to let XCF begin using this new link.
   - ReIPL SYS3 into the sysplex, specifying that XCF on SYS3 add and use links B11, B12, D11, and D12.
4. **Migrating SYS4 into the sysplex**
   - Remove one link (C11) between SYS1 and SYS4 from use by global resource serialization and make it available to XCF.
     - On SYS1, issue the VARY C11,OFFLINE,FORCE command so global resource serialization can no longer use the link. (Respond *free* to message ISG186D.)
     - On SYS1, issue the VARY C11,ONLINE command to make the link available to XCF.
     - On SYS1, issue the SETXCF START,PATHIN,DEVICE=(C11) command to let XCF begin using the link.

- Make another link (C12) between SYS1 and SYS4 available to XCF.
  - On SYS1, issue the SETXCF START,PATHOUT,DEVICE=(C12) command to let XCF begin using this new link.
- Remove one link (E11) between SYS2 and SYS4 from use by global resource serialization and make it available to XCF.
  - On SYS2, issue the VARY E11,OFFLINE,FORCE command so global resource serialization can no longer use the link. (Respond *free* to message ISG186D.)
  - On SYS2, issue the VARY E11,ONLINE command to make the link available to XCF.
  - On SYS2, issue the SETXCF START,PATHIN,DEVICE=(E11) command to let XCF begin using the link.
- Make another link (E12) between SYS2 and SYS4 available to XCF.
  - On SYS2, issue the SETXCF START,PATHOUT,DEVICE=(E12) command to let XCF begin using this new link.
- Remove one link (F11) between SYS3 and SYS4 from use by global resource serialization and make it available to XCF.
  - On SYS3, issue the VARY F11,OFFLINE,FORCE command so global resource serialization can no longer use the link. (Respond *free* to message ISG186D.)
  - On SYS3, issue the VARY F11,ONLINE command to make the link available to XCF.
  - On SYS3, issue the SETXCF START,PATHIN,DEVICE=(F11) command to let XCF begin using the link.
- Make another link (F12) between SYS3 and SYS4 available to XCF.
  - On SYS3, issue the SETXCF START,PATHOUT,DEVICE=(F12) command to let XCF begin using this new link.
- ReIPL SYS4 into the sysplex, specifying that XCF on SYS4 add and use links C11, C12, E11, E12, F11, and F12.

Figure 70 on page 169 shows the same complex after migration, but before the links dedicated to global resource serialization are released.

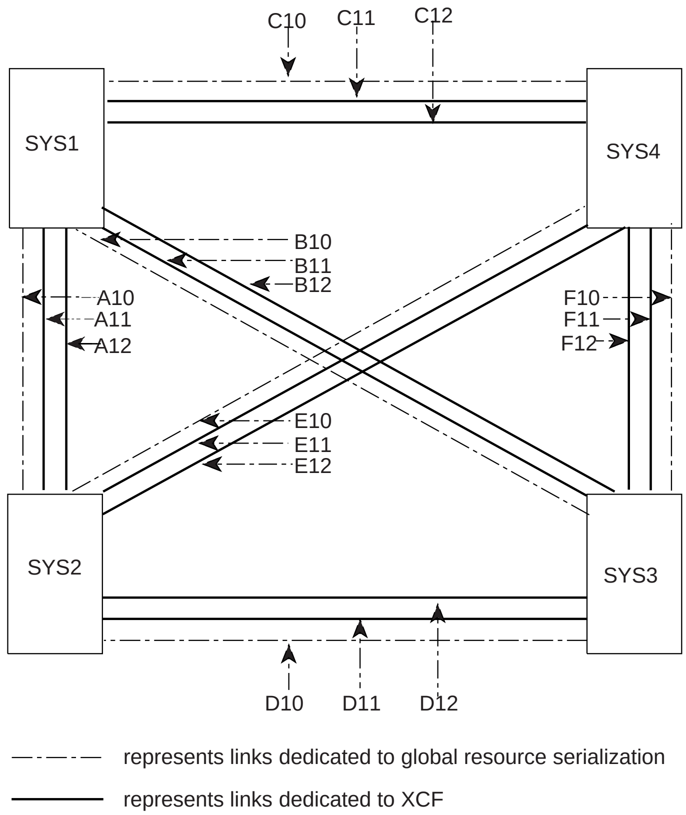


Figure 70. Global Resource Serialization Complex after Migration

The final step, once you are satisfied that your sysplex is performing normally, is to release the links that remain dedicated to global resource serialization. Use the VARY device,OFFLINE,FORCE command and respond *free* to message ISG186D for each link that you wish to free on each system. Using the sysplex shown in Figure 70, you would issue the VARY device,OFFLINE,FORCE command:

- On SYS1 to release links A10, B10, and C10
- On SYS2 to release links A10, D10, and E10
- On SYS3 to release links B10, D10, and F10
- On SYS4 to release links C10, E10, and F10.

Tuning the Complex

A global resource serialization complex increases the availability of systems and resources, and might improve system performance, because converting reserves can:

- Reduce the number of system interlocks that occur because of reserves
- Decrease contention for resources on volumes now serialized by use of a reserve
- Remove the need to use job scheduling to serialize access to resources on shared DASD volumes
- Avoid the data integrity exposure that occurs when a system reset prematurely ends a reserve
- Avoid the situation when one processor can monopolize a shared volume

A global resource serialization complex does, however, increase the system's use of the processor, channels and devices, and storage. This additional overhead occurs for two main reasons:

1. Every system in the ring processes every request for a global resource and maintains information about the status of every global resource.
2. The RSA-message used to pass information about global resource requests from one system to another requires processing overhead each time it makes a cycle around the ring. This overhead occurs even when the RSA-message is empty.

In addition, every task that requests a global resource is suspended while the ring processes the request. The time that a task is suspended while it is waiting for access to a global resource is the global resource request response time.

Thus, tuning a global resource serialization complex involves balancing your installation's need for an acceptable response time while minimizing the effect that ring processing has on overall system performance. Except for very small processors or systems that are already running close to capacity, the effect of ring processing is normally not significant. Thus, focus your tuning work on response time — the delay that individual global resource requestors encounter. Your installation must determine what response time is acceptable.

If the response time is acceptable, there is no need to tune the complex. If the response time is not acceptable, then you need to investigate the problem and take action to resolve, or at least minimize, the difference between the actual response time and the acceptable response time.

The design of your complex, described in detail in Chapter 8, "Designing the Complex" on page 115, is very closely connected to ring performance. Thus, many of the factors that affect ring performance are relatively fixed; for example, if all other factors are equal, a three-system ring takes more time to process a global resource than a two-system ring. If you need three systems in the ring, however, you cannot resolve a performance problem by removing one system.

To evaluate the impact of these factors, you first need to understand how to calculate average response time. To illustrate the calculations, assume the following configuration:

- There are four systems in the ring.
- Communication links are through an IBM 3088 MCCU.
- The RESMIL value for all systems is 1 millisecond.
- The RSA-message size is 4K.

Average Response Time

Average response time is the average amount of time a requestor must wait before a request for a global resource can be granted. It depends on cycle time — the amount of time that the RSA-message requires to make a complete cycle around the ring. In tuning ring performance, the primary goal is to ensure that the average response time is as close as possible to the acceptable response time at your installation.

One of the factors used to calculate average response time is the transmission delay for a global resource serialization signal. Table 10 shows the transmission delays for the global resource serialization signalling paths.

Table 10. Transmission Delays by Signalling Path and Device

Signalling Path	Device	Transmission Delay (in milliseconds)
Global resource serialization	3088	1
Global resource serialization	ESCON channel in basic mode	0.5
XCF	3088	1
XCF	ESCON channel in CTC or basic mode	0.5

You can use the following formulas to calculate average response time and predict the effect of changes you might make. The formulas you need depend on whether your ring is using ring acceleration.

If the ring is using ring acceleration, then **n** is the number of systems, and **a** is the ACCELSYS value. The calculations for cycle time and average response time are:

```
cycle time = (RESMIL * n) + (transmission delay * n)
response time = cycle time/2 + (RESMIL * (a - 1)) + (transmission delay * a)
```

Because the configuration includes a 3088, the transmission delay is about 1 millisecond for the RSA-message and 1 millisecond for the ring acceleration signal. Assuming ACCELSYS(2), the average response time is about 7 milliseconds, as follows:

```
cycle time = (1 millisecond * 4) + (1 millisecond * 4)
response time = 8 milliseconds/2 + 1 millisecond + 2 milliseconds
```

If the ring is not using ring acceleration, **n** is the number of systems, and the calculations for cycle time and average response time are:

```
cycle time = (RESMIL * n) + (transmission delay * n)
response time = cycle time * 1.5
```

In this case, the average response time is about 12 milliseconds, as follows:

```
cycle time = (1 millisecond * 4) + (1 millisecond * 4)
response time = 8 milliseconds * 1.5
```

Experience has shown that the cycle time is a stable value; it does not normally vary significantly during any given time period. Resource contention, however, can add to the response time. That is, average response time measures only the time a global resource requestor waits for ring processing to complete. It does not reflect the time spent waiting until a requested resource becomes available (this delay is not directly related to ring processing).

Tuning Factors

Achieving acceptable response time for global resource requests involves many factors:

- Number of systems in the ring
- Transfer rate on the communication links
- Level (version and release) of MVS
- RSA-message size
- Global resource request rate
- RESMIL value
- Ring acceleration (ACCELSYS)

The following sections describe the factors that can affect how successfully your complex meets your goals. Where applicable, the descriptions include specific actions for particular problems.

Number of Systems

It is obvious that a two-system complex can respond more quickly to requests for global resources than a four-system complex. The fewer the systems, the shorter the cycle. Adding a system to the ring, however, need not cause a corresponding increase in response time. Lowering the residency time (RESMIL value) on all systems can make the addition of another system transparent to global resource requestors.

Transmission Rate

The transmission rate reflects how quickly the systems in the ring can communicate. It is, like the number of systems in the ring, relatively fixed. Using an IBM 3088 or an ESCON channel operating in basic mode to provide communication links yields significant improvement over using integrated CTC adapters. Following the channel placement recommendations in “Link Placement” on page 124 can avoid channel delay. The level of MVS installed can also affect the transmission rate.

Level of MVS

The level of MVS installed on the systems in the complex can affect the RSA-message size, and the size of a global resource request.

For levels of MVS earlier than MVS/SP Version 2 Release 2, the RSA-message size is 4K.

With MVS/SP Version 2 Release 2, the default RSA-message size is 8K, and an installation can increase the size to 32K. Compression of requests, as well as the larger RSA-message, increase ring capacity — the number of global resource requests the ring can process in a given period of time.

For MVS/SP Version 3 or later, the default RSA-message size is 32K, and the average size of a global resource request is further compressed. These changes promote increased ring capacity. Ring acceleration can also reduce response time; see “Ring Acceleration (ACCELSYS)” on page 133. In addition, MVS/SP Version 3 or later process DEQ requests for a single global resource differently, resulting in reduced response time.

The degree to which the level of MVS installed affects ring performance is most noticeable when all systems in the ring are at the same level. For example, ring acceleration requires that all systems include MVS/SP Version 3, MVS/ESA SP Version 4, or above. When the systems in the complex are operating different levels of MVS, the benefits are not as effective. An example of how a mixture of MVS levels in a complex can affect ring performance is the size of the RSA-message.

RSA-Message Size

The maximum size of the RSA-message, as well as the cycle time and the average global resource request size, determine ring capacity — the number of global resource requests the ring can process in a given period of time.

When different levels of MVS are present in the same complex, global resource serialization automatically adjusts the maximum size of the RSA-message to the lowest common value. For example, assume that the ring consists of two MVS/SP Version 5 systems; the maximum RSA-message size is 32K. Assume that an MVS/XA system joins the ring; it is an MVS/SP Version 2 Release 2 system using the default RSA-message size of 8K. Global resource serialization adjusts the maximum size of the RSA-message to 8K. If the MVS/XA system leaves the ring, global resource serialization again adjusts the size, in this case restoring it to 32K.

In this example, the MVS/XA system reduces ring capacity by limiting the maximum size of the RSA-message to 8K. Because the MVS/XA system is running MVS/SP Version 2 Release 2, you can change the default maximum RSA-message size to 32K, if you have applied the fix for APAR OY08389.

Whether ring capacity is a performance problem or not depends on the global resource request rate.

Global Resource Request Rate

The global resource request rate is the number of global resource requests that the systems in the ring actually generate, most conveniently expressed as the number of global resource requests per second.

If the systems generate more requests than the ring can process, the RSA-message cannot hold all of the requests. Some requests must wait for at least one additional cycle before getting into the RSA-message, thus increasing response time. Using the RNLs to reduce the number of unnecessary global resource requests is a possible solution. Lowering the residency time (RESMIL value) is often a better way to deal with a high global resource request rate. The lower RESMIL value increases ring capacity; the RSA-message makes more cycles around the ring in any given time period, and thus the ring can process more requests in the same amount of time.

If the systems generate very few requests, global resource serialization might raise the actual RESMIL to avoid excessive CPU utilization. In rare cases, this can noticeably increase the average response time. If the increased response time is unacceptable, specify a RESMIL slightly lower than the value specified in Table 11 on page 174 or Table 12 on page 174.

RESMIL Value

The residency time (also called the RESMIL value) is the amount of time that the RSA-message spends in each system in the ring in addition to the time needed to processes the RSA-message.

“Residency Time Value (RESMIL)” on page 130 and “Residency Time Value (RESMIL)” on page 117 describe how to set an initial value when you set up your complex. Use this information in tuning your complex. Setting the initial RESMIL value correctly is your best technique for tuning the complex.

Establishing a response time objective is one way to select a value for RESMIL. (See “Measuring Response Time” on page 176 for one way to measure actual response time.) To establish a response time objective, determine what response time is acceptable or desirable, then set the RESMIL value to meet that objective.

Choose a low response time objective (10 milliseconds or lower) if all of the systems in the complex are 3090 processors or if any one of the following conditions is true:

- Your installation has chosen to convert catalog reserve SYSIGGV2.
- Your installation has batch jobs that issue many global resource requests and that must complete in a fixed time.

Once you have set a response time objective, you next translate that objective into a RESMIL value, depending on the number of systems in the ring. Table 11 and Table 12 can help you with this process. The RESMIL values shown are based on the formulas shown earlier in "Average Response Time" on page 170, with the following assumptions:

- The RSA-message contains only one request.
- The transmission time is one millisecond.
- There is no contention time for the requested resource.

The RESMIL values shown have been rounded down to the nearest integer.

As described earlier, there are many factors (such as data transmission rate, RSA-message size, and global resource request rate) that affect the actual response time. Thus, setting a particular RESMIL value does not guarantee meeting the corresponding response time objective. You can, however, use the RESMIL value in the table as a starting point. Use the values in Table 11 if you use ring acceleration; use the values in Table 12 if you do not.

Table 11. RESMIL Values with Ring Acceleration — ACCELSYS(2)

Response Time Objective (Milliseconds)	2-System Ring	3-System Ring	4-System Ring	5-System Ring
10	3	2	2	1
20	8	6	5	4
30	13	10	8	7
40	18	14	12	10
50	23	18	15	13

Table 12. RESMIL Values without Ring Acceleration

Response Time Objective (Milliseconds)	2-System Ring	3-System Ring	4-System Ring	5-System Ring
10	2	1	0	0
20	5	3	2	1
30	9	5	4	3
40	12	7	5	4
50	15	10	7	5

ACCELSYS Value

The value you specify for ACCELSYS can be between 2 and **n**, where **n** is the number of systems in the global resource complex. Specify ACCELSYS(2) to obtain the maximum performance benefits. The default value for ACCELSYS is 99, which turns ACCELSYS off. See "Recovery" on page 121 or "Recovery" on page 134 for information about recovery considerations.

Tuning Process

Tuning a global resource serialization complex, like any system tuning process, requires a disciplined approach of measuring the system's performance, setting specific goals, taking actions to reach the goals, then measuring and evaluating the results of the actions.

You will probably want to take a base set of measurements of your system performance before you begin the process of installing your complex and repeat the measurements at several points along the way. You might want to measure your system:

1. Before you begin to install the complex
2. While each system is running as a one-system complex
3. After the initial complex is running
4. After each change to the design of the initial complex — such as adding a system
5. After each tuning change that you make

Obviously, each set of measurements should be taken under the same set of conditions. That is, come as close as you can to ensuring that the system is processing the same workload during each measurement period.

Measurements

Gathering the information you need to measure and evaluate ring performance is a very important part of the tuning process. RMF reports provide much useful information about system performance and about resource use. You can use GTF to gather information about the size of the RSA-message, and you can measure response time.

Using RMF

Ring performance is only one aspect of total system performance. Focus your monitoring efforts on total system performance and look more closely at ring performance only when it appears to be affecting how well your system meets your overall performance objectives.

RMF Monitor I session reports are particularly useful in determining how ring performance affects overall system performance. One key report is **Workload Activity**. Use this report to determine the resources (processor, I/O, and storage) that global resource serialization is using. To obtain the clearest picture of resource consumption, place global resource serialization in its own performance group or report performance group.

RMF Monitor II session reports can also provide information about how global resource serialization affects the system. For example, you can use the **Address Space State Data** report to determine how much processor time global resource serialization consumes and the number of page faults the GRS address space experiences. To provide the optimum response time, the page-in rate for the GRS address space should be close to zero.

RMF Monitor III (workload delay monitor) reports can also help you deal with problems related to delays of jobs or users. These reports can show address spaces delayed and whether resource contention is contributing to the delay, as well as the jobs affected. They can point out jobs that are being slowed by ENQ delays. If the reports indicate ENQ delays, possible reasons might be:

- A job is delayed because the system is waiting for the RSA-message to complete its cycle. Lowering the RESMIL value might resolve the problem.
- A job is delayed because the RSA-message is encountering a communication delay. Ensure that the links used to send the RSA-message are not installed on the same channels as devices that monopolize the channel for long periods of time.

- A job is delayed because there is contention for the resource; another job is using it. If the delay is caused by a reserve, investigate the possibility of converting the reserve to reduce contention for the resource.

The Monitor I **Enqueue Contention Activity** report can also help you to identify the resources that are causing the most significant contention delays.

Using GTF

For systems that are not part of a multisystem sysplex, using the generalized trace facility (GTF) can provide additional information. You can use GTF to monitor:

- How frequently the RSA-message passes around the ring
- The actual size of the RSA-message
- The duration of the cycle time

To gather this information, trace the global resource serialization CTC channel program for a short period of time during peak processing. Place the following GTF trace options in a parmlib member that GTF reads when the trace is started:

```
TRACE=SSCHP,IOP,CCWP
IO=SSCH=(C44,C4C,C54)
CCW=(SI,DATA=8)
END
```

These sample statements trace the CTC links identified by device numbers C44, C4C, and C54. Replace these device numbers to trace the links that global resource serialization is using in your installation at the time of the trace. The data count (DATA=8) is small because the actual contents of the RSA-message are not of interest. The trace statements do record the number of bytes in the RSA-message; a length of 39 bytes indicates an empty RSA-message (an RSA-message that contains no resource requests).

If the RSA-message is almost always empty, you can probably set a higher RESMIL value without affecting response time. If the RSA-message is frequently close to full (more than 25K when the maximum size is 32K), set a lower RESMIL value to send the RSA-message around the ring more frequently. If the RSA-message is full even occasionally (more than five percent of the time), it is probably having an adverse effect on response time. Set a lower RESMIL value to send the RSA-message around the ring more frequently.

For more information about using GTF, see *z/OS MVS Diagnosis: Tools and Service Aids* and *z/OS MVS Initialization and Tuning Reference*.

When you examine the data, using either the GTFTRACE function of IPCS (interactive problem control system) or your own post-processing program, be aware that the direction (clockwise or counter-clockwise) of the RSA-message is determined dynamically when the systems build the ring. Thus, an address used to send the RSA-message at one time might receive it at another time. Once determined, the direction of the message cannot change unless a system enters or leaves the ring.

Measuring Response Time

The cause of a response time problem that shows up either as an increase in interactive user response time or an increase in the time it takes to complete a batch job, is sometimes difficult to pinpoint. One way to obtain a very useful end user view of ring performance is to code a program that issues repetitive global resource requests (ENQ macros with a scope of SYSTEMS) and measures the elapsed time required for a response.

Figure 72 on page 178 shows an example of how to invoke a program that measueres request response time from the perspective of the problem program issuing the request. You can take repetitive samples, allowing you to analyze response time over a longer period. The program, GENQRESP, is provided in SYS1.SAMPLIB(ISGNQRSP). You will need to ensure that G.SAMPLES DD is appropriate for your installation.

The program uses STIMER to suspend itself for a user-specified interval. When the interval has expired, the program issues an ENQ with a scope of SYSTEMS for a nonexistent resource. The program notes the value of the system TOD clock before issuing the ENQ request and again when control returns. The difference between the two values is the global resource request response time. The program then frees the resource and repeats the request.

The GENQRESP program encounters the same contention for the processor and storage as does any other problem program in your system. Thus, even after the system grants the global resource request, the program might not receive control immediately because of other factors, such as waiting for the processor, paging, or swapping. To ensure that the response time GENQRESP measures is as close as possible to the actual response time, it is a good idea to run GENQRESP on a lightly-loaded system.

Run the program on the system in the ring that has the lightest workload to minimize the effect of paging and swapping delays on the results. Also, try to run the program each time under the same set of conditions. That is, come as close as you can to ensuring that the system is processing the same workload each time you run the program.

Figure 71 shows an example of the output of GENQRESP.

```
    TOD CLOCK                ENQ TIME (IN U-SEC)

0A2CC4DDE984EAB1              00000000011336

0A2CC4DDE9D9F421              00000000008485

0A2CC4DDEA239931              00000000014236

0A2CC4DDEA856D41              00000000014689

0A2CC4DDEAE7DA41              00000000006145

0A2CC4DDEB28D4A1              00000000007376

0A2CC4DDEB6E86D1              00000000012141

0A2CC4DDEBC6B451              00000000008454

0A2CC4DDEC182481              00000000006383

0A2CC4DDEC59CCD1              00000000010125
```

Figure 71. Sample Output of GENQRESP

```
//GENQRESP  JOB accounting information...
//*
//* THE NUMBER OF REQUESTS TO ISSUE BEFORE TERMINATING AND THE INTERVAL
//* BETWEEN REQUESTS ARE SPECIFIED AS CONSTANTS IN THE CODE.
//*
//* THE OUTPUT DATASET, DD 'SAMPLES', HAS THE FOLLOWING FORMAT:
//*
//* START   END
//* COL     COL   FORMAT             DESCRIPTION
//*-----   -----  ------   --------------------------------------------
//*  1      16   TODCLOCK  TOD CLOCK VALUE WHEN ENQ WAS ISSUED
//* 31      44   DECIMAL   RESPONSE TIME FOR GLOBAL ENQ REQUEST
//*                        IN MICROSECONDS (1 SECOND = 10**6 MICROSECOND
//*
//* BECAUSE THE PROGRAM SAVES ONLY 32 BITS OF THE TOD CLOCK, RESPONSE
//* TIMES LONGER THAN ABOUT ONE HOUR ARE NOT RECORDED CORRECTLY.
//*
//* FOR THE MOST CONSISTENT RESULTS, ASSIGN THIS JOB TO A DOMAIN
//* WITH A MINIMAL MPL HIGH ENOUGH TO KEEP IT FROM BEING SWAPPED.
//*
//STEP 1 EXEC ASMHCLG,PARM.L='MAP,LIST,NET,NCAL',
// REGION.L=400K
//C.SYSPUNCH DD DUMMY
//C.SYSIN   DD DSN=SYS.SAMPLIB(ISGNQRSP),DISP=SHR
//C.SYSIN   DD *
        ENTRY GENQRESP
/*
//G.SAMPLES DD DSN=yourhlq.ENQRESP.DATA,
// UNIT=SYSDA,
// DISP=(NEW,CATLG),
// DCB=(LRECL=80,BLKSIZE=3200, RECFM=FB),
// SPACE=(CYL,(1,1))
```

Figure 72. Measurement Program Example

Actions

If any of these measurements reveal problems, the most important and useful action is to change the RESMIL value. Divide the change equally among all systems. There is no need to have a different RESMIL value for each system. "Residency Time Value (RESMIL)" on page 130 and "RESMIL Value" on page 173 contain more detailed information.

If your major area of concern is the response time for global resource requests (that is, your concerns are resource availability or delays for work because of ring processing), you can reduce the cycle time by reducing the RESMIL value for each system. Reducing the cycle time reduces the time global resource serialization requires to process each request for a global resource and makes the complex more responsive to individual resource requests. Reducing the cycle time, however, increases the number of times the system must process the RSA-message per second; it thus tends to increase the global resource serialization overhead — the demands it makes on the processor, channels, and devices.

If your major area of concern is the system overhead that global resource serialization causes (that is, your concern is system throughput), you can increase the cycle time by increasing the RESMIL value for each system. Increasing the cycle time reduces the system overhead. It decreases the number of times the system must process the RSA-message per second and thus tends to decrease the demands global resource serialization makes on the processor, channels, and devices. A longer cycle time, however, tends to increase the time global resource serialization requires to process each request for a global resource and makes the complex less responsive to individual requests for global resources.

There are two other basic tuning actions. One is to reduce the number of requests for global resources that the complex must process. That is, you want to ensure that all resources processed as global resources actually require global serialization. To reduce the number of requests for global resources, place entries in the SYSTEMS exclusion RNL to exclude from global serialization those resources, such as temporary data sets, that require only local serialization.

Another basic action is to convert as many reserves as possible. This action does not directly affect the performance of the complex, but it does increase the availability benefits your installation gets from the complex. Therefore, consider developing a long-term plan to work toward the goal of increasing the number of reserves converted to requests for global resources. For example, if you cannot convert reserves only because a volume can be accessed both by systems in the complex and systems outside the complex, change your use of the volume so that only systems in the complex can access it. You can then convert the reserves.

Chapter 11. Diagnosing Global Resource Serialization Problems

Occasionally, situations will arise during the operation of a global resource serialization complex where workload slows down or comes to a complete halt. There are times when these situations are due to problems with the allocation of global resource serialization managed (ENQ) resources. This chapter describes strategies to aid in the diagnosis and correction of these problems in a sysplex environment for either a global resource serialization ring complex or a global resource serialization star complex.

Discriminating between System and Application Problems

The first step in determining what actions to take is to discriminate between a problem with the global resource serialization complex and the applications it serves. There are several kinds of problems that can occur which will affect global resource serialization processing:

1. Tuning:

   A poorly tuned system can elongate global resource serialization requests (ENQ and DEQ). An example of a poorly tuned system could be a ring complex where some of the systems have too high a RESMIL value. Another example is a star complex where the lock structure is too small, causing excessive false contention in the lock structure. Tuning the complex will alleviate these problems.
2. Intersystem communication breakdown:

   Global resource serialization relies on inter-system communication, through XCF communication facilities, which can be either CTCs or coupling facility signalling structures. Communication failures or delays may cause global resource serialization to take recovery actions which can delay and/or elongate ENQ and DEQ request processing.
3. Coupling facility availability:

   The loss of a coupling facility may cause problems with a global resource serialization ring. In star mode, if the ISGLOCK structure fails or the containing coupling facility is lost, the systems in the sysplex cooperate to rebuild the structure.
4. Software:

   Global resource serialization occasionally runs into situations that are not understood by the software or that are not automatically corrected. If a problem is detected that could cause a resource allocation integrity error (for example, more than one exclusive owner of a resource), global resource serialization will take appropriate actions to ensure that such an error does not occur. These actions include fencing a set of resources from being allocated or partitioning a system from the complex.
5. Resource allocation:

   Even if your global resource serialization complex is well tuned, a combination of applications, system utilities, and online users can impede workload progress due to the use of resources. For example, a long running job or utility can hold data sets exclusively, effectively blocking other jobs and users from proceeding. In more extreme cases, it is possible that a set of requests can cause a deadlock for resource requests by causing a situation where a set of users requires resources held by other users. This situation can only be remedied by breaking the deadlock, usually by cancelling one or more of the jobs in the deadlock.

Check If the Complex Is Operating Normally

First, the installation should check to ensure that the complex is operating normally. This is best accomplished by issuing the DISPLAY GRS,SYSTEM command. The following examples show normal output from these commands for both ring and star mode.

```
ISG343I 17.43.42 GRS STATUS          FRAME  1     F      E   SYS=PROD2
SYSTEM    STATE              SYSTEM    STATE
PROD1     ACTIVE             PROD2     ACTIVE
TEST1     ACTIVE

Ring complex, normal response for DISPLAY GRS,SYSTEM command
```

```
ISG343I 17.43.42 GRS STATUS          FRAME  1     F      E   SYS=PROD2
SYSTEM    STATE              SYSTEM    STATE
PROD1     CONNECTED          PROD2     CONNECTED
TEST1     CONNECTED

Star complex, normal response for DISPLAY GRS,SYSTEM command
```

Tuning the Global Resource Serialization Ring

If a global resource serialization ring complex is running without disruption, slowdowns are usually caused by an improperly tuned ring. Delay of the RSA message can become pronounced on larger complexes, delaying the initiation of new workload. To ″speed up the ring″, the installation can take one, two, or all of the following actions.

1. Speed up the RSA.

   The speed of the RSA message is dependent on the RESMIL values specified in GRSCNFxx or the SETGRS RESMIL= command. Determine the RESMIL values used by each of the systems in the complex. To improve ENQ/DEQ response time, decrease the RESMIL value used on all the systems in the complex. You can use the ROUTE *ALL command to effect the change on all systems at one time. Try using a RESMIL of 1 or 2. If this does not meet your performance goals, try a RESMIL of 0.

   There is also a RESMIL setting of OFF. Use this setting carefully, as all of the other RESMIL values are tuned automatically by the complex. If the ring is lightly loaded, global resource serialization will tune the RESMIL value up one millisecond each time an empty RSA makes a trip around the sysplex until RESMIL reaches the specified value plus 5 (RESMIL=1 will tune between 1 and 6 milliseconds). When the ring becomes loaded, RESMIL returns to the specified value. When an installation specifies RESMIL=OFF, the RSA will be sent immediately after receipt and processing by each system, without tuning. This may adversely impact CPU performance.

2. Use Ring Acceleration.

   Ring acceleration improves performance by reducing the number of systems that must see an ENQ before the issuing system may grant ownership of the resource. This reduces the time between a system receiving the RSA and granting a resource request (but does not decrease the system’s wait time for the RSA). There are possible integrity concerns introduced by the use of ring acceleration (see Ring Acceleration (ACCELSYS)), but the opportunity for such failures is small. By specifying ACCELSYS(2), an installation can reduce the overall response time for an ENQ/DEQ request.

3. Use Star Mode.

   By far, a global resource serialization star complex outperforms any ring complex, usually by orders of magnitude, with fewer recovery and operational concerns. IBM recommends that all installations migrate to a star complex whenever possible.

Ring Disruption Recovery

In a global resource serialization ring, communication and connectivity errors are often associated with the following messages:

- ISG177E
- ISG178E

During a ring disruption and the ensuing recovery, the status of the systems ought to change from:

- ACTIVE (before the disruption)
- INACTIVE (during the disruption)
- QUIESCED
- ACTIVE

As the ring is rebuilt, the systems will be returned to ACTIVE status one at a time. One of the systems in the complex is charged with bringing a QUIESCED system back into the ring. This system will be indicated by a status of ACTIVE+VARY.

Even in the best tuned complexes, ring disruptions will periodically occur, especially if there are systems with small LPAR percentages or single CPU machines that may become unresponsive due to other error conditions (a large system dump). After the error condition is corrected, the complex should automatically return to normal operation.

If these messages appear frequently, it is likely that there is a configuration error, either:

- The specified TOLINT value is too small

  TOLINT (Toleration Interval) is the maximum amount of time that the system will wait for the RSA to arrive before indicating an error condition and disrupting the ring. You need to ensure that this value is not too low, causing false error indications or too high, causing an excessive delay in recognizing a ring disruption situation. Use the SETGRS TOLINT= command to increase the value. You can use the ROUTE *ALL command to effect the change on all systems in the sysplex at the same time.

- XCF communication is not responsive

  Check your XCF signalling configuration to ensure that messages for the SYSGRS group are being serviced without excessive delay. Use data from RMF (or another performance monitor) to ensure that XCF signalling is optimized for the SYSGRS group. See *MVS/ESA Parallel Sysplex Performance XCF Performance Considerations* for information on how to tune XCF signalling.

Global Resource Serialization Ring Rebuild

If a ring rebuild seems to ″hang up″ or take a long time, quiesce one of the systems until the XCF failure detection interval is reached. The system will issue message IXC402D to indicate that communications with that system has been lost. Restart the system and see if the ring successfully rebuilds. If the ring does not completely rebuild after one or two attempts, the system(s) that have not rejoined the complex will never do so. Partition the system(s) from the sysplex (using the VARY XCF,system,OFF command) and re-IPL. If possible, obtain a standalone dump of the failing system(s) and contact IBM Service.

Checking XCF/XES Connectivity and Performance

In both ring and star complexes, XCF and XES connectivity are critical to global resource serialization function. If either are not well tuned, the performance of the allocation of global resource requests will suffer. If your installation is running a global resource serialization ring complex, refer to the *MVS/ESA Parallel Sysplex Performance XCF Performance Considerations* to ensure optimal tuning of the sysplex.

In a global resource serialization star complex, you should apply appropriate resource to the coupling facility where you have allocated the ISGLOCK structure. Make sure that the structure is large enough to minimize false contention and that the coupling facility containing the ISGLOCK structure is fast enough to satisfy lock requests from the z/OS images. If you do not, you could see the following problems with your global resource serialization complex:

Symptom	Likely causes
Excessive CPU utilization in the GRS address space	1. The CF with the ISGLOCK structure is using shared CPs. 2. The CF with the ISGLOCK structure is of an older technology than the z/OS system. 3. High contention for global resource serialization managed resources.
Long ENQ response times	1. The CF does not have enough paths to handle the incoming requests. 2. The ISGLOCK structure is too small, causing high false contention rates. 3. The CF with the ISGLOCK structure is using shared CPs. 4. The CF with the ISGLOCK structure is of an older technology than the z/OS system.
ENQ requests suspended	1. The ISGLOCK structure is being rebuilt. 2. There are hung requests to the ISGLOCK structure. 3. A system in the sysplex is not responding to XES requests.

ISGLOCK Structure Request Processing

Infrequently, there are situations that may cause requests to the ISGLOCK structure to be left in an incomplete state. When this occurs, resource requests for those resources that have been hung up will never complete, holding up the requesters indefinitely. The DISPLAY GRS,CONTENTION command provides information regarding resources and requesters that may be in this state. To determine if there is a problem with request processing, you should issue the command on all systems in the sysplex, because the data required to determine the condition is located on each system. When the system is running correctly, the response to the DISPLAY GRS,CONTENTION command, message ISG343I, will look as follows:

```
ISG343I 13.46.47 GRS STATUS 379
[resource contention information]
NO REQUESTS PENDING FOR ISGLOCK STRUCTURE
[latch contention information]
```

When there is a potential problem, the command will indicate the resource and requesters associated with the hung resources. Potentially hung resources are noted by the indication of a delay of more than two seconds in response time. If this text does not appear, the request may still be active, and the appearance in the output is not indicative of a problem. However, if the situation persists, the number of hung requesters will increase. To correct the situation, rebuild the ISGLOCK structure with the SETXCF START,REBUILD,STRNAME=ISGLOCK. An example of the output from the DISPLAY GRS,CONTENTION command when there may be a problem is shown below:

```
ISG343I 13.46.47 GRS STATUS 380
[resource contention information]
GLOBAL REQUESTS PENDING FOR ISGLOCK STRUCTURE:
SYSDSN   SYS1.PROD1.LINKLIB
PRODTOOL 001E 007E7B68 ENQ-EXCL LOCK REQUEST AT 10/25/1999 13:59:21
THIS REQUEST IS DELAYED MORE THAN 2 SECONDS
[latch contention information]
```

Checking for ENQ Resource Allocation Problems

When workload slows down and global resource serialization appears to be operating normally, the problem is often due to some part of the workload dominating ENQ resources in the sysplex. Since many workloads require exclusive access to resources (for example, to update a file), resource contention occurs between different parts of the workload when incompatible requests are made for resources. By itself, resource contention is not a sign of a problem. However, contention held for a long period of time among the same resources and requesters may be an indication of a problem.

Global resource serialization provides diagnostic commands to help determine the source of contention.

Command	Use
DISPLAY GRS,CONTENTION	Provides an alphabetized list of all visible[1] ENQ resources that are in contention. Each resource is reported with the owners and waiters of the resource. [1]The DISPLAY GRS,CONTENTION command will only report contention for SCOPE=SYSTEM resources that are allocated on the system where the command executed. It will not report contention for SCOPE=SYSTEM resources on other systems in the complex.

Command	Use
DISPLAY GRS,ANALYZE,WAITER²	Provides a list of requesters that have been waiting the longest for ENQ resources. Each waiter is reported with: 1. The resource name and scope. 2. The count of waiters and blockers of the resource. 3. The top blocker of the resource. Each waiter is reported with its wait time, system resource that it was ENQed on, and the type of access (shared or exclusive) requested. The counts of waiters and blockers are explicitly returned only when the count is greater than one. ²The various forms of the DISPLAY GRS,ANALYZE command are available on OS/390 Release 3 and higher with APAR OW38979 installed on the system..
DISPLAY GRS,ANALYZE,BLOCKER	Provides a list of the requesters that have been blocking ENQ resources for the longest time. Each blocker is reported with: 1. Resource name and scope. 2. The count of waiters and blockers of the resource. The block time, system the blocker ENQed from, jobname, and the type of access requested are also reported.
DISPLAY GRS,ANALYZE,DEPENDENCY	Provides resource allocation dependency analysis: 1. Starting with each of the longest ENQ waiters, an analysis is performed, iteratively chaining from waiter to top blocker until either a request that is not waiting is found, or a resource allocation deadlock is detected. 2. Starting with the top blockers of a specified resource, an analysis is performed, iteratively chaining from waiter to top blocker until either a request that is not waiting is found, or a resource allocation deadlock is detected. **Note:** The various forms of the DISPLAY GRS,ANALYZE command are available on OS/390 Release 9 with APAR OW38979 installed on the system.

To illustrate how to use contention analysis, an example is presented. In this example, the three-system sysplex is made up of systems PROD1, PROD2 and TEST.

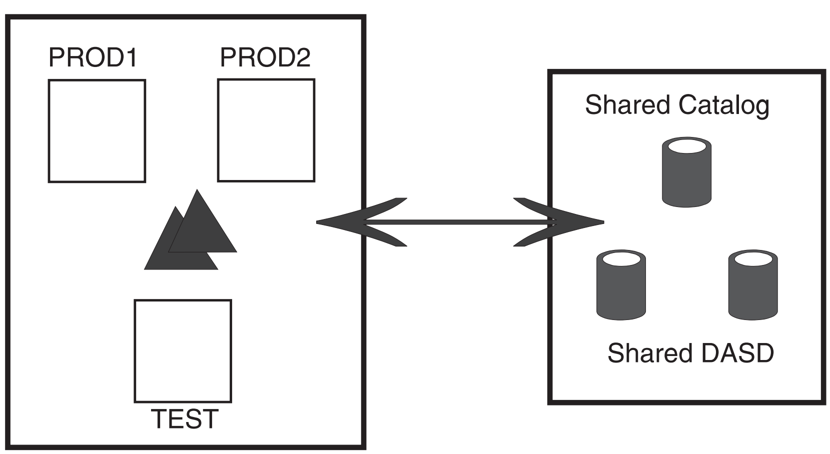


Figure 73. Example of Three System Sysplex

In the scenario, four different work units will be affected:

1. The master scheduler address space (*MASTER*) on PROD1
2. A production job (PRODJOB), running on PROD1
3. A database clean up job (CLEANUP), running on PROD2
4. The system programmer's TSO session (SYSPROG), running on TEST

The production job on PROD1 is a multi-step process that submits the cleanup job, which is to run after the completion of the production run. The cleanup job is kept from running by the exclusive data set ENQ, [SYSDSN, PROD.DB] owned by the production job.

The scenario begins with the production job running. It reaches the step where it submits the cleanup job. The cleanup job initiates but is blocked in allocation on the global ENQ for [SYSDSN, PROD.DB]. However, as part of allocation, it takes exclusive ownership of [SYSDSN, PROD.PROCS]. The current view of contention is displayed in the following figure. In the figure, units of work are represented by rectangles and resources are represented by ovals. The arrow and text from the unit of work to the resource represents the dependency.

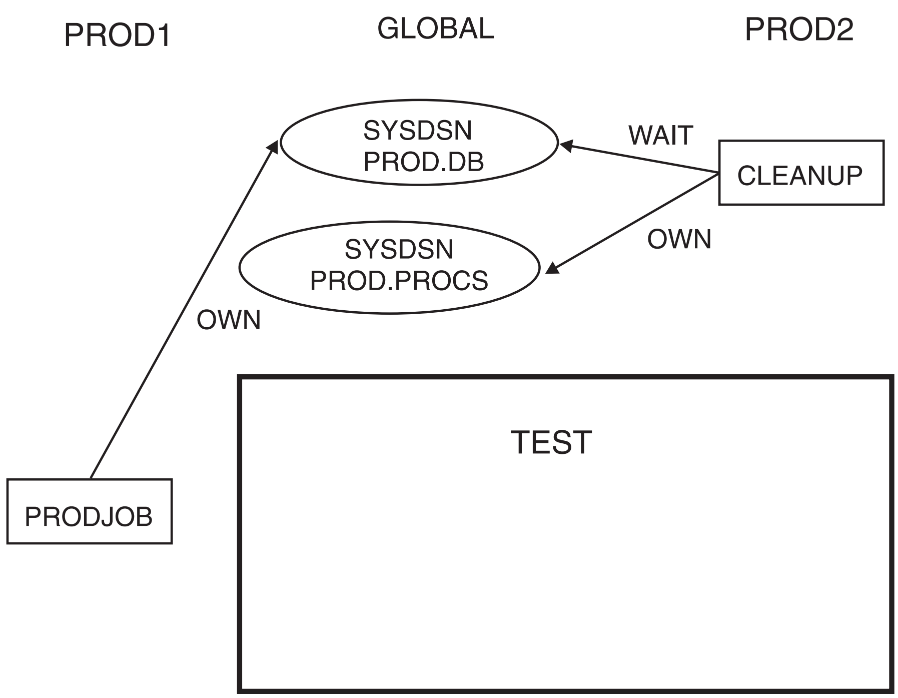


Figure 74. Current View of Contention

While the production job is executing, a task in the master scheduler address space (*MASTER*) fails, but does not end, while holding the system command resource, [SYSIEFSD, Q10]. This resource is required by tasks that wish to issue MVS system commands. Following this failure, the production job invokes the MGCRE macro to issue a system command. Since the command resource is permanently hung up by the *MASTER* task, ownership will never be granted to PRODJOB. Contention for ENQ resources now looks like:

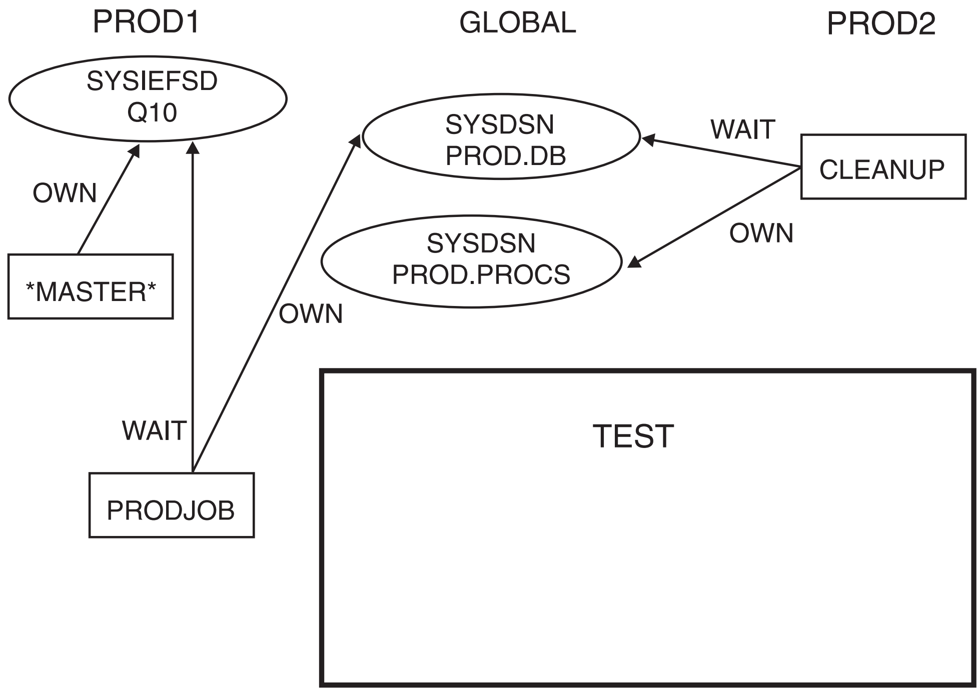


Figure 75. Contention for ENQ Resources

The system programmer discovers that there is some sort of problem with the production database; the production job and the cleanup job seem to be hung up. Interactive requests for the database fail with an indication that the database is unavailable. The system programmer runs an exec from the TSO session, which attempts to allocate both the production database, [SYSDSN, PROD.DB] and the production procedures library, [SYSDSN, PROD.PROCS]. This, of course, hangs the TSO session in an ENQ wait. The final state of contention is as follows:

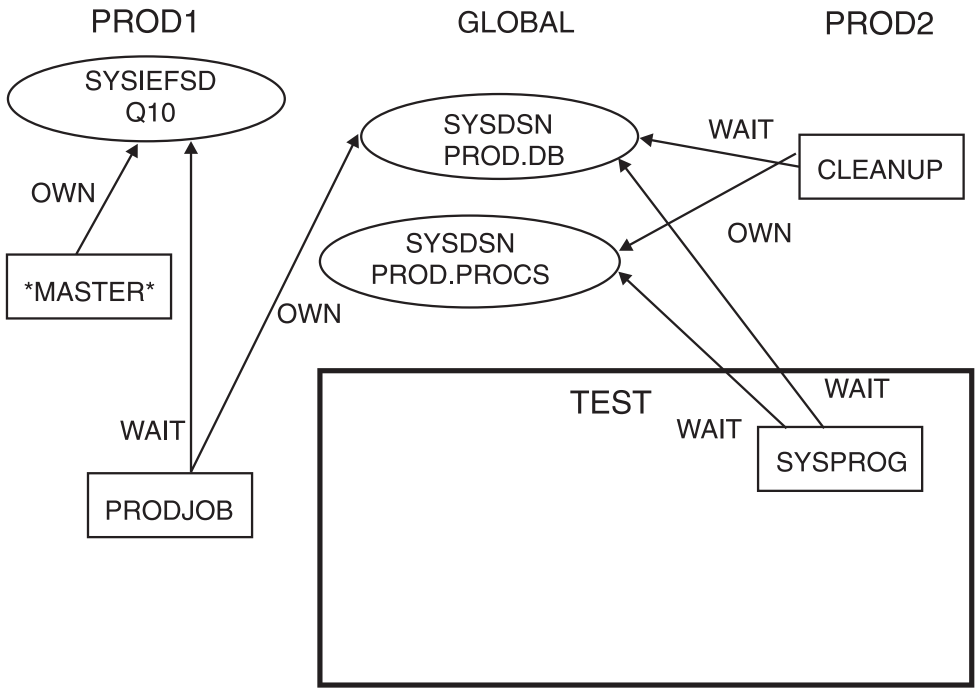


Figure 76. Final State of Contention

To debug this problem, use the contention analysis features provided by global resource serialization. The first thing that the system programmer would discover is that commands do not seem to work on PROD1, so any systems analysis would have to occur either on TEST or PROD2. The system programmer must determine if any resources are in contention. If DISPLAY GRS,C were issued on PROD2 or TEST, the result would be as follows:

```
ISG343I 15.05.24 GRS STATUS 539
S=SYSTEMS SYSDSN   PROD.DB
SYSNAME        JOBNAME         ASID     TCBADDR   EXC/SHR    STATUS
PROD1     PRODJOB            001A       007E7B68 EXCLUSIVE    OWN
PROD2     CLEANUP            0029       007E7B68   SHARE      WAIT
TEST      SYSPROG            0027       007E7B68   SHARE      WAIT
S=SYSTEMS SYSDSN   PROD.PROCS
SYSNAME        JOBNAME         ASID     TCBADDR   EXC/SHR    STATUS
PROD2     CLEANUP            0029       007E7B68 EXCLUSIVE    OWN
```

Looking at this output, it would appear that the problem is with PRODJOB; it is blocking both CLEANUP and SYSPROG from continuing. However, the DISPLAY GRS,C command does not return information about local resources on PROD1, as it was issued on PROD2 or TEST. If the command was issued, the entire view of contention was presented:

Note that on a normal system, there will always be some level of ″background″ contention that is going on all the time. The above example ignores that level of contention and only displays the contention that is applicable.

```
ISG343I 15.02.58 GRS STATUS 981
S=SYSTEMS SYSDSN   PROD.DB
SYSNAME        JOBNAME         ASID     TCBADDR   EXC/SHR    STATUS
PROD1     PRODJOB            001A       007E7B68 EXCLUSIVE    OWN
PROD2     CLEANUP            0029       007E7B68   SHARE      WAIT
TEST      SYSPROG            0027       007E7B68   SHARE      WAIT
S=SYSTEMS SYSDSN   PROD.PROCS
SYSNAME        JOBNAME         ASID     TCBADDR   EXC/SHR    STATUS
PROD2     CLEANUP            0029       007E7B68 EXCLUSIVE    OWN
TEST      SYSPROG            0027       007E7B68 EXCLUSIVE    WAIT
S=SYSTEM  SYSIEFSD Q10
SYSNAME        JOBNAME         ASID     TCBADDR   EXC/SHR    STATUS
```

Here, you can see that the local resource [SYSIEFSD, Q10], held by *MASTER* is really holding up all of the workload.

In a fully loaded system, where there is a considerable amount of workload being processed concurrently, the opportunities for contention and the number of units of work involved in that contention can become much higher. It may become impossible to quickly analyze what resources and units of work are part of a ENQ lockout and which ones are not. When this occurs, using the DISPLAY GRS,ANALYZE command is much more useful. Additionally, the GRS analysis command options are truly sysplex-wide in scope. The analysis will include local resources on all systems in the sysplex.

The analysis provided by this command is based on the fact that most of the ″benign″ contention in the sysplex is short term. That is, if you issue the same command over a period of time, the contention that is most affecting the sysplex will remain in the output of the command. The output from the command is ordered by the length of time that the contention has been in effect. In a serious resource lockout, where one requester dominates ownership of a resource for a long period of time, or a resource deadlock, where a set of requesters requires resources held by the others in the set such that no request can be granted, the contention will quickly rise to the top of the output.

Using the previous lockout scenario, the DISPLAY GRS,ANALYZE,BLOCKER command would return:

```
ISG349I 15.03.09 GRS ANALYSIS 984
LONG BLOCKER ANALYSIS:  ENTIRE SYSPLEX
BLOCKTIME SYSTEM  JOBNAME E/S SCOPE QNAME    RNAME
00:01:33 PROD1    PRODJOB *E*  SYSS SYSDSN   PROD.DB
                        OTHER BLOCKERS: 0  WAITERS: 2
00:00:57 PROD1    *MASTER**E*  SYS  SYSIEFSD Q10
                        OTHER BLOCKERS: 0  WAITERS: 1
00:00:44 PROD2    CLEANUP *E*  SYSS SYSDSN   PROD.PROCS
                        OTHER BLOCKERS: 0  WAITERS: 1
```

It is clear from this output that PRODJOB has been blocking other requesters for the longest time. The display does not tell the complete story. The view obtained from DISPLAY GRS,ANALYZE,WAITER command shows that PRODJOB is also a waiter:

```
ISG349I 15.03.31 GRS ANALYSIS 987
LONG WAITER ANALYSIS:  ENTIRE SYSPLEX
WAITTIME  SYSTEM  JOBNAME E/S SCOPE QNAME    RNAME
00:01:33 PROD2    CLEANUP *S*  SYSS SYSDSN   PROD.DB
BLOCKER  PROD1    PRODJOB  E  OTHER BLOCKERS: 0  WAITERS: 1
00:00:57 PROD1    PRODJOB *E*  SYS  SYSIEFSD Q10
BLOCKER  PROD1    *MASTER* E
00:00:44 PROD2    SYSPROG *S*  SYSS SYSDSN   PROD.DB
BLOCKER  PROD1    PRODJOB  E  OTHER BLOCKERS: 0  WAITERS: 1
00:00:44 PROD2    SYSPROG *E*  SYSS SYSDSN   PROD.PROCS
```

Again, because this is a simple case, it is easy to see that, although PRODJOB has been blocking the longest, PRODJOB is itself blocked by *MASTER* for [SYSIEFSD, Q10].

What if the scenario is far more complicated? Then the DISPLAY GRS,ANALYZE,DEPENDENCY command is very useful in determining if a single or a small set of jobs is causing the lockout. The command can also detect a resource allocation deadlock. For this scenario, the output from the command would be:

```
ISG349I 15.03.54 GRS ANALYSIS 990
DEPENDENCY ANALYSIS:  ENTIRE SYSPLEX
----- LONG WAITER #1
WAITTIME  SYSTEM  JOBNAME E/S SCOPE QNAME    RNAME
00:01:33 PROD2    CLEANUP *S*  SYSS SYSDSN   PROD.DB
BLOCKER  PROD1    PRODJOB  E
00:00:57 PROD1    PRODJOB *E*  SYS  SYSIEFSD Q10
BLOCKER  PROD1    *MASTER* E
--:--:-- PROD1    *MASTER*
ANALYSIS ENDED: THIS UNIT OF WORK IS NOT WAITING
----- LONG WAITER #2
WAITTIME  SYSTEM  JOBNAME E/S SCOPE QNAME    RNAME
00:00:57 PROD1    PRODJOB *E*  SYS  SYSIEFSD Q10
BLOCKER  PROD1    *MASTER* E
--:--:-- PROD1    *MASTER*
ANALYSIS ENDED: THIS UNIT OF WORK IS NOT WAITING
----- LONG WAITER #3
WAITTIME  SYSTEM  JOBNAME E/S SCOPE QNAME    RNAME
00:00:44 PROD2    SYSPROG *S*  SYSS SYSDSN   PROD.DB
BLOCKER  PROD1    PRODJOB  E
00:01:33 PROD1    PRODJOB *E*  SYS  SYSIEFSD Q10
BLOCKER  PROD1    *MASTER* E
--:--:-- PROD1    *MASTER*
ANALYSIS ENDED: THIS UNIT OF WORK IS NOT WAITING
----- LONG WAITER #4
WAITTIME  SYSTEM  JOBNAME E/S SCOPE QNAME    RNAME
00:00:44 PROD2    SYSPROG *E*  SYSS SYSDSN   PROD.PROCS
BLOCKER  PROD2    CLEANUP  E
```

From this analysis, it is obvious that the problem is with *MASTER* and not PRODJOB. In fact, all of the dependency analyses end with *MASTER*. Since you cannot restart *MASTER*, the only way to clear up this lockout is to re-IPL PROD1. In the case where the unit of work that all of the other requests depend on is a cancelable job or a subsystem that can be recycled, the operator can take appropriate action against that address space to resume normal system operations.

For complete information on the DISPLAY GRS,ANALYZE command, see *z/OS MVS System Commands*

Part 4. Appendixes

Appendix A. Data Set ENQ Contention Monitor

The data set ENQ contention monitor is a sample application that determines which data sets are experiencing contention from multiple jobs. The data set ENQ contention monitor, which runs as a started task, periodically examines the data returned by the GQSCAN macro to locate data set contention. If a TSO/E user is the sole owner of a data set that other jobs are waiting to use, the TSO/E user receives a message asking the user to free the data set.

The data set ENQ contention monitor works only for TSO/E users that hold resources on the system where it is started. Therefore, you might want to start the data set ENQ contention monitor on each system in a global resource serialization complex. The data set ENQ contention monitor can detect contention for both local and global resources.

Installing the Data Set ENQ Contention Monitor

The data set ENQ contention monitor is written in IBM Assembler-H, and is a single program called ISGECMON, which is located in SYS1.SAMPLIB. To install the monitor:

1. Assemble the source code for ISGECMON
2. Link-edit the object code into a system library.
3. Create a new member in SYS1.PROCLIB that will invoke the program.

The following sections describe the listed steps in detail.

Assembling the Data Set ENQ Contention Monitor Source Module

In the following JCL, underscores indicate values that you can replace with information specific to your installation.

The numbers are not part of the JCL statements but correspond to notes that follow the example. Do not code these as part of the JCL.

First, assemble the module. Example JCL is shown below.

```
1.  //ASSEMBLE JOB
    //* INVOKING ASSEMBLER
2.  //ASMSTEP EXEC PGM=ASMBLR,REGION=1024K,
3.  //        PARM='RENT,LOAD,NODECK'
4.  //SYSLIB DD DSN=SYS1.MODGEN,DISP=(SHR,PASS)
    //       DD DSN=SYS1.MACLIB,DISP=(SHR,PASS)
    //SYSUT1 DD UNIT=SYSDA,SPACE=(CYL,(1,1)),DISP=(NEW,DELETE)
    //SYSUT2 DD UNIT=SYSDA,SPACE=(CYL,(1,1)),DISP=(NEW,DELETE)
    //SYSUT3 DD UNIT=SYSDA,SPACE=(CYL,(1,1)),DISP=(NEW,DELETE)
5.  //SYSLIN DD DSN=USERID.MY.OBJ(ISGECMON),DISP=OLD
6.  //SYSPRINT DD SYSOUT=A,DCB=(RECFM=FBM,LRECL=121,BLKSIZE=3509),
    //          COPIES=1
    //SYSPUNCH DD SYSOUT=A,DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200),COPIES=1
7.  //SYSIN DD DSN=SYS1.SAMPLIB(ISGECMON),DISP=OLD,UNIT=SYSDA
    //SYSUDUMP DD SYSOUT=A
    //SYSABEND DD SYSOUT=A
    //
```

Notes on the JCL to Assemble the Monitor Module

Each numbered JCL statement in the previous example is described as follows:

1. The JOB statement specifies the beginning of a job and assigns a job name.

2. The EXEC statement specifies the beginning of a job step and identifies the assembler.
3. The PARM parameter specifies options for the assembler.
4. The SYSLIB DD statement specifies the macro library concatenation.
5. The SYSLIN DD statement specifies the data set that will contain the object module (ISGECMON). The partitioned data set USERID.MY.OBJ must contain the assembled member ISGECMON when this job ends.
6. The DCB (data set control block) specifies the DCB options.
7. The SYSIN DD statement specifies the data set that contains the source code.

Link-Editing the Data Set ENQ Contention Monitor Source Module

Once you have assembled the module, you can use JCL modeled on the following example to install the program into a system library in the LNKLST concatenation.

In the following JCL, underscores indicate values that you can replace with information specific to your installation.

The numbers are not part of the JCL statement but correspond to notes that follow the example. Do not code these as part of the JCL.

```
1.  //LINKEDIT JOB
2.  //LINK EXEC PGM=IEWL,
3.  //    PARM='RENT,XREF,REUS,LET,LIST,NCAL,SIZE=(750K,200K)'
    //SYSPRINT DD SYSOUT=A
4.  //OBJLIB DD DSN=USERID.MY.OBJ,DISP=SHR
    //SYSUT1 DD SPACE=(1024,(200,20)),UNIT=SYSDA
5.  //SYSLMOD DD DSN=LINKLIST.LIB,DISP=OLD
6.  //SYSLIN DD  *
        INCLUDE OBJLIB(ISGECMON)
        ENTRY ISGECMON
        NAME ISGECMON(R)
    /*
    //
```

Notes on the JCL to Link-Edit the RNL Syntax Checker Modules

Each numbered JCL statement in the previous example is described as follows:

1. The JOB statement specifies the beginning of a job and assigns a name to the job.
2. The EXEC statement specifies the beginning of a job step and identifies the linkage editor.
3. The PARM parameter specifies linkage editor options.
4. The OBJLIB statement identifies a data set containing the object module ISGECMON. The partitioned data set USERID.MY.OBJ must contain the assembled member ISGECMON.
5. The SYSLMOD DD statement specifies the data set that receives the object module.
6. SYSLIN DD * contains the linkage editor or control statements for the data set ENQ contention monitor.

Changes to SYS1.PROCLIB

Install the following JCL in SYS1.PROCLIB to allow the data set ENQ contention monitor to be started from the operator console:

```
//ISGECMON PROC INTERVAL=60
//ISGECMON EXEC PGM=ISGECMON,PARM='&INTERVAL'
//*
//*  Invoke from console with
```

```
//*       START ISGECMON
//*  to have the program scan for contention
//*  every 60 seconds.
//*
//*  Optionally, invoke from console with
//*       START ISGECMON,INTERVAL=ssss
//*  where ssss is the number of seconds (in decimal)
//*  to pause between scans.
//*
```

Using the Data Set ENQ Contention Monitor

Enter the START command from an operator console to start the data set ENQ contention monitor; use the CANCEL command to stop it.

Starting the Monitor

Enter the following command to start the monitor from the operator console:

```
START ISGECMON,INTERVAL=ssss
```

The INTERVAL parameter specifies, in decimal, the number of seconds that the monitor is to pause between each contention check. You can use the INTERVAL parameter to control how sensitive the program is. A larger value means that data set contention is not detected immediately. A smaller value causes contention to be detected more promptly, but a smaller value also causes the monitor to use more CPU cycles.

Stopping the Monitor

If you need to stop the data set ENQ contention monitor for any reason, issue the following command from the operator console:

```
CANCEL ISGECMON
```

Output

When the monitor detects that a TSO/E user owns a data set that another job or user is waiting for, it sends the following message to the TSO/E user:

```
===>> Please free 'Data Set.Name'. Other jobs are waiting to use it.
(ISGECMON)
```

Appendix B. Accessibility

Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use software products successfully. The major accessibility features in z/OS enable users to:

- Use assistive technologies such as screen-readers and screen magnifier software
- Operate specific or equivalent features using only the keyboard
- Customize display attributes such as color, contrast, and font size

Using assistive technologies

Assistive technology products, such as screen-readers, function with the user interfaces found in z/OS. Consult the assistive technology documentation for specific information when using it to access z/OS interfaces.

Keyboard navigation of the user interface

Users can access z/OS user interfaces using TSO/E or ISPF. Refer to *z/OS TSO/E Primer*, *z/OS TSO/E User's Guide*, and *z/OS ISPF User's Guide Volume I* for information about accessing TSO/E and ISPF interfaces. These guides describe how to use TSO/E and ISPF, including the use of keyboard shortcuts or function keys (PF keys). Each guide includes the default settings for the PF keys and explains how to modify their functions.

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