

Securing Your Cloud: Assessing z/VM and Linux on IBM Z Security

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 **Security**

 **Cloud**

IBM Z



International Technical Support Organization

**Securing Your Cloud: Assessing z/VM and Linux on
IBM Z Security**

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Note: Before using this information and the product it supports, read the information in “Notices” on page vii.

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Preface

The cloud has become an integral part of the business technological landscape. As more and more workloads are being offloaded to IBM® Z based cloud environments, it is important to ensure that these workloads and environments are secure.

In the ever-evolving landscape of information technology, innovation and adaptability are paramount. Cloud computing, virtualization, big data analytics, artificial intelligence and cybersecurity are just a few of the many trends shaping the way businesses operate and interact with their customers.

The need for insightful, practical and up-to-date resources has never been more critical.

This IBM Redbooks® publication describes the necessary steps to secure your environment for all of the components that are involved in an IBM Z® cloud infrastructure that uses IBM z/VM® and Linux on IBM Z.

The audience for this book is IT architects, security consultants and those planning to use IBM Z for their cloud environments.

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Summary of changes

This section describes the technical changes made in this edition of the book and in previous editions. This edition might also include minor corrections and editorial changes that are not identified.

Summary of Changes
for SG24-8353-01
for Securing Your Cloud: Assessing z/VM and Linux on IBM Z Security
as created or updated on November 28, 2023.

December 2023, Second Edition

This revision includes the following new and changed information.

New information

- ▶ Crypto management under z/VM
- ▶ Identity management under z/VM, including:
 - Multi-factor authentication(MFA)
 - Use of LDAP servers
- ▶ Audit in cloud environments
- ▶ z/Secure for RACFVM 2.5.1
- ▶ Linux on IBM Z security
- ▶ Cyber resiliency, digital forensics and incident response (DFIR) and disaster recovery

Changed information

- ▶ Updated for IBM z16™
- ▶ Updated for IBM z/VM 7.3



Introduction to security on IBM Z

This chapter provides an introduction to security on IBM Z, describes the specifics of IBM z/VM security, and lists the benefits of using an external security manager (ESM), such as IBM Resource Access Control Facility (RACF) for z/VM.

z/VM stands for *IBM z/Architecture® Virtual Machine*, and z/VM virtual machines are also referred to as guests, user IDs, or service machines.

With z/Architecture, you have many security features that you can use to secure your applications. However, you do not only set up the features; you must customize them correctly. This is the topic of this book.

Because operating systems alone cannot provide the necessary security, this chapter also provides a brief overview of hardware security features.

Note: If you must comply with the requirements of the Common Criteria Operating System Protection Profile (OSPP), you must install RACF and the Single System Image (SSI) feature because evaluation for z/VM was done only with these features enabled. For more information, see *z/VM Secure Configuration Guide*, SC24-6230.

This chapter describes the following topics:

- ▶ Why IT security matters
- ▶ A brief overview of hardware security features
- ▶ Principles of RACF operations
- ▶ Why you should use RACF to secure your cloud infrastructure
- ▶ RACF database organization and structure

1.1 Why IT security matters

Information Technology (IT) security, often referred to as cybersecurity, is of paramount importance in today's digital age. It plays a critical role in protecting digital assets, maintaining the trust of users and organizations, and ensuring the smooth functioning of society. Here are some of the reasons IT security matters:

1. **Protection of Sensitive Data:** IT security safeguards sensitive and confidential data, including personal information, financial records, trade secrets, and government data. Preventing unauthorized access or data breaches is essential to protect individuals and organizations from financial and reputational harm.
2. **Prevention of Data Breaches:** Data breaches can lead to significant financial losses, legal liabilities, and damage to an organization's reputation. Robust IT security measures are essential for preventing unauthorized access and data leaks.
3. **Preservation of Privacy:** IT security helps preserve individual privacy by safeguarding personal information stored in digital systems. This is particularly important as data privacy regulations, such as GDPR and CCPA, impose strict requirements on organizations.
4. **Business Continuity:** IT security measures ensure the continuity of business operations. This includes protecting critical systems and data from disruptions caused by cyberattacks, natural disasters, or technical failures.
5. **Prevention of Cyberattacks:** Cyberattacks, such as ransomware, malware, and phishing, pose significant threats to organizations and individuals. IT security measures detect and mitigate these threats, reducing the risk of compromise.
6. **Trust and Reputation:** Organizations that prioritize IT security build trust with their customers and partners. A security breach can damage an organization's reputation and erode trust, leading to a loss of customers and business partners.
7. **Compliance and Legal Obligations:** Many industries are subject to regulatory requirements related to data security. IT security measures are necessary to comply with these regulations and avoid legal penalties.

In summary, IT security is essential because it protects sensitive data, preserves privacy, prevents cyberattacks, and ensures the smooth operation of digital systems and critical infrastructure. It also has far-reaching economic, national security, and public safety implications in our increasingly digital and interconnected world.

1.2 A brief overview of hardware security features

The hardware security features provide a fundamental part of the security definitions of software techniques and solutions, and the available operating systems for IBM Z (z/VM, Linux on IBM Z, z/VSE®, and z/OS) each use these hardware features to some degree.

Understanding IBM Z hardware and z/Architecture is key to understanding how operating systems and applications maintain data, process, and application integrity. To learn more about z/Architecture, see [z/Architecture Principles of Operation SA22-7832](#), relevant for your hardware architecture.

Despite being different classes of IBM hardware, IBM Z and LinuxONE both adhere to z/Architecture. This book uses the terms IBM Z and LinuxONE interchangeably.

Security features on the mainframe are integrated into the hardware. The following list provides some of the available hardware security features:

- ▶ With the Hardware Management Console (HMC), logical partitions (LPARs) can be defined and isolated from each other. Additionally, all the resources that are needed to run the operating systems are defined through LPAR profiles by the HMC. These resources are storage and processors and Direct Access Storage Device (DASD) and tape subsystems.
- ▶ Crypto Express Cards can encrypt both session traffic and physical data on DASDs and tape. For better performance, cryptographic coprocessors are used. For more information, see section 2.4.2, “z/VM cryptographic definitions” on page 23.
- ▶ Signed microcode is applied to the hardware to assure microcode authenticity.

IBM Z provides, and z/VM virtualizes a host of features that isolates virtual machines (VMs) (also called guests) from one another. This isolation is implemented in the z/VM Control Program (CP), which can be considered the kernel of the hypervisor. Separation of guest workloads is a vital component of system integrity, and it provides the foundation of the security context on which the IBM Z Integrity Statement is based. For more information about the z/VM CP, see [z/VM CP Planning and Administration, SC24-6271](#).

1.3 Principles of RACF operations

Modern z/VM security requires an external security manager (ESM), such as RACF for z/VM. This security server functions as a Policy Decision Point and Policy Enforcement Point for all security relevant events in your virtual infrastructure (and, by extension, your cloud). RACF for z/VM can be configured to handle resource authorization, privileged command access, and logon controls.

RACF provides services for authentication and authorization to resources. Where applicable, it interfaces with other products such as IBM Security® zSecure for RACF/VM or IBM Z Multifactor Authentication to add more security controls to your system.

While RACF/VM is shipped as part of every z/VM order, it is a priced feature and must be both enabled and configured. This means a RACF database must be built and the security server’s virtual machine must be started. In z/VM RACF, this VM is RACFVM.

Note: If you have RACF installed, users’ passwords are never stored in clear text in the system; they are stored in encrypted form in the RACF database. The encryption algorithms are described in “Password encryption algorithm” on page 49. Additionally, the passwords in the USER directory are no longer in effect.

Password encryption support for KDFAES, which is used to encrypt passwords and password phrases, is available. Using this algorithm provides better protection against brute-force attacks if an offline copy of the RACF database becomes exposed.

The RACF database is used to store all information about users, groups, and resources. Access to resources is controlled through entries in the following lists:

- ▶ Standard access control lists of the resource profiles
- ▶ Conditional access control lists of resource profiles (resource access is allowed only through a certain program)

Note: The preferred practice of RACF administrators is to give access rights to groups rather than users.

For more information about how to get started with RACF and how to adopt RACF definitions to your business demands for a security structure, see Chapter 3, “IBM Resource Access Control Facility Security Server for IBM z/VM” on page 35 and *z/VM RACF Security Server Security Administrator’s Guide*, SC24-6218.

1.3.1 Principle of best matching profile

RACF uses the principle of *best matching profiles* to check whether access might be granted due to the access rights being stored in a RACF database.

A profile covering the name of a given resource is best used to check on the access. The access intent must at least meet the access that is stored in the RACF profile’s access list. This principle is described in *z/VM RACF Security Server Security Administrator’s Guide*, SC24-6311.

If you run z/VM in an SSI cluster environment, then RACFVM is an identity service machine, which means it runs on every z/VM image in the cluster. To provide this service, a RACF database is needed and shared among the SSI members. The RACF database and its backup are on two distinct DASD volumes, each of which is shared in an SSI cluster. For more information about RACF databases, see 1.5, “RACF database organization and structure” on page 5.

1.4 Why you should use RACF to secure your cloud infrastructure

If you are running applications that must meet mandatory regulations, such as the rules of the Payment Card Industry Data Security Standard (PCI DSS), then you are obligated to adhere to a number of controls and evidences to pass auditor checks. You can meet this requirement by setting the auditing controls according to your installation’s needs, as described in section 4.4, “Auditing” on page 107.

In addition to the operating system built-in security mechanisms, such as isolation of virtual storage by the z/VM CP, RACF provides ways to better control access to resources in your system. However, meeting the regulatory needs is not done by only setting up the RACF databases and defining profiles to protect resources. Your entire organization should implement a security policy and set up the RACF definitions according to a defined policy.

Implementing security processes is an ongoing process in your company and needs the full support of all managers of your organization. Implementing security processes needs much organizational work done with documentation processes and reviews, both of which are deeply integrated in your company’s structure. This process means a reasonable amount of work for security administrator staff and many departments of an organization.

With RACF installed, you can do the following tasks:

- ▶ Track who uses privileged accounts, that is, MAINT and MAINT730.
- ▶ Prevent technical support user IDs and VM guests from being revoked by a password revocation policy. To do so, you define these IDs as Protected user IDs. Together with the

RACF class SURROGAT 1 **ogonby** policy, you can get full information about who used the VM.

- ▶ Provide logging mechanisms (SMF records) to show the following information:
 - Who accessed what resources.
 - Which access violations occurred.
- ▶ Meet Segregation of Duty needs by having defined Security Administrators separately from System Programmer staff.

1.5 RACF database organization and structure

This section describes the RACF database, how it is defined to the system, and its internal organization.

1.5.1 Database definition to the system

The RACF database is referenced by the database name table (ICHRDSNT) in the system. You can set up the RACF database by running the **RACDSF**, **RACALLOC**, and **RACINITD** RACF commands. For more information about these commands, see Chapter 4, “Operating Considerations unique to z/VM”, in *RACF Security Server System Programmer’s Guide* SC24-6219.

Note: Allocation and DASD sharing options depend on the type of z/VM installation you use. Set up RACF database sharing correctly according to your system’s installation, or RACF database corruption might occur. In an SSI environment, the RACF database must be shared among all members of the cluster.

Additional changes to the definition of RACF database devices apply if you run an IBM Geographically Dispersed Parallel Sysplex® (IBM GDPS®) controlled system.

The number of physical extents of the RACF database is 1 by default. It is controlled through the RACF database range table (ICHRRNG), which is a load module. This table is in RACFLPA LOADLIB on the RACFVM 305 minidisk.

Details about the RACF database range table are listed in Chapter 3, “RACF Customization”, in *RACF Security Server System Programmer’s Guide*, SC24-6312.

1.5.2 Internal organization of RACF database specifying class options

RACF can protect resources of the following types:

- ▶ Users
- ▶ Groups
- ▶ General resources

Classes of general resources are defined in the class descriptor table (CDT). Each general resource class is defined by a unique entry in the CDT.

The CDT describes the structure of profiles for the general resource classes. If you do not comply to the settings in the CDT for the general resource class, one of the following might apply:

- ▶ You cannot define the profile.
- ▶ RACF cannot determine the matching profile for the access check, which leaves resources unprotected by RACF in the system.

For example, we define a resource entry for a VLAN VSWITCH entry by using the command that is shown in Example 1-1.

Example 1-1 RACF VLAN definition

```
RAC RDEF VLAN SYSTEM.VSWITCH1.010 UACC(NONE) OW(SYS1)
```

Because CDT for VLAN defines the last qualifier as a 4-digit value, RACF issues the message that is shown in Example 1-2.

Example 1-2 RACF error message

```
IKJ56702I INVALID ENTITY, SYSTEM.VSWITCH.010
```

To correct this error, ensure that you define the profile as SYSTEM.VSWITCH1.0010.

Additionally, the CDT is used to determine whether a RACF class may be RACLISTed or GENLISTed by running the **SETROPTS** command. RACLIST is a performance option, profiles of the classes are kept in storage, and no I/O operation occurs on the RACF database when checking on these profiles. However, changes to the profiles need an in-storage refresh of RACLISTed profiles. This is done by running the **SETROPTS REFRESH** command.

In addition, there are two CDT entry types:

- ▶ ICHRRCDX is the name for the IBM-supplied class entries.
- ▶ ICHRRCDE is the name for installation-defined class entries.

Note: Do not delete or modify any of the class entries in the IBM-supplied load module ICHRRCDX.

For a list of IBM-supplied class entries, see Appendix B, “Description of the RACF classes”, in [RACF Security Server System Programmer's Guide, SC24-6312](#).



IBM z/VM hypervisor

This chapter describes the security aspects of z/VM facilities. It introduces how the z/VM hypervisor can provide basic security in its virtualization environment on IBM z/VM and how it can be improved with the installation of an external security manager (ESM), such as IBM Resource Access Control Facility (RACF).

Protecting information from unintended use is one key element of a secure IT environment. Basically, there are two different methods to ensure privacy of information:

- ▶ Access control
- ▶ Encryption methods

Access control mechanisms determine who has the right to access particular information or data. The access control mechanisms then verify who accesses the information (*authentication*) and whether they have the right to access this information (*authorization*). There are cases where proper access control cannot be ensured in all situations, especially if data is stored on movable media and also when data is transferred through a network that might not be protected. It is not possible to ensure that there is no unintended access to data while it is stored or transferred through a network. The only way to protect such information is by using encryption methods.

This chapter describes the following topics:

- ▶ z/VM hypervisor
- ▶ Device management
- ▶ Securing the data
- ▶ Securing your communication
- ▶ z/VM connectivity
- ▶ Remote Spooling Communications Subsystem

2.1 z/VM hypervisor

z/VM is the world's first hypervisor. It faithfully replicates and extends the capabilities of IBM Z and LinuxONE environments by sharing the hardware assets, virtualization facilities and communication resources. It contains an operating system for configuration and maintenance operations and for the running of certain workloads; as a result, its internal security does not differ from other operating systems. However, the virtual infrastructure relies on the security of the hypervisor, so protecting the z/VM hypervisor typically prevents attempts to breach the security of the operating system and compromises to the integrity of the operating system and data.

Each virtual machine can have its own security configuration and faces threats particular to it. It is essential to protect the hypervisor itself as an equally important part of an overall end-to-end security policy because actions such as creating, changing, and removing virtual machines (VMs) are performed at the hypervisor level. Protecting the guests and not the hypervisor would be like locking all the windows to your home and then leaving the front door open. Access to the virtualization management system should be restricted to authorized administrators only.

z/VM virtual machines, or guest machines, can share system resources with very high levels of resource utilization. z/VM provides extreme scalability, security, and efficiency while providing a robust base for database serving and containerized workloads on the IBM Z and LinuxONE platforms. z/VM can be run on IBM Z and LinuxONE servers. z/VM can host Red Hat, SUSE, and Ubuntu Linux distributions. Support for simultaneous multithreading (SMT) technology extends per-processor, core capacity growth beyond single-thread performance for Linux on IBM Z running on an IBM Integrated Facility for Linux (IFL) specialty engine on an IBM Z or LinuxONE server.

Performing z/VM maintenance is part of the system administrator role. It is important to apply service to your z/VM system to ensure that the latest security measures are in place. Installing the corrections when they are released decreases the time frame that the vulnerability can be exploited.

Besides operating system setup and customization for security, monitoring the hypervisor for signs of compromise helps you promptly respond to a threat. Use monitoring tools to help monitor the hypervisor and look at the hypervisor logs for suspicious activities, both of which make the work of the hypervisor system administrator easier.

z/VM 7.3 provides a principal hypervisor for your modernization journey to hybrid cloud, hosting enterprise-class virtual servers to exploit IBM Z and LinuxONE. z/VM 7.3 provides new function APARs, delivered in the service stream of the current Version7 release. z/VM supports Infrastructure as a service (IaaS), the basic building block for cloud and cloud-native workloads based on Red Hat OpenShift Container Platform and IBM Cloud® Paks or other container technologies. z/VM supports noncontainerized workloads, deployed by using cloud and traditional operations models, from IBM such as IBM WebSphere®, open source such as MongoDB, or software from ISVs.

z/VM provides the following enhancements:

- ▶ Single System Image (SSI) supports eight-members, increasing the maximum size of an SSI cluster from four members, allowing you to increase the number of SSI clusters to allow for more workload and providing more flexibility to use live guest relocation (LGR) for nondisruptive upgrades and workload balancing.
- ▶ Non-volatile memory express (NVMe) emulated device (EDEVICE) support enables NVMe devices connected through PCI Express (PCIe) adapters to be defined and

managed as Fixed-Block Architecture (FBA) EDEVICEs. As such, all host and guest FBA functions are supported except those that require stand-alone support such as Warm Start and Checkpoint. Linux guests exploiting EDEVICEs defined on NVMe adapters are not eligible for LGR. NVMe adapters are only available on LinuxONE servers.

- ▶ Up to 4 TB of memory per LPAR. This new function was delivered in the service stream of z/VM 7.2. With z/VM 7.3, a fully configured 8-member SSI can address up to 32 TB on a single IBM Z or LinuxONE server, or 32 TB across multiple servers along with up to 80 logical processors supported on each member.
- ▶ Dynamic Memory Downgrade was delivered in the z/VM 7.2 service stream and provides the added flexibility of moving real memory from one or more z/VM system images to one or more others running on the same physical server. This can help you to non-disruptively align your hardware assets with shifting workload demands across your z/VM system images, whether they are in an SSI cluster or in separate z/VM LPARs. This can be particularly useful when moving running virtual machines from one SSI member to another by using LGR.
- ▶ External Security Manager (ESM) interface enhancements allow control of the CP DEFINE MDISK command. They are used by and enable a z/VM security administrator to restrict and audit all means of creating a minidisk.

2.1.1 Single System Image overview

Since the introduction of z/VM 6.2 in December 2011, the architecture of Linux solutions on IBM Z changed dramatically and introduced z/VM Single System Image (SSI) with live guest relocation (LGR).

An SSI cluster is a multi-system environment on which the z/VM systems can be managed as a single resource pool and guests can be moved from one system to another while they are running. Each SSI member is a z/VM logical partition (LPAR) connected through channel to channel (CTC) connections, and the z/VM SSI cluster consists of up to eight z/VM systems in an Inter-System Facility for Communications (ISFC) collection. CTC connections are physical connections and because the channels are isolated from the “outside world”, there is no need to encrypt at the host level. Certain channel extenders offer an additional encryption capability for clusters stretching beyond a single data center.

Each z/VM system is a member of the SSI cluster and is self-managed by the z/VM Control Program (CP). All members can access

DASD volumes, the same Ethernet LAN segments, and the same storage area networks (SANs).

Live guest relocation (LGR)

With the IBM z/VM SSI, a running Linux on an IBM Z virtual machine can be relocated from one member system to any other, a process known as LGR. LGR occurs without disruption to the business and provides application continuity across planned z/VM and hardware outages and flexible workload balancing that allows work to be moved to available system resources.

There are several reasons why you might need to relocate a running virtual server:

- ▶ Maintenance or migration of hardware or software
- ▶ Fixing performance problems
- ▶ Workload rebalancing

Relocating virtual servers can be useful for load balancing and for moving workload off of a physical server or member system that requires maintenance. After maintenance is applied to

a member, guests can be relocated back to that member, allowing you to maintain z/VM and keeping your Linux on IBM Z virtual servers available.

Note: Linux on IBM Z is the only guest environment that is supported for relocation.

LGR is described in Chapter 3, “Live guest relocation (LGR) overview”, in *An Introduction to z/VM Single System Image (SSI) and Live Guest Relocation (LGR)*, SG24-8006 and Chapter 7, “z/VM live guest relocation”, of *The Virtualization Cookbook for IBM Z Volume 1: IBM z/VM 7.2*, SG24-8147.

Changes for SSI in the USER directory

This section provides an overview of the definitions in the z/VM directory for guests with single configuration and multiple configurations (see Figure 2-1).

► Single-configuration VM definition

A single-configuration VM definition consists of a user entry and any included profile entry. For example, you can specify a single-configuration virtual machine as EDI and log on to a z/VM system as EDI. In an SSI cluster, the VM can be logged on to only one SSI member at a time. Your Linux guests are always defined as single users.

► Multi-configuration VM definition

A multi-configuration VM definition consists of an identity entry and all associated subconfiguration entries (**SUBCONFIG** in **BUILD ON** z/VM Directory Manager (IBM DirMaint) statement). In an SSI environment, this VM definition allows multiple instances, which enables the user ID to be logged on concurrently to multiple members of the SSI cluster. Each of these VM instances can have a different configuration as minidisks in each LPAR member and so on.

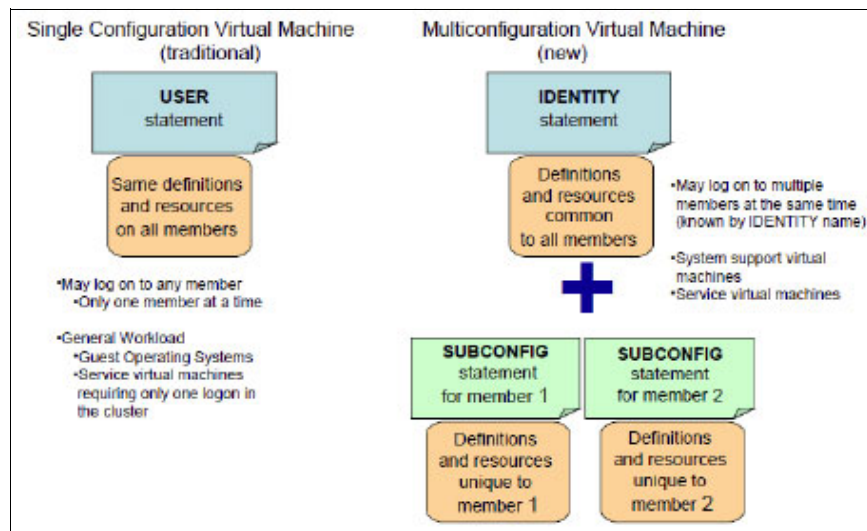


Figure 2-1 User definitions as a User or Identity

USERS are relocatable and have access to the same resources no matter where they go. An IDENTITY is restricted to a single cluster member and may have access to private resources.

Note: A z/VM SSI cluster uses a single source directory to define VMs on the system. However, note that separate object directories are built on each member node of the cluster. As a result, care must be exercised when making changes to VMs on the system so that a new object directory is compiled on each member of the cluster at the same time.

2.1.2 Security settings in an SSI cluster

The following list provides some preferred practices to make your SSI cluster more secure and compliant with security rules:

- ▶ A user ID has the same password on all systems (Single or Multi-Configuration).
- ▶ A Single Configuration VM can log on to only one member of the cluster.
There are error messages as with logging on to a user ID on the same system.
- ▶ A Multi-Configuration Virtual Machine can have a different definition on each system.
- ▶ A user ID's privilege classes are the same on every system.
There is a common source directory definition.
- ▶ The cluster maintains a *single security context* for the entire system.
An ESM, even in stand-alone systems, extends these capabilities.
- ▶ Consider Relocation Domains.
Relocation Domains can be built so that guests can be constrained to certain cluster members. It is a way of building security zones into the SSI by constraining data flow (where the data is the actual server).

A z/VM system is secured by using the security features of the z Systems or LinuxONE hardware by maintaining compliance to security policy within operating practices. The system administrator must lead the way in following security standards and guidelines.

When the Resource Access Control Facility (RACF) feature for z/VM is installed, it can be configured to control functions normally being checked in the directory for authorization. RACF can control the password field, the minidisk access, spool files, and commands privileges.

A preferred practice to extend the z/VM environment is installing an external security manager (ESM), such as IBM RACF for z/VM or other ESM product to maximize your security.

2.1.3 Controlling the System Operator

The System Operator is a highly privileged VM that runs under z/VM. It has all CP defined privilege classes (and access to every command), and it has special authorities over the hypervisor as well. It also receives informational and error messages from the components of z/VM as they occur. This user ID (most commonly OPERATOR) should be given special protections, which are described in this section.

Controlled area

Run the system operator in a physically controlled environment, for example, in a machine room or in an operator's work area. Provide proper access control through badges for authorized personnel entry only.

Automation

Set up an automation environment so that the operator close console files daily so that operator logs are ready for archiving processes. Using system user IDs, set the observer as TCP/IP, IBM DirMaint on the operator user ID.

LOGONBY definition

z/VM can define logon to the system privileged user IDs, such as Operator, Maint, and Maint730. The point of LOGONBY is that no one is sharing credentials, even when using a highly authorized virtual machine.

RACF definition

With RACF, define the operator user ID as protected and enable surrogate logon processing by defining the appropriate RACF profile. Give access to surrogate profiles only to operating staff and perhaps system programmers.

Note: With RACF installed, set up an observer for operator user ID (by using Performance Toolkit for z/VM) to get an option of scrolling through the events that might have happened in the past. If you do not set up this configuration, then all RACF messages like ICH408I are directed to operator. Because the operator's console is just spooled and only the most recent messages can be seen on the console, it is inconvenient to scroll through the history of system events. Think about using a tool that helps you manage the console log of the operator daily. The archiving of console logs can then be done either by z/VM (VMARC) or by transferring it to other archiving components on other systems.

2.1.4 The system configuration file

The system configuration file is one of the major files of z/VM. It contains operating characteristics, such as the layout of the system residence disk, real storage, and I/O devices configuration.

The system configuration file is on a partition of a volume that is allocated as PARM. This minidisk is normally under user ID maint, and it is on minidisk address CF1. The file is called SYSTEM CONFIG by default, although you can change the name in your installation. The file is read at IPL time by the CP program that uses the statements that are contained in the file to configure the system.

Note: Since z/VM 6.2, SYSTEM CONFIG is on PMAINT's CF0 minidisk. As a preferred practice, always run a CPSYNTAX check after modifying SYSTEM CONFIG.

The following sections summarize the statements that are contained in the configuration file that are relevant to security.

DEFINE COMMAND

Use the **DEFINE COMMAND** or **CMD** statement to define a new CP command or a new version (by IBM class) of an existing CP command on the system during initialization.

DEFINE LAN

Use the **DEFINE LAN** statement to create a guest LAN that can be shared among virtual machines on the same VM system. Each guest LAN segment is identified by a unique combination of ownerid and lanname. A VM user can create a simulated network interface card (NIC) and connect it to this LAN segment.

DEFINE VSWITCH

Use the **DEFINE VSWITCH** statement to create a CP system-owned switch (a virtual switch) to which VMs can connect. Each switch is identified by a *switchname*. A z/VM user can create a simulated QDIO NIC and connect it to this switch with the **NICDEF** directory statement. Under

the **DEFINE VSWITCH** statement, the **VLAN** parameter is important if you want to isolate guests subnets based on VLAN IDs.

DISABLE COMMAND

Use the **DISABLE COMMAND** or **CMD** statement to prevent CP from processing requests for the specified CP command during and after initialization.

DISABLE DIAGNOSE

Use the **DISABLE DIAGNOSE** statement to prevent CP from processing requests for one or more locally developed **DIAGNOSE** codes during and after initialization.

ENABLE DIAGNOSE

Use the **ENABLE DIAGNOSE** or **CMD** statement to permit CP to process requests for the specified CP command during and after initialization.

ENFORCE_BY_VOLId

Use the **ENFORCE_BY_VOLId** configuration statement to enforce attachment of DASD devices by their VOLIDs on the **ATTACH** command.

FEATURES

Use the **FEATURES** statement to set certain attributes of the system at system initialization.

JOURNALING

Use the **JOURNALING** statement to tell CP whether to include the journaling facility, whether to enable the system being initialized to set and query the journaling facility, and what to do if someone tries to log on to the system or link to a disk without a valid password.

Note: Journaling is not a sufficient replacement for ESM auditing, which is done by RACF.

MODIFY COMMAND

Use the **MODIFY COMMAND** or **CMD** statement to redefine an existing CP command on the system during initialization.

MODIFY LAN

Use the **MODIFY LAN** statement to modify the attributes of an existing guest LAN during initialization.

MODIFY PRIV_CLASSES

Use **MODIFY PRIV_CLASSES** to change the privilege classes that are authorizing the following CP functions:

- ▶ Logging on as the primary system operator
- ▶ Intensive error recording
- ▶ Using the read function of the CP IOCP utility
- ▶ Using the write function of the CP IOCP utility
- ▶ Specifying the default user class

MODIFY VSWITCH

Use the **MODIFY VSWITCH** statement to modify the attributes of an existing virtual switch.

PRIV_CLASSES

Use the **PRIV_CLASSES** statement to change the privilege classes authorizing the following CP functions:

- ▶ Logging on as the primary system operator
- ▶ Intensive error recording
- ▶ Using the read function of the CP IOCP utility
- ▶ Using the write function of the CP IOCP utility
- ▶ Specifying the default user class

SYSTEM_USERIDS

Use the **SYSTEM_USERIDS** statement to specify user IDs that perform special functions during and after IPL. These functions include accumulating accounting records, system dump files, EREP records, and symptom records, and specifying the primary system operator's user ID and disconnect status.

USER_DEFAULTS

Use the **USER_DEFAULTS** statement to define default attributes and permissions for all users on the system.

Password suppression

Password suppression prevents any password from being visible on the terminal panel. To enable password suppression, place the following statement in the SYSTEM CONFIG file:

```
FEATURES PASSWORDS_ON_CMDS AUTOLOG NO LINK NO LOGON NO
```

Note: This is a default setting since z/VM v7.10, however, you should check older system configuration files to ensure this is set correctly.

Preventing users of T-disks and minidisks from seeing residual data

You must ensure that each time the system assigns T-disk space, it clears the space of all residual data. To ensure that this occurs, place the following statement in the SYSTEM CONFIG file:

```
FEATURES ENABLE CLEAR_TDISK
```

Note: This is a default setting since z/VM v7.10, however, you should check older system configuration files to ensure this is set correctly.

Before the minidisk is released, it must be formatted to clear it of any residual data.

Note: For a complete description of the syntax and usage for the system configuration file, see *z/VM CP Planning and Administration*, SC24-6083.

2.1.5 Addressing password security

All passwords in a standard z/VM system are default passwords that are defined by the installation process. Before moving your system into production, change those passwords immediately, and in compliance with your corporate security policies.

It will be mandatory based on your company policy, industry, or government regulations to change the following two types of password in the USER DIRECT file:

- ▶ **userid**: The password that is required to log on.
- ▶ **minidisk**: The minidisk password, which gives access to read, write, and multiple.

Changing that password can be done manually by using XEDIT, which is the z/VM text editor, or by using a macro to automate the process. Alternatively, a directory management product, such as DirMaint, may be used.

Because every default password on the z/VM system is the same eight-character string, a global replace by using XEDIT is the fast approach to compliance. However, you should consider whether some machines should be LOGONBY or changed to a special password, as discussed in “Special passwords” on page 15.

Manually changing the password is tedious and error prone, so make a backup copy of the USER DIRECT file and only after changing the default passwords.

Special passwords

There are special passwords in the User Direct file that have specific functions:

NOLOG	When the user ID is set with NOLOG, it cannot be used to log in to a z/VM system until you set another password. As a preferred practice, set all unused VMs to NOLOG.
AUTOONLY	The user ID starts running only when you issue the xautolog or autolog commands. You cannot issue logon or logoff for this userid.
LBYONLY	This user ID can be logged on only by issuing the logon by command. You cannot log on this user ID with the logon command.

RACF control of passwords supersedes any password definitions in the CP User Directory. For more information, see “Password and password phrases rules” on page 92.

2.1.6 Implementing CP LOGONBY

The CP LOGONBY directory statement designates up to eight VMs to another VM. This function was originally a DirMaint implementation and was added to VM a number of releases ago (VM/ESA Version 2 Release 1). The CP LOGON BY function allows authorized VMs to log on to a shared VM by using their own password. This function is handy when you have several VMs that need to share the MAINT VM, but only one person can be logged on at a time.

To fully understand this function, you must become familiar with the following terms:

- ▶ *Shared user*: A user ID that can be logged on to by a different user.
- ▶ *Surrogate user*: A person logging on to the shared user ID.
- ▶ *Direct logon*: A traditional logon, in which you log on to your own user ID.
- ▶ *Shared logon*: A logon in which a surrogate user uses the **BY** option of the LOGON command to log on to a different user ID.

The implementation of CP LOGONBY can be done updating the user directory of the user that is intended to be used as the shared user with the LOGONBY entry. In Example 2-1, user MAINT is defined to be shared and user EDI is defined as one of its surrogate users.

Example 2-1 User directory of a shared user ID

```
USER OP1 LNX4ITSO 64M 96M BG
  INCLUDE IBMDFLT
```

IPL CMS PARM AUTO CR
LOGONBY EDI WILLIANR

Now, user EDI, using its password, can log on to user OP1 as shown in Example 2-2.

Example 2-2 Logon using LOGONBY

```
L OP1 BY EDI
ENTER PASSWORD (IT WILL NOT APPEAR WHEN TYPED):
z/VM Version 6 Release 3.0, Service Level 1601 (64-bit),
built on IBM Virtualization Technology
There is no logmsg data
FILES: 0001 RDR, NO PRT, NO PUN
LOGON AT 09:46:46 EDT TUESDAY 06/14/16
z/VM V6.3.0 2016-05-18 16:18
Ready; T=0.01/0.01 09:46:46
```

It is possible to define up to eight users as surrogates of a shared user by using **CP LOGONBY**. This task can be done adding the users in the same **LOGONBY** statement of the shared user ID. Example 2-3 is an example of user MAINT being defined as surrogate of OP1.

Example 2-3 Define up to eight users as a surrogate on a LOGONBY statement

```
USER OP1 XXXXXXXX 64M 96M G
  INCLUDE IBMDFLT
  IPL CMS PARM AUTOOCR

LOGONBY EDI WILLIANR
```

EDI can use their passwords to log on to the OP1 shared ID, as shown in Example 2-4.

Example 2-4 Log on a shared user ID

```
L OP1 BY EDI
ENTER PASSWORD (IT WILL NOT APPEAR WHEN TYPED):

z/VM Version 6 Release 3.0, Service Level 1601 (64-bit),
built on IBM Virtualization Technology
There is no logmsg data
FILES: 0001 RDR, NO PRT, NO PUN
LOGON AT 09:47:59 EDT TUESDAY 06/14/16
z/VM V6.3.0 2016-05-18 16:18
Ready; T=0.01/0.01 09:47:59
```

The way that the directory is defined in Example 2-1 on page 15 and Example 2-3 makes it possible for user id OP1 to be logged on by using its directory password. This configuration impacts the accountability of a shared user ID because any person that knows the shared user ID password can log on to it.

To avoid this situation, use the keyword **LBYONLY** on the shared user ID password, and it will not be possible to log on the shared user ID by using the directory password. In fact, if a logon on the shared user ID is tried, CP returns a message that the user ID is not in the CP directory and only logging on by the surrogate users can happen, as shown in Example 2-5.

Example 2-5 Using LBYONLY statement to avoid direct logon to the shared id

#Shared user directory with the LBYONLY statement:

```
USER OP1 LBYONLY 64M 96M G
      INCLUDE IBMDFLT
      IPL CMS PARM AUTOOCR
      LOGONBY EDI WILLIANR
```

#a) Tentative log on to OP1:

```
L OP1
HCPLGA053E OP1 not in CP directory
```

#b) Log on op1 by using the surrogate user ID:

```
l op1 by edi
ENTER PASSWORD (IT WILL NOT APPEAR WHEN TYPED):

z/VM Version 6 Release 3.0, Service Level 1601 (64-bit),
built on IBM Virtualization Technology
There is no logmsg data
FILES: 0002 RDR, NO PRT, NO PUN
LOGON AT 09:35:17 EDT WEDNESDAY 06/15/16
z/VM V6.3.0 2016-05-18 16:18
Ready; T=0.01/0.01 09:35:17
```

This function can be extended by using the SURROGAT class in RACF for z/VM. For more information, see 3.3 “RACF management processes” on page 63.

2.1.7 Role-based access controls and CP privilege classes

In the z/VM system of privilege, a user either can have no privileges or can be assigned to one or more *privilege classes*. Each privilege class represents a subset of Control Program commands that the system permits the user to enter. Each privilege class, sometimes called *CP privilege class*, is defined around a particular job or set of tasks, which creates an area outside of which the user cannot go. Of course, it is common for a user to be assigned to more than one CP privilege class. Users cannot enter commands in privilege classes to which they are not assigned.

Note: Any user, except those with either NO PRIVILEGE or CP privilege class G, is considered part of the configuration but is not necessarily considered trusted.

It is also possible to create privilege classes that meet the enterprise security policy according to the roles that are described in it, as described in “CP privilege classes” on page 84.

Here is a summary of CP privilege classes, and their associated users, tasks, and security implications:

Privilege class A	The primary system operator. The system operator is among the most powerful and privileged of all z/VM users. The system operator is responsible for the system's availability and its resources. The system operator also controls accounting, broadcasts messages, and sets performance parameters.
Privilege class B	The system resource operator. The system resource operator controls the allocation and de-allocation of real resources, such as memory, printers, and DASD. The system resource operator does not control any resource that is already controlled by the system operator or the spooling operator.
Privilege class C	System programmer. The system programmer updates the functions of the z/VM system and can change real storage in the real machine.
Privilege class D	Spooling operator. The spooling operator controls spool files and real unit record devices, such as punches, readers, and printers.
Privilege class E	System analyst. The system analyst has access to real storage and examines dumps to make sure that the system is performing as efficiently and correctly as possible.
Privilege class F	IBM service representative. The representative of IBM who diagnoses and solves problems by examining and accessing real input and output devices and the data they handle.
Privilege class G	CMS general user. This is the most prevalent and innocuous of the CP privilege classes. The commands that privilege class G users can enter affect only their own VMs.

Privilege classes A, B, C, D, E, and F should be granted to only human users and VM workloads after careful consideration regarding the scope of responsibility. For example, users with privilege class B or C can modify an installation's system of CP privilege. Users with privilege class C can enter the **cp store host** command that alters real storage. Privilege class G users have the power to modify only their own VMs; they have little security relevance and cannot violate the security policies of the system. A Linux guest needs about 25% of what class G provides to IPL.

You can create your own privilege classes, based on the needs of a given workload. The letters I-Z and numbers 1-6 are available for this purpose. Class H is reserved by IBM.

In the CP, each level of privilege is discrete and not predicated on others. Furthermore, each privilege class has a subset of commands and they are related to one or more function types (subsets of users).

2.2 Device management

There are four methods to define I/O devices to the CP during IPL:

- ▶ Let the CP dynamically sense devices.
- ▶ Use **RDEV** statements or **EDEV** statements in the system configuration file.
- ▶ Use **RDEVICE** macroinstructions in the **HCPRIO ASSEMBLE** file.
- ▶ Use the Hardware Configuration Manager (HCM) and Hardware Configuration Definition (HCD) to define the devices.

Typically, CP senses the devices. Only devices that require additional definition have an **RDEVICE** or an **EDEVICE** statement in the system configuration file.

Note: To learn more about defining real devices, Chapter 5, “Defining I/O devices”, in *CP Planning and Administration*, SC24-6178.

The capabilities support of real devices is done by CP on behalf of the virtual guests, which means to the virtual guests the device is transparent in use without having access to the physical device. CP provides the system services for the device, including error recovery for guest DIAGNOSE I/O requests and a full command set for the device. Devices can be dedicated to just one guest or shared amongst multiple guests (which is done for DASD).

If a device supports dedicated-only use by a single guest, this device must be logically attached to a single guest at any one time. The guest must be fully capable of running with the device. CP does not supply DIAGNOSE I/O services to the guest.

2.3 Securing the data

The protection and securing of an organization’s information is considered part of the foundation for business success. Ensuring strong security protection of your data is mandatory and should be deployed with a careful plan and overall understanding about the security and business requirements that your organization needs.

As a starting point for defining your security policies, a smart decision is to start with a closed security police and grant access and privileges as the business requires.

2.3.1 Securing your minidisks

The z/VM system is designed to permit access to the minidisks when you provide the correct link password that is defined on the z/VM directory. The other way is having the link in your user direct definition. As this is a controlled environment, it sounds like a secure approach, but only with an appropriate external security manager (ESM) to make your configuration resilient and less prone to error.

Note: It is important to change all the default passwords in the USER DIRECT file to avoid unauthorized access.

2.3.2 Securing GUEST LANS and virtual switches

z/VM Virtual Switch supports access ports as USER-based or PORT-based. It can be VLAN-unaware, and the VSWITCH handles all VLAN tagging and trunk ports when it is VLAN-aware and processes its own VLAN tagging.

Access to VLANs is controlled by the **GRANT** option of the CP **SET VSWITCH** command (**MODIFY VSWITCH** in **SYSTEM CONFIG**). For a given user, a set of VLANs can be granted on a VSWITCH by listing them in the **VLAN** parameter. If more than one VLAN is specified, the **PORTTYPE** parameter must also be set to **TRUNK**. If a list of VLANs is given but **PORTTYPE ACCESS** is used, an error occurs, as shown in Example 2-6 on page 21.

Example 2-6 SET VSWITCH GRANT with multiple VLANs and PORTTYPE ACCESS

```
set vswitch vlantst grant tcpip vlan 10 20 30
HCPSWS2847E PORTTYPE ACCESS is not allowed when the user is authorized
HCPSWS2847E for more than one VLAN
```

Note: Guest LANs are discouraged these days because they are more cumbersome to configure and less secure than a virtual switch.

2.4 Securing your communication

Security in individual layers might be enough to keep the data integrity, confidentiality, and availability at the destination, but it is important to secure the data while it is in transit during communication.

Some solutions can be implemented at the client side, but the organization cannot rely on client-side only security. Users can forget to update their security software or security operating system updates can unconsciously install malware on their devices that prevents the execution of the security software, or the users do not install the security software.

What the organization can do is make sure the communication between the client and the server is encrypted with a secure cryptographic protocol. New vulnerabilities are often discovered on cryptographic protocols, cipher algorithms, and protocol implementation, so the security team must be up to date about what is secure to be used, and new vulnerabilities that must be mitigated as soon as they are reported.

The IT infrastructure inside the organization is the responsibility of the organization, so all means to avoid security breaches are valid to protect the information. A well-planned network infrastructure also helps secure the data communication. The first point of contact with the internet should be the network security system. It controls the incoming and outgoing traffic to the organization's network based on the application set of rules.

Separating the network into layers helps protect the information. Therefore, during network infrastructure planning, consider at least a layer for a DMZ, a layer for the web servers, a layer for the application servers, and a layer for database servers. This is not a rule and can be structured in different ways, but layering the network is important and must be considered when planning the network infrastructure.

Installing intrusion detection systems assists in monitoring for attacks and helps parse audit logs that can use a large amount of storage and have a huge amount of information that a human cannot read and find a pattern for an attack at the same time it is happening. Intrusion detection systems help system and network administrators detect attacks and alert them about it while it shows the techniques in use to exploit possible breaches.

2.4.1 Encrypting your communication

There are several ways to move data into and out of a mainframe. Since the early 1970s, terminals have connected to mainframes by using 3270 data streams. This high-performance protocol is still in use around the world and is how many developers connect to z/OS. By default, this data travels in clear text. Installations should evaluate the nature of the data that is transmitted over a 3270 connection and implement security measures, such as encryption, when warranted.

Enabling encrypted sessions requires configuration changes on both the host side and the client side. Fortunately, terminal emulators such as IBM PCOMM, IBM Host on Demand, and the open source x3270 emulators all support encryption of host sessions with simple configuration options.

The Transport Layer Security/Secure Socket Layer (TLS/SSL) server provides the processing capability that allows secure (encrypted) communication between two TCP/IP connection participants (one of which is a server or client application on the local z/VM host). Such communication may be secured by a static SSL connection or through Dynamic SSL/TLS, which allows a client or server application to control the acceptance and establishment of connections that are encrypted by using SSL.

For static TLS connections, no changes to a z/VM application server are necessary to participate in TLS. The application server does not perform any data encryption or decryption; this is handled by the z/VM TLS/SSL server.

Dynamic TLS connections are supported by the following z/VM TCP/IP application servers and clients, which have been updated to accommodate this support:

- ▶ TCP/IP server
- ▶ SSL server
- ▶ FTP server
- ▶ FTP client
- ▶ Telnet server (Internal to the TCP/IP server)
- ▶ Telnet client
- ▶ SMTP server

Under the TLS protocol, the application server is always authenticated. To participate in a TLS session, an application server must provide a certificate to prove its identity. Server certificates are issued by Certifying Authorities (CAs), each of which establishes its own identity by providing a CA certificate. Server certificates and CA certificates are stored in a certificate database (also referred to as a *key* database) that is accessible to the TLS/SSL server.

Only TN3270 connections can do client key exchanges, as shown in number 4 of Figure 2-2.

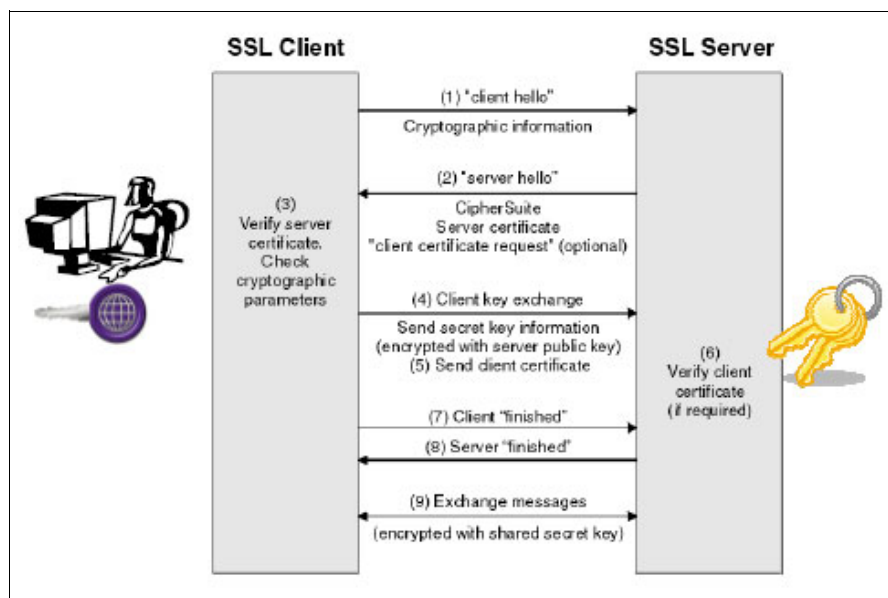


Figure 2-2 SSL scheme

You can configure the TLS/SSL server to meet industry and governmental cryptographic security requirements by updating the VMSSL keywords and parameters that are related to cipher suites and protocol levels. z/VM V6.3 and onward support TLS 1.2; use this level of TLS/SSL for encrypting traffic to or within the hypervisor layer. Weaker cipher suites are disabled by default. If weaker encryption is required for compatibility purposes, it can be reenabled through the same keywords and parameters.

Note: For more information about how to customize and enable encrypted communications to and from z/VM, see Chapter 4, “Installing and configuring z/VM”, in *The Virtualization Cookbook for IBM Z Volume 1: IBM z/VM 7.2*, SG24-8147.

2.4.2 z/VM cryptographic definitions

When an LPAR is configured to benefit from hardware cryptography support, z/VM running in such an LPAR can use the hardware support for cryptographic operations to provide it to its guests. This section focuses on how to set up the z/VM definitions for guests running Linux on IBM Z.

Using the IBM z16 cryptographic hardware, you gain security from using the CPACF and IBM Z Crypto-Express8S (CEX8S) through in-kernel cryptography APIs and, for Linux on IBM Z, the libica cryptographic functions library. Using these features provides these benefits:

- ▶ File system encryption
- ▶ Communication encryption (to applications such as IBM HTTP Server)
- ▶ System security by providing advanced cryptographic functions

The way that z/VM provides this support is by granting access to the cryptographic resource, sometimes called the Adjunct Processor (AP) queue, domains to the guests. From a system implementation perspective, an AP of a CEX8S feature is one of its internal cryptography engines (cryptography coprocessor units). AP designates to the processor, while the adapter number (AP ID) specifies the number associated with it.

In a z/VM environment, it is expected that the LPAR running z/VM has access to multiple AP queues. There are two ways z/VM can provide access for the guests to the AP queues:

- ▶ Shared queue support (APVIRTual operand on the CRYPTO directory control statement)

Shared queue support allows you to assign multiple z/VM guests to a single pool of hypervisor-managed crypto resources. This grants access to clear-key operations in the Crypto Express Adapters without the need to dedicate an entire AP queue to a z/VM guest.

- ▶ Dedicated queue support (APDEDicated operand on the CRYPTO directory control statement)

Dedicated cryptographic resources are required if a guest workload requires secure key operations (such as the use of dm-crypt in Linux for filesystem encryption) or if cryptographic requirements or key materials are not allowed to be shared with other guests.

The **CRYPTO** user directory statement grants a z/VM userid access to crypto resources associated with the Crypto Express adapters, as shown in Example 2-7.

Example 2-7 CRYPTO user directory statement

```
CRYPTo +- DOMAIN ---+domains +- APDEDicated +- ids ---+>>
```

```
+-- APVIRTua1-----^
```

Note:

- ▶ Guests should not try to dedicate the same domains (first to IPL wins, all others complain)
- ▶ Guests with a dedicated crypto resource may not be relocated
- ▶ Guests may not have both dedicated and shared crypto resources
- ▶ Shared crypto resources are limited to clear-key (Accelerator) mode only

When a key is defined in an IBM Z crypto-environment as a secure key, the key is protected by another key that is called a *master key*. A clear key has not been encrypted under another key and has no additional protection within the cryptographic environment. For clear keys, the security of the keys is provided by operational procedures.¹

In an environment where the Linux guests on z/VM need only clear key support, use the shared queue support for hardware encryption. Even when z/VM virtualizes the AP queues for shared queue support, there must be at least one physical queue available for z/VM that is not dedicated to any guest.

Setup for a Linux guest to use cryptography cards

To enable a z/VM guest (Linux guest) to use the hardware cryptography support that is provided by the Crypto-Express8s feature, there must be an entry in the user directory of the Linux guest in the VM USER statement. This is done with the CRYPTO statement for each guest (see *z/VM CP Planning and Administration*, SC24-6083).

Guests with dedicated-queues support

For a Linux guest that needs access to dedicated-queues, the CRYPTO statement in the USER entry for the guest must contain which domain and which AP number is used, which means one or more AP queues are identified and reserved for this guest. There is no virtualization for these dedicated-queues, no sharing is done, and the queues are not available for other guests. With dedicated-queues, secure key and clear key operations can be performed by the Linux guest. The statement in the directory looks like the following one:

```
CRYPTO DOMAIN x APDED y
```

Where:

- ▶ DOMAIN x: x can be one or more domains that are defined for the z/VM LPAR.
- ▶ APDED y: y can be one or more APs (CEX8S cards) that are defined for the z/VM LPAR.

The combination of AP numbers and domain numbers should be unique across all cryptography users in the directory. Although you can use directory processing to specify the same AP and DOMAIN combination for multiple users, these users should not be logged on at the same time. If they are, more than one user might have concurrent access to the same AP queue. Directory processing does not enforce this restriction because duplicate definitions can be useful for backup configurations.

You can have multiple CRYPTO statements within one single user statement. However, if you choose different domains to different APs, all APs are available for all defined domains:

```
CRYPTO DOMAIN 10 APDED 1
```

¹ <http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP100647>


```
CRYPTO DOMAIN 11 APDED 4
```

This means that AP 1 and 4 are defined to the domains 10 and 12. This can also be shown as:

```
CRYPTO DOMAIN 10 11 APDED 1 4
```

The directory entry for the guests looks as shown in Example 2-8.

Example 2-8 Sample directory entries for dedicated-queues for cryptography access

```
USER EDI xxxxxxxx 64M 96M ABCDEFG
  INCLUDE IBMDFLT
  CRYPTO DOMAIN 004 APDED 005
  CRYPTO DOMAIN 3 APDED 0 7
  IPL CMS PARM FILEPOOL VMSYSU AUTOOCR
  OPTION LNKNOPAS QUICKDSP
  MDISK 0191 3390 71 10 ZVMUSR MR
```

The privileged command, **Q CRYPTO DOMAIN USERS** shows the output that is shown in Example 2-9.

Example 2-9 Result of a Q CRYPTO DOMAIN command

```
q crypto dom users
AP 000 CEX8C Domain 031 operational online shared
AP 001 CEX8P Domain 031 operational online free
AP 002 CEX8C Domain 031 operational online shared
AP 003 CEX8P Domain 031 operational online free
```

Guests with shared-queue support

For a Linux guest that needs access to clear key cryptography operations, shared access to AP queues is the preferred way to implement this access. For this case, the `CRYPTO` statement in the `USER` entry for the guest needs to indicate that access to virtual queues is wanted. No domain and no AP queue must be specified. The Linux guest gets one virtualized card and one random virtual queue on one random virtual AP. The AP number and domain are chosen by z/VM and are not identical to the one for the z/VM LPAR.

Note: As of the IBM z13, you can now specify a `CRYPTO APVIRT` statement in your System Configuration file, which allows the system administrator to designate particular AP domains that are attached to the LPAR as “Reserved for APVIRT”.

For this support, z/VM uses all available AP queues, which are not dedicated to other guests, and these are shared between all guests that use the shared support. If there are multiple AP types available for z/VM, then z/VM chooses the best AP type for acceleration for the Linux guest. When a type is selected, z/VM routes all cryptography requests from the guest to however many queues/cards of that type are available. The statement in the directory looks like this:

```
CRYPTO APVIRT
```

The AP queue number and the domain number, which are provided by z/VM to these two guests, are virtual numbers and do not correspond to the “real” domains and APs, which are used by z/VM to run the cryptography requests of these guests. The directory entry for the guests looks like what is shown in Example 2-10.

Example 2-10 Directory entry with dedicated and shared cryptography queues

```

USER GUESTL1 xxxxxx 256M 1G G
  INCLUDE IBMDFLT
  IPL CMS
  MACH XA
  NICDEF C200 TYPE QDIO LAN SYSTEM VSWITCH1
  CRYPTO DOMAIN 9 APDED 2 3
----- 3 line(s) not displayed -----
USER GUESTL2 xxxxxx 256M 1G G
  INCLUDE IBMDFLT
  IPL CMS
  MACH XA
  NICDEF C200 TYPE QDIO LAN SYSTEM VSWITCH1
  CRYPTO APVIRT

```

To update the USER entry in the directory to contain the CRYPTO statement, you can use an editor, and change all necessary USER entries. In an environment with DirMaint, proceed as follows to provide shared access to a Linux guest LNXSU1 for clear key operation and dedicated access to the AP queue with domain 11 and AP number 02 to LNXSU2 for secure key operation.

To change the directory for EDI to get shared access to the cryptography hardware, run the command **dirm for EDI crypto**. The panel that is shown in Figure 2-3 opens. In this Dirmaint panel, select APVIRTUAL (for the operand APVIRT in the CRYPTO statement) with any character and press F5 to submit the request.

```

-----DirMaint CRYPTO-----
Query or update the current CRYPTO statement in the user's directory entry.
Select one of the following:
  _ ? (Query) _ DELETE _ APVIRTUAL _ DOMAIN
For DOMAIN, Select one or more domain values (0 thru 15):
  _ 0 _ 1 _ 2 _ 3 _ 4 _ 5 _ 6 _ 7
  _ 8 _ 9 _ 10 _ 11 _ 12 _ 13 _ 14 _ 15
Optionally select one of the following:
  CSU _ * _ 0 or _ 1
Optionally select one or more of the following:
  _ APVIRTUAL _ KEYENTRY _ MODIFY _ SPECIAL _ APDEDICATED
For APDEDICATED, Select one or more ap values (0 thru 63):
  _ 0 _ 1 _ 2 _ 3 _ 4 _ 5 _ 6 _ 7 _ 8 _ 9
  _ 10 _ 11 _ 12 _ 13 _ 14 _ 15 _ 16 _ 17 _ 18 _ 19
  _ 20 _ 21 _ 22 _ 23 _ 24 _ 25 _ 26 _ 27 _ 28 _ 29
  _ 30 _ 31 _ 32 _ 33 _ 34 _ 35 _ 36 _ 37 _ 38 _ 39
  _ 40 _ 41 _ 42 _ 43 _ 44 _ 45 _ 46 _ 47 _ 48 _ 49
  _ 50 _ 51 _ 52 _ 53 _ 54 _ 55 _ 56 _ 57 _ 58 _ 59
  _ 60 _ 61 _ 62 _ 63

5741-A07 (c) Copyright IBM Corporation 1979, 2011.
1= Help 2= Prefix Operands 3= Quit 5=Submit 12=Cursor

```

Figure 2-3 DirMaint Crypto panel

2.4.3 Checking the cryptographic card definitions in z/VM

To verify that hardware cryptography support is available in z/VM and can be provided to z/VM guests, you can verify the definitions in the image activation profile of the LPAR in which z/VM is running. Then, you can check the definitions in the z/VM user directory to see what is already provided to the guests.

The QUERY CRYPTO command

You can use the **QUERY CRYPTO** command to verify the cryptography support. Figure 2-4 shows the syntax for this command. For more information about this command, see [z/VM CP Commands and Utilities, SC24-6081](#).

```
>>--Query--CRYPTo--+-----+<
      | -DOMains--+-----+-----+
      |                    '-Users-'
      |-----+-----+
      +--+-----+---POLling---'
      `--APVIRtUal-`

Authorization
Privilege Class: A, B, C, E
```

Figure 2-4 QUERY CRYPTO syntax

The **QUERY CRYPTO** command displays which crypto resources are available to your z/VM system. Note that this list will be limited to adapters and domains associated with a z/VM instance. This command shows only information about the subset of cryptography cards and domains as defined for the LPAR in which the z/VM system is running. The z/VM user that performs this command must have a high CP Privilege Class of A-B-C-E.

In a z/VM environment, where there are cryptographic units available but no guests are assigned access, Example 2-11 shows the response to the **QUERY CRYPTO** command.

Example 2-11 Crypto-units available: z/VM guests do not have access to AP queues

```
CP Q CRYPTO
Crypto Adjunct Processor Instructions are installed
```

Adding in the AP operand, you get more information about the installed AP queues, as shown in Example 2-12. In this example, there are domains available for shared access (clear key) of the queues.

Example 2-12 Response to QUERY CRYPTO

```
q crypto ap
AP 000 CEX8C  Domain 030 operational  online  shared
AP 001 CEX8P  Domain 030 operational  online  free
AP 002 CEX8C  Domain 030 operational  online  shared
AP 003 CEX8P  Domain 030 operational  online  free
```

The QUERY VIRTUAL CRYPTO command

The **QUERY VIRTUAL CRYPTO** command shows status information about the virtual cryptographic facilities of the z/VM guest. If the guest to which you are currently logged into does not have access to cryptography queues, the response in Example 2-13 is shown.

Example 2-13 Guest does not have access to cryptography queues

```
CP Q V CRYPTO
No AP Crypto Domains are available
```

If the guest to which you are currently logged into does have access to the cryptography queues, the response in Example 2-14 is shown.

Example 2-14 Guest has access to cryptography queues

```
AP 003 CEX8C Domain 002 dedicated
Ready;
```

Trusted Key Entry support

The Trusted Key Entry (TKE) feature is a combination of workstation hardware and TKE Licensed Internal Code. It provides key management functions for operating systems such as Linux on IBM Z and z/OS. Crypto-Express cards are used to provide hardware support to most cryptographic functions through the Cryptographic Coprocessor Feature (CCF). While it is an optional, priced feature, it is highly encouraged for key management of the crypto adapters.

TKE provides a secure, remote, and flexible method for providing Master Key Part Entry, and to manage remotely PCIe cryptographic coprocessors for the crypto-domains, that is, through smartcards or other secured devices. The cryptographic functions on the TKE are run by one PCIe cryptographic coprocessor. The communication between the TKE workstation and z Systems servers happens through a TCP/IP connection, which is available through Ethernet LAN connectivity only.

Note: How to set up the TKE, manage master keys for crypto-domains, and much more is explained in [z/OS Cryptographic Services ICSF TKE Workstation User's Guide](#),

To let guests running under z/VM benefit from cryptographic hardware, crypto domains and crypto-coprocessors must be attached to z/VM LPARS through HMC dialogues. After this is done, crypto-domains can either be dedicated to or shared with other LPARs.

2.5 z/VM connectivity

Connectivity in z/VM can be provided by customizing TCP/IP. The TCP/IP VM provides the primary TCP/IP service that is called the *stack*. The stack controls the network interfaces, such as Open Systems Adapter (OSA), and supports the application programming interfaces (APIs).

For more information about how to set up and define the stack, see Chapter 19, “Configuring the TCP/IP Server”, in *TCP/IP Planning and Customization*, SC24-6238.

2.5.1 DEVICE and LINK statements

For TCP/IP to use network devices on z/VM, you must ensure that the device addresses are attached to the TCP/IP VM by doing one of the following actions:

- ▶ Modify the DTCPARMS file to enable the necessary devices to be attached by using the `:Attach.` tag.
- ▶ Add the appropriate DEDICATE control statements to the TCP/IP VM's directory entry.

z/VM does not require a device definition in the system configuration file or HCPRIO. The device attributes are determined automatically during device initialization.

Example 2-15 demonstrates the Device and Link configuration statements for an OSA device that is found in the `PROFILE TCPIP` file.

Note: While system configuration is not required from an I/O standpoint, in an SSI environment, you might need to code RDEVICE statements in SYSTEM CONFIG to set up the Equivalence ID (EQID) for the QDIO devices.

Example 2-15 DEVICE and LINK statements for an OSA device in the PROFILE TCPIP

```
DEVICE DEV$04B0 OSD 04B0
LINK OSA01 QDIOETHERNET DEV$04B0 PATHMTU 1500 VLAN 20
```

VLAN

In z/VM environment, the virtual servers that are connected to each other form a virtual LAN (VLAN) which eliminates the requirement for any physical cabling or external networking connection among them. Functioning as an internal LAN, it moves data at memory speed between the virtual servers with high throughput and low latency communication path.

HiperSockets

IBM HiperSockets are an extension to the Queue Direct I/O (QDIO) Hardware Facility, providing a microcode only, low latency communications vehicle for internet protocol (IP) inter-program communication (IPC). With the use of HiperSockets, a program can directly communicate with a program running within the same LPAR and across any LPAR within the same central processor complex.

2.5.2 HiperSockets VSWITCH Bridge

A type of connectivity was introduced with the IBM z13 and z/VM V6.3. The HiperSockets VSWITCH Bridge was introduced to allow an internal HiperSockets network to be extended outside the IBM Z processor complex. Using this capability, a network configuration can be greatly simplified:

- ▶ Guests of z/VM that need access to both VSWITCH and HiperSockets hosts need be attached only to either connection type to have access to both, without routing.
- ▶ HiperSockets networks in different IBM Z CPCs can be logically connected to each other, which means that z/VM guests that use LGR can treat the HiperSockets networks in different CPCs as the same because traffic is bridged between them.

The HiperSockets VSWITCH Bridge does not require a TCP/IP stack to function. The capability is provided by the CP system service that supports VSWITCH operation. The bridge is set up by defining a HiperSockets connection as an UPLINK port on a VSWITCH.

The HiperSockets VSWITCH Bridge takes care of all issues relating to moving a frame from QDIO OSA frame type to IQDIO HiperSockets mode (and vice versa).

Note: For more information, see *IBM HiperSockets Implementation Guide*, SG24-6816.

2.5.3 Security considerations

Because HiperSockets are usually an isolated network with no exposure outside the IBM Z CPC, there are security considerations for the use of the HiperSockets VSWITCH Bridge. Bridging a HiperSockets CHPID that is used for secure cross-system traffic within a IBM Z CPC to an external network connection might be a cause of concern that the secure traffic may be exposed. However, because HiperSockets are a LAN segment, there are security considerations whether they are transmitting data in-memory or over OSA CHPIDs.

Note: The HiperSockets-VSWITCH Bridge is not a promiscuous bridge; it does not passively transfer all traffic appearing on the HiperSockets onto the VSWITCH or vice versa. It actively sends only frames with destinations that are unknown on the HiperSockets to the VSWITCH. Likewise, the VSWITCH sends only frames to the HiperSockets for addresses that the HiperSockets has registered to the VSWITCH.

Because of the way the function works, it is not feasible that secure traffic on a HiperSockets CHPID could be exposed by the HiperSockets-VSWITCH Bridge:

- ▶ The function only copies frames to destinations that are unknown on the HiperSockets over to the VSWITCH.
- ▶ The HiperSockets network traffic analyzer (NTA) function, which is the only method that is available for tracing or 'sniffing' traffic on a HiperSockets, only functions with Linux running natively in the LPAR authorized for NTA.

The number of HiperSockets networks that are available in a IBM Z CPC makes it possible that a dedicated HiperSockets virtual network could be used for the HiperSockets VSWITCH Bridge function without any perceived risk to the traffic carried on HiperSockets already in use.

Interaction with Parallel Sysplex and IQDCHPID

The IBM Z Parallel Sysplex cluster contains multisystem data sharing technology that allows multiple databases to perform direct reads and writes to shared data.

The Cross-system Coupling Facility (XCF) is a component of z/OS that manages communications between applications in a Parallel Sysplex.

A common optimization technique that is used when TCP/IP traffic is carried over XCF in a z/OS Parallel Sysplex is to combine the DYNAMICXCF function with the VTAM **IQDCHPID** start option. **IQDCHPID** sets a particular HiperSockets CHPID to be used to carry TCP/IP traffic over the HiperSockets instead of over XCF, reducing the impact of large TCP/IP transfers on the performance of other XCF functions.

If a CHPID that is used for **IQDCHPID** is also used with the HiperSockets-VSWITCH Bridge function, there might be concern that XCF traffic would be exposed to the LAN or that large volumes of LAN traffic would be flooded onto the XCF internal connections. Also, if the Parallel Sysplex extends across multiple CPCs and HiperSockets-VSWITCH Bridge was used on each CPC, there might be concern about traffic loops occurring through the LAN.

These issues do not occur because neither HiperSockets-VSWITCH Bridge or DYNAMICXCF with IQDCHPID are promiscuous bridges. In DYNAMICXCF with IQDCHPID, VTAM decides whether the packet is sent over XCF or over the HiperSockets to reach the other TCP/IP stack:

- ▶ If VTAM sends the packet over XCF, it never appears on the HiperSockets and cannot be presented to the VSWITCH.
- ▶ If VTAM sends the traffic over the HiperSockets, it is because the other system was directly addressable on the same HiperSockets. The HiperSockets-VSWITCH Bridge does not forward the traffic.

For similar reasons, traffic that is bridged onto the HiperSockets from the VSWITCH appears only on the HiperSockets:

- ▶ Traffic coming into a z/OS system through the HiperSockets-VSWITCH Bridge does not appear again on XCF because the Bridge placed only the traffic onto the HiperSockets because the destination was addressable directly on the HiperSockets.
- ▶ The HiperSockets-VSWITCH Bridge does not flood arbitrary VSWITCH or LAN traffic into the HiperSockets because it forwards only frames that are addressed to systems on the HiperSockets.

Note: If the traffic on the VSWITCH contains many broadcasts, this increases the activity on the HiperSockets because the broadcast traffic is forwarded by the Bridge.

Despite the fact that you cannot see any significant unwanted effects of combining DYNAMICXCF and IQDCHPID with the HiperSockets-VSWITCH Bridge, there is not a particularly valid reason to do it either. DYNAMICXCF usually is implemented in support of critical z/OS high availability technologies such as Sysplex Distributor, so keeping this network isolated is important to the integrity and availability of the system.

Multihomed hosts

z/OS systems that take advantage of HiperSockets usually have OSA Express connectivity directly to an outside LAN. In TCP/IP terms, a host that has multiple network interfaces in different subnets is described as a *multihomed host*.

Note: Most TCP/IP stacks support multihoming. Even mobile device OSes such as Android and iOS support multihoming to manage connectivity to mobile data and Wi-Fi networks at the same time. Multihoming by itself is not an availability technique, and is not a replacement for multiple network interfaces in the same subnet (z/OS uses a combination of multihoming and dynamic routing to achieve redundancy and high availability).

z/OS systems were once one of the few systems in a network environment to be multihomed. It is becoming increasingly common for other servers to be set up this way. Cheaper networking hardware and virtual LAN technologies such as IEEE 802.1Q make it easier to set up systems that connect to more than one network at a time. The reasons for using multihoming include separation of backup and other management traffic from application delivery, and separating different application delivery zones from each other.

If you do decide to implement HiperSockets-VSWITCH Bridge around multihomed hosts (particularly z/OS systems), and these systems will be connected to HiperSockets and LANs at the same time, *do not* bridge between any HiperSockets and LANs that are attached to such multihomed hosts simultaneously. Bridging the HiperSockets and the LAN requires that the networks be defined as the same subnet, and interfaces of different technologies (in this example, HiperSockets and QDIO OSA-Express) do not operate well if defined to the same subnet.

2.6 Remote Spooling Communications Subsystem

Remote Spooling Communications Subsystem (RSCS) Networking for z/VM is a networking program that enables users on a z/VM system to send messages, files, commands, and jobs to other users within a network. It is an easy way to transfer data files (as spool files) among z/VM systems or other systems, such as, z/OS. It also acts as a print server for remote printers that are attached to other z/VM systems or a TCP/IP network. Through RSCS, users can send and receive messages, files, issue commands, and print and submit jobs within their networks.

RSCS can communicate with system nodes that are running under the control of network job entry (NJE) compatible subsystems, such as:

- ▶ JES2 or JES3
- ▶ RSCS
- ▶ VSE/POWER
- ▶ IBM AS/400® Communications Utilities
- ▶ Products that provide NJE functions for Linux or IBM AIX®

NJE is the native peer-to-peer networking protocol for IBM mainframes running RSCS. It is designed to be flexible so that you can customize it to meet the changing needs of your installation and network. Using exit facilities and control files, such as the configuration file and events file, you can set up and tailor the way RSCS works and establish security rules by using specific exits.

Additionally, z/VM V7.3 supports the encryption of TCPNJE traffic. A TCPNJE link connects the local RSCS system to a remote NJE system through TCP/IP. Since TCPNJE uses the z/VM TCP/IP stack, this also supports encryption by the TLS/SSL server, as describe in 2.4.1 “Encrypting your communication” on page 21.

For more information about RSCS and the NJE communication protocol, see the following website:

<http://www.ibm.com/common/ssi/cgi-bin/ssialias?subtype=WH&infotype=SA&htmlfid=ZSW03288USEN&attachment=ZSW03288USEN.PDF>

Main functions

RSCS is a subsystem that can perform the following functions:

- ▶ Handle data being sent to, from, or through z/VM systems.
- ▶ Store and retrieve input and output data files on the z/VM system spool.
- ▶ Use communications equipment to transfer data between its z/VM system and remote users, devices, and other systems.

How RSCS fits into your installation

RSCS uses the z/VM system spool to manage file transfers. It uses the spool for temporary file storage and to store files being transferred between its local system and remote users, devices, or systems.

To manage files that are spooled to remote nodes, RSCS relies on tag information. A spool file tag becomes part of each data file that is spooled to RSCS. The tag contains information that describes where the file came from (origin information) and where it is going (destination information).

RSCS EXITS

RSCS exits are used to restrict the sending and receiving files of programs that can affect the performance of the system, such as executable files that can have malware. Using exit facilities and control files, such as the configuration file and EVENTS file, you can set up and tailor the network where RSCS functions. You can use the exit facility to modify RSCS processing to meet any special functional requirements for your installation.

Note: For more information, see *RSCS Networking Exit Customization*, SC24-6224.

Security aspects

The Gateway Security Modification (GSM) is a feature of RSCS that can reject any files that go through RSCS. You can create control files to restrict certain users from sending files to a specific system and issue monitor commands of RSCS.

As a preferred practice, create a rule so that the users have permission to send/receive files to other systems while restricting the areas that they can use.

Table 2-1 shows the main security packages that should be implemented in your environment.

Table 2-1 Some of RSCS Exits focusing some security aspects

Package name	Main function	Exit
Gateway security modifications (GSM)	Controls the data traffic.	Gateway programming interface, Exit 0, Exit 1, Exit 14, Exit 15, Exit 19, Exit 21, Exit 29, and Exit 32
Selective file filter (SFF)	Purges unwanted files.	Exit 0, Exit 1, Exit 15, Exit 21, and Exit 29
Simple security package (SSS)	Limits file traffic or user ID usage.	Exit 0, Exit 1, Exit 14, Exit 15, Exit 19, Exit 21, and Exit 32

RSCS advantages

In a multisystem network, because the systems are interconnected, data can be moved through and between them from any system and to any system. RSCS running under z/VM (in addition to what it can do in a single-system environment) can do networking.

To users, networking means they can do the following actions:

- ▶ Exchange data with users on the same system.
- ▶ Exchange data with systems and users at other locations.

- ▶ Send jobs to other systems for processing.
- ▶ Direct processed output to devices, such as printers and punches, that are connected to another system.

Employees can get that data that they need from other systems. When work passes from one phase to another, moving as it does from department to department, RSCS can transfer data from one employee to the next, from one system to another system. Employees can do the following actions:

- ▶ Correspond electronically.
- ▶ Use programs on another system to process their jobs.
- ▶ Send jobs from a remote workstation at their location to the local or to a remote system.
- ▶ Direct output to RSCS-controlled 3270 printers or ASCII devices from jobs they have submitted to either local or remote systems.
- ▶ Send or receive output for other system-controlled printers through RSCS.
- ▶ Send an output file that they have created for another employee to print on that employee's system.

You can buy and locate resources (processors, computer programs, and I/O devices) to fit your business needs, whether by departments or regions. Because these resources can be shared, you can distribute the workload of your business and improve your employees access to these resources. This can lead to greater efficiency and productivity in your business.

Note: For more information, see *RSCS Networking Planning and Configuration*, SC24-6227.



IBM Resource Access Control Facility Security Server for IBM z/VM

The IBM Resource Access Control Facility (RACF) Security Server feature, function level 730 for z/VM 7.3, builds on the function that is provided by previous releases. Significant enhancements are included in version 7.3 that increase the capability and security of RACF. A restriction was also introduced that prohibits the sharing of the RACF database between z/OS and z/VM.

This chapter describes the processes of installing, configuring, managing, monitoring, auditing, and controlling of RACF resources. This chapter follows the concepts that are outlined in *z/VM: Secure Configuration Guide, SC24-6323*.

Note: *z/VM: Secure Configuration Guide, SC24-6323* describes installing and customizing z/VM and RACF in a way that meets requirements for certification for the Common Criteria Operating System Protection Profile (OSPP). This chapter does not describe all of the steps that are involved in setting up the certified configuration. However, there are important basic steps that are outlined in *z/VM: Secure Configuration Guide, SC24-6323* that are important even for a normal RACF installation.

A directory manager is recommended for a single system image (SSI) environment to maintain synchronization between object directories. Although the Common Criteria evaluation does not make any claims about z/VM, security administrators should determine which directory manager best fits their security policies and act accordingly.

This chapter assumes the use of the IBM z/VM Directory Manager (DirMaint) product for managing the user directory of the system, with RACF and DirMaint configured to work together. Unlike other operating systems, z/VM separates the processes of user definition and security administration. You must first define the virtual machine (VM) in the user directory, which provides basic resource control configuration. If you are using an external security manager (ESM), you must also add users and define users resources to the ESM

database. You can find information about DirMaint installation and its use in Appendix A, “DirMaint implementation” in *Security on z/VM*, SG24-7471.

More information about the DirMaint-RACF Connector, can be found in *z/VM: 7.3 Directory Maintenance Facility Tailoring and Administration Guide*, SC24-6283

This chapter describes the following topics:

- ▶ RACF z/VM concepts
- ▶ Installing and configuring RACF
- ▶ RACF management processes

3.1 RACF z/VM concepts

This section describes some concepts around using RACF to protect the security of a z/VM installation.

3.1.1 External security manager

An ESM is software that provides enhanced security access control over the functions that are provided by the operating system itself. z/VM, like z/OS, implements the ESM concept so that you can choose and configure a security manager that suits the needs of your organization. RACF Security Server for z/VM is the IBM ESM for the z/VM platform.

The ESM receives requests from resource managers on the system (CP, Shared File System, TCP/IP, FTP, and so on) on behalf of VMs that must access resources. In z/VM, each of the resource managers likely has a different VM and a person who is responsible for this support, rather than having a single *superuser* that is responsible for these processes. When the resource manager is enabled for an ESM, it calls the ESM to check whether the VM has the proper authorization to access the resource.

The ESM performs a number of operations to determine what happens next. It first checks to see whether it is set up to be responsible for the type of resources being requested (for example, minidisks or virtual switches). If the ESM is responsible, it checks whether the VM has direct access to the resource, or is a member of a group that has access to the resource. If the VM or a group of which the VM is a member has the authority, then access is granted to the resource.

The ESM can also be configured to control what happens when the ESM is not responsible for the type of resources being requested, or if there is not an explicit resource definition to control access to the particular resource being requested. The ESM can be configured to deny access to the resource in these situations. Alternatively, the ESM can defer authorization to CP, which means that the resource manager then must use the traditional access methods (for example, passwords that are configured in the user directory in the case of minidisks) to control access to the resource.

Note: The default action that is taken by RACF is to defer to CP. Section 3.2.5, “Using HCPRWAC” on page 60 describes this action in more detail, and how to change this default action.

The z/VM resource managers interface with the ESM by using the RPI interface.

3.1.2 Security policy

An ESM must be configured to support its role in maintaining system security and integrity. In the case of RACF, there are several areas where this configuration takes place:

- ▶ RACF options
- ▶ Classes
- ▶ User definitions
- ▶ Resource definitions (profiles)
- ▶ Access control lists (ACLs)
- ▶ Audit settings

The combination of all of these configuration settings must follow your organization's *security policy*. The policy is agreed to across operational and business areas in your organization, and covers issues such as the following ones:

- ▶ The default levels of access that should exist for different types of resources
- ▶ Whether access to resources should be managed through grouping them or by maintaining separate ACLs for each resource
- ▶ What level of tracking of access requests should take place (for example, auditing all access requests or just failures)
- ▶ The roles and responsibilities of administrators and users in the organization, including the separation of duties between those roles

The security policy is implemented by using the configurations and settings in RACF.

Note: Chapter 2, “Organizing for RACF Implementation”, in *z/VM RACF Security Server Security Administrator's Guide*, SC24-6311, contains an excellent reference about to how to start implementing a security policy by using RACF.

The “default” security policy

The process that is described in this chapter is based on the steps that are outlined in *Program Directory for RACF Security Server*, GI13-4364-02. In this process, you use a utility that is supplied with RACF to create an initial database of RACF profiles and ACLs that are based on your system's current CP directory. In effect, this process implements a “default” security policy. Likewise, the functions of other system components (such as the DirMaint-RACF connector.

The policy that is inferred by using the basic RACF utilities is sufficient for most installations. After all, it is based exactly on the policy as implemented by the CP directory, and most installations make no changes to the definitions that are contained there. Here are the basic rules that re inherent in this policy:

- ▶ All resources have profiles protecting that resource specifically (known as *discrete profiles*).
- ▶ The owner of a resource has full authority over that resource, including the authority to grant other users access to it.
- ▶ Administration roles (auditor and security administrator) are separated.

Some highly sensitive organizations, or those installations with experienced security administration staff, might want to adjust the output that is generated by the utilities so that they better reflect the specific needs of the organization.

Optimizing administration

Another aspect of the “default” operation of RACF functions and utilities is that the number of resource profiles and ACLs is not optimized. With every resource having a discrete profile, the number of profiles in the database can grow, and it can become more complex to manage many resources. Section 3.3.4, “Securing your minidisks with RACF” on page 73 describes this topic, and a more streamlined way to manage resource protection.

If you use only the RACF utilities and tools for management, such as the DirMaint-RACF connector, there is not a significant issue here. Although the number of profiles in RACF might become large, the utilities keep them up to date. If you choose to optimize your RACF operation and use techniques such as generic profiles and group-based access control, be aware that you might have to do some work to implement your own system to manage your altered policy. For example, you might not be able to use the DirMaint-RACF connector to manage minidisk profiles (the VMMDISK class) if you use group membership to authorize minidisk access.

3.2 Installing and configuring RACF

RACF for z/VM is shipped with the z/VM 7.3.0 system deliverable and managed by using Virtual Machine Serviceability Enhancement Staged / Extended (VMSES/E). RACF for z/VM is a priced product that is supplied in a disabled state. It must be enabled and configured by the system programmer before you use it.

The Program Directory for the product describes the installation process and can be downloaded from the following website:

<https://www.vm.ibm.com/progdir/>

Note: Make sure that your installation has a license for RACF before you activate it.

Program Directory for RACF Security Server, GI13-4364-02 describes the step-by-step process to install and configure the product.

Here are the main steps in the process:

1. Plan for requirements and install RACF using the VMSES/E tools.
2. Perform post installation steps, as described in 3.2.1, “Pre-installation tasks” on page 39.
3. Build the RACF enabled CPLOAD MODULE, as described in 3.2.2, “Building the RACF enabled CPLOAD MODULE” on page 52.
4. Update the RACF database and options, as described in 3.2.3, “Updating the RACF database and options” on page 54.
5. Place RACF into production, as described in 3.2.4, “Placing RACF into production” on page 59.
6. Set up RACF ISPF for users 3.2.5, “Using HCPRWAC” on page 60.

You should print the procedural checklist from the RACF Security Server for z/VM Program Directory so that you do not miss any important steps in the process.

This chapter assumes that the reader has basic z/VM system programming knowledge. Experience with VMSES/E and its processes is helpful, but is not essential.

3.2.1 Pre-installation tasks

This section describes the tasks that you must perform after you have activated the RACF code. These tasks reflect preferred practices that were tested in the ITSO test environment.

- ▶ Allocating the RACF DASD
- ▶ Defining RACF user IDs
- ▶ Evaluating the minidisk access
- ▶ Updating the RACF user ID directory entry
- ▶ Running RPIDIRCT
- ▶ Customizing the processing of SMF records
- ▶ Password encryption algorithm

Allocating the RACF DASD

The default definitions of the minidisks that are used to hold the primary and backup RACF database are not recommended for production use. By default, both minidisks are defined on the same volume, which means the database might be lost if that volume is lost. Also, if you have enabled the z/VM SSI feature, you are required to have the RACF database on full-pack minidisks.

If you are using SSI, follow the directions in the following sections (from the “Sharing RACF Databases in a z/VM Single System Image Cluster” section of *z/VM RACF Security Server System Programmer’s Guide*, SC24-6312 to define both RACF database minidisks as full-pack minidisks:

- ▶ Defining the RACF database disks as shared
- ▶ Defining the initial RACF database

Note: If you use IBM Geographically Dispersed Parallel Sysplex (GDPS), you cannot use the **DEVNO** parameter on MDISK statements. Instead, you *must* follow the instructions that are contained in the Program Directory for defining the RACFVM 200 and 300 disks.

To verify that the directory update is correct, run **DIRM REVIEW** for RACFVM. The output is shown in Example 3-1 (for clarity, only the statements belonging to the first member of the SSI cluster are shown).

Example 3-1 DIRM REVIEW for RACFVM after minidisk updates

```
IDENTITY RACFVM XXXXXXXX 20M 20M ABCG
DVHRXV3366I The following configurations will be used on SSI nodes.
DVHRXV3366I The following configuration RACFVM-1 will be used on SSI
DVHRXV3366I node RDBKSYC1.
SUBCONFIG RACFVM-1
  LINK MAINT 0190 0190 RR * CMS SYSTEM DISK
  LINK MAINT 019D 019D RR * HELP DISK
  LINK MAINT 019E 019E RR * PRODUCT CODE DISK
  MDISK 0191 3390 05262 009 RS1RES MR XXXXXXXX XXXXXXXX XXXXXXXX
  MDISK F200 3390 05245 017 RS1RES MWV XXXXXXXX XXXXXXXX XXXXXXXX
  MDISK 0490 3390 05271 070 RS1RES MR XXXXXXXX XXXXXXXX XXXXXXXX
  MDISK 0305 3390 05341 136 RS1RES MR XXXXXXXX XXXXXXXX XXXXXXXX
  MDISK F300 3390 05477 017 RS1RES MWV XXXXXXXX XXXXXXXX XXXXXXXX
  MDISK 0301 3390 05494 007 RS1RES MR XXXXXXXX XXXXXXXX XXXXXXXX
  MDISK 0302 3390 05501 007 RS1RES MR XXXXXXXX XXXXXXXX XXXXXXXX
```

```
*DVHOPT LNK0 LOG1 RCM1 SMS0 NPW1 LNGAMENG PWC20230912 CRC ;
DVHRXV3366I Preceding records were included from RACFVM-1 configuration
```

DVHRXV3366I for node RDBKSYC1.

DVHRXV3366I The following configuration RACFVM-2 will be used on SSI

DVHRXV3366I node RDBKSYC2.

SUBCONFIG RACFVM-2

```
LINK MAINT 0190 0190 RR * CMS SYSTEM DISK
LINK MAINT 019D 019D RR * HELP DISK
LINK MAINT 019E 019E RR * PRODUCT CODE DISK
MDISK 0191 3390 05262 009 RS2RES MR XXXXXXXX XXXXXXXX XXXXXXXX
MDISK F200 3390 05245 017 RS2RES MWV XXXXXXXX XXXXXXXX XXXXXXXX
MDISK 0490 3390 05271 070 RS2RES MR XXXXXXXX XXXXXXXX XXXXXXXX
MDISK 0305 3390 05341 136 RS2RES MR XXXXXXXX XXXXXXXX XXXXXXXX
MDISK F300 3390 05477 017 RS2RES MWV XXXXXXXX XXXXXXXX XXXXXXXX
MDISK 0301 3390 05494 007 RS2RES MR XXXXXXXX XXXXXXXX XXXXXXXX
MDISK 0302 3390 05501 007 RS2RES MR XXXXXXXX XXXXXXXX XXXXXXXX
```

*SUBCONFIG RACFVM-3

```
* LINK MAINT 0190 0190 RR * CMS system disk
* LINK MAINT 019D 019D RR * help disk
* LINK MAINT 019E 019E RR * Product code disk
```

*SUBCONFIG RACFVM-4

```
* LINK MAINT 0190 0190 RR * CMS system disk
* LINK MAINT 019D 019D RR * help disk
* LINK MAINT 019E 019E RR * Product code disk
*
```

*

*DVHOPT LNK0 LOG1 RCM1 SMS0 NPW1 LNGAMENG PWC20230912 CRC

DVHRXV3366I Preceding records were included from RACFVM-2 configuration

DVHRXV3366I for node RDBKSYC2.

* BUILD ON @@member3name USING SUBCONFIG RACFVM-3

* BUILD ON @@member4name USING SUBCONFIG RACFVM-4

```
ACCOUNT IBM
IPL 490 PARM AUTOCR
IUCV *RPI PRIORITY MSGLIMIT 100
IUCV ANY PRIORITY MSGLIMIT 50
IUCV ALLOW MSGLIMIT 255
MACH XA
OPTION QUICKDSP MAXCONN 300
CONSOLE 0009 3215 T OPERATOR
SPOOL 000C 2540 READER *
SPOOL 000D 2540 PUNCH A
SPOOL 000E 1403 A
```

MDISK 0200 3390 DEVNO A26E MWV XXXXXXXX XXXXXXXX XXXXXXXX

MDISK 0300 3390 DEVNO A36E MWV XXXXXXXX XXXXXXXX XXXXXXXX

*DVHOPT LNK0 LOG1 RCM1 SMS0 NPW1 LNGAMENG PWC20230912 CRCE

DVHREV3356I The following are your user option settings:

DVHREV3356I Links DISABLED Logging ON RcvMsg ON Smsg OFF NeedPW ON

DVHREV3356I Lang AMENG

DVHREV3357I The following links are in effect to your virtual machine:

DVHREV3357I To your 0191 as their 0001, Mode RRD by user ID RACSMF-1

DVHREV3357I To your 0301 as their 0301, Mode MRD by user ID RACSMF-1

DVHREV3357I To your 0302 as their 0302, Mode MRD by user ID RACSMF-1


```

DVHREV3357I To your 0191 as their 0001, Mode RRD by user ID RACSMF-2
DVHREV3357I To your 0301 as their 0301, Mode MRD by user ID RACSMF-2
DVHREV3357I To your 0302 as their 0302, Mode MRD by user ID RACSMF-2
DVHREV3357I To your 0200 as their 0200, Mode MW by user ID RACMNT-1
DVHREV3357I To your 0300 as their 0300, Mode MW by user ID RACMNT-1
DVHREV3357I To your 0301 as their 0301, Mode MR by user ID RACMNT-1
DVHREV3357I To your 0302 as their 0302, Mode MR by user ID RACMNT-1
DVHREV3357I To your 0200 as their 0200, Mode MW by user ID RACMNT-2
DVHREV3357I To your 0300 as their 0300, Mode MW by user ID RACMNT-2
DVHREV3357I To your 0301 as their 0301, Mode MR by user ID RACMNT-2
DVHREV3357I To your 0302 as their 0302, Mode MR by user ID RACMNT-2
DVHREV3357I To your 0305 as their 0305, Mode RR by user ID IBMUSER
DVHREV3357I To your 0305 as their 0305, Mode RR by user ID SYSADMIN
* * * End of File * * *

```

Defining the RACF database disks as shared

The RACF database DASD must be defined to CP as shared by adding **RDEVICE** statements to the SYSTEM CONFIG file for the SSI cluster. SYSTEM CONFIG is on PMAINT CFO. For this example, we add the following statements to SYSTEM CONFIG:

```

RDevice A26E Type DASD Shared YES
RDevice A36E Type DASD Shared YES

```

Note: Run the **CPSYNTAX** utility over your SYSTEM CONFIG file after making any changes. In an SSI configuration, you must use the **LPAR** option to test the SSI multi-configuration nature of SYSTEM CONFIG. Run this once for each logical partition (LPAR) in your SSI configuration, even if you believe that you made a change that needs to be tested once.

Defining the initial RACF database

After defining the new full pack minidisks for the RACF database, you must initialize the disks. An easy way to do this is to copy the existing supplied database minidisks by using DDR. In this example, we did this by using the process that is shown in Example 3-2.

Example 3-2 Use DDR to initialize the RACF database disks

```

link racfvm f200 1200 rr
Ready; T=0.01/0.01 11:50:09
link racfvm 200 2200 w
Ready; T=0.01/0.01 11:52:59
ddr
z/VM DASD DUMP/RESTORE PROGRAM
ENTER:
sysprint cons
ENTER:
input 1200 dasd
ENTER:
output 2200 dasd scratch
ENTER:
copy all
HCPDDR711D VOLID READ IS RACF
DO YOU WISH TO CONTINUE? RESPOND YES, NO OR REREAD:
yes
COPYING RACF
COPYING DATA 06/14/16 AT 15.54.06 GMT FROM RACF TO SCRATCH
INPUT CYLINDER EXTENTS OUTPUT CYLINDER EXTENTS

```

```

                START      STOP      START      STOP
                0          16          0          16
END OF COPY
ENTER:

END OF JOB
Ready; T=0.01/0.01 11:54:12
det 1200 2200
1200 2200 DETACHED
Ready; T=0.01/0.01 11:55:36
link racfvm f300 1300 rr
Ready; T=0.01/0.01 11:55:52
link racfvm 300 2300 w
Ready; T=0.01/0.01 11:56:03
ddr
z/VM DASD DUMP/RESTORE PROGRAM
ENTER:
sysprint cons
ENTER:
input 1300 dasd
ENTER:
output 2300 dasd scratch
ENTER:
copy all
HCPDDR711D VOLID READ IS RACFBK
DO YOU WISH TO CONTINUE? RESPOND YES, NO OR REREAD:
yes
COPYING RACFBK
COPYING DATA 06/14/16 AT 15.56.53 GMT FROM RACFBK TO SCRATCH
INPUT CYLINDER EXTENTS      OUTPUT CYLINDER EXTENTS
                START      STOP      START      STOP
                0          16          0          16
END OF COPY
ENTER:

END OF JOB
Ready; T=0.01/0.01 11:56:56
det 1300 2300
1300 2300 DETACHED
Ready; T=0.01/0.01 11:57:01

```

The volume label that is read from the source disk in each DDR step helps you ensure that the correct disk is being copied. “RACF” and “RACFBK” are the labels that are expected on the primary and backup disks.

Defining RACF user IDs

Note: *z/VM RACF Security Server System Programmer's Guide*, SC24-6312 describes how to move from minidisk to full-pack if an increase in the database allocation is needed.

The following VMs are defined in a default CP directory:

7VMRAC30 Product owning VM (This is a release-specific user ID and changes with every new release of z/VM.)

RACFVM	Production VM
RACFSMF	SMF VM
RACMAINT	Backup VM
IBMUSER	Initial RACF administrator
AUTOLOG1	System startup machine
AUTOLOG2	System startup machine
SYSADMIN	Authorized RACF administrator

Users with NOLOG password

In a normal z/VM installation, several user IDs are defined with the password NOLOG. *z/VM RACF Security Server Security Administrator's Guide*, SC24-6311 describes two ways to handle such users:

- ▶ Leave the password as NOLOG.

RPIDIRCT defines these users as protected and revoked by setting the NOPASSWORD, NOPHRASE, and REVOKED attributes. However, because NOLOG is a special reserved password to CP that prevents access, a logon request from such a user cannot be passed to RACF. This means that if such a user must be able to access the system in the future, both the CP directory and RACF must be updated to activate the user.

- ▶ Change the password to UNLOG.

Similar to the NOLOG password, **RPIDIRCT** defines these users as protected and revoked by setting the NOPASSWORD, NOPHRASE, and REVOKED attributes. UNLOG is not a CP reserved password, so CP passes a logon request for such a user to RACF. This means that the user can be given system access in the future only by performing a RACF update.

What you decide to do here depends on the local security policy and procedure, and whether you intend to use the DirMaint-RACF connector. The password management code in the connector handles what to do with privileged passwords such as NOLOG, so changing the directory before setting up RACF yields little advantage.

Note: **RPIDIRCT** creates a user with a NOLOG or UNLOG password with the NOPASS, NOPHRASE, and REVOKED set. However, the DirMaint-RACF connector sets only REVOKED for a NOLOG user. If your installation does all password management by using DirMaint, this is not an issue because the connector resets the password field in RACF if the user is migrated out of NOLOG status.

If you decide to change the NOLOG passwords to UNLOG, proceed with “Changing NOLOG to UNLOG”. If you decide not to, continue with “Evaluating the minidisk access” on page 44.

Changing NOLOG to UNLOG

To perform this change, you must determine what file is used for the source directory while implementing RACF. If you implemented DirMaint, then you must obtain a copy of the USER WITHPASS file from the DIRMAINT VM, as shown in Example 3-3 on page 43. If you have not implemented DirMaint, you can use a copy of the USER DIRECT file on MAINT's 2CC disk. When you receive this file, save it as an *A2* file to allow the RACF user ID to access the file in later steps. This file is required when the **RPIDIRCT EXEC** runs later.

Example 3-3 DIRM USER WITHPASS

```
dirm user withpass
DVHXMT1191I Your USER request has been sent for processing.
Ready; T=0.03/0.03 11:38:50
```

DVHREQ2288I Your USER request for MAINT at * has been accepted.
 RDR FILE 0012 SENT FROM DIRMAINT PUN WAS 0020 RECS 2261 CPY 001 A NOHOLD
 DVHREQ2289I Your USER request for MAINT at * has completed; with RC = 0.

receive 12 user withpass a2 (replace

File USER WITHPASS A2 replaced USER WITHPASS A0 with USER WITHPASS A0 rec
 from DIRMAINT at VMLINUX5

Ready; T=0.01/0.01 11:39:15

The easy way is to perform a global XEDIT **change** command and change NOLOG to UNLOG within the file, as shown in Figure 3-1.

```

USER      WITHPASS A2  F 80  Trunc=80 Size=220
===> ch /NOLOG/UNLOG/*
  90 USER $ALLOC$  NOLOG
  96 USER $DIRECT$ NOLOG
 100 USER $SYSCKP$ NOLOG
 104 USER $SYSWRM$ NOLOG
 108 USER $PAGE$   NOLOG
 112 USER $SPOOL$  NOLOG
 116 USER $TDISK$  NOLOG
 728 USER ROOT NOLOG 32M 32M G
 732 USER DAEMON NOLOG 32M 32M G
 736 USER BIN NOLOG 32M 32M G
 740 USER SYS NOLOG 32M 32M G
 744 USER ADM NOLOG 32M 32M G
 748 USER NOBODY NOLOG 32M 32M G
 752 USER DEFAULT NOLOG 32M 32M G
2203 * * * End of File * * *
```

Figure 3-1 USER WITHPASS

Evaluating the minidisk access

A z/VM system has several user minidisks with a read password of ALL, which means that the disk is accessible to all users on the system without asking for a password. This is usually for disks that contain programs that can be used by all users on the system. MAINT 190 and TCPMAINT 592 are examples (CMS and TCP/IP clients). The **RPIDIRCT EXEC**, which is used in the RACF installation process to create RACF authorization commands from CP directory entries, uses the UACC (universal access) attribute of the created resource to make an equivalent:

```
RDEFINE VMMDISK MAINT.190 OWNER(MAINT) UACC(READ)
```

Auditors often flag any profile with UACC(READ) as a potential area for information leakage, and recommend UACC(NONE) be used instead. On z/OS, it is a preferred practice to use a PERMIT ACL specifying ID(*) in place of UACC(READ). Review the passwords on your system before running **RPIDIRCT**.

Running RPIDIRCT

RPIDIRCT EXEC is used to generate the RPIDIRCT SYSUT1 file that contains all the RACF commands to add the users to define the RACF classes such as VMMDISK and VMRDR,

and to permit the owners to the resources. This exec is run from the product owning VM for RACF.

Before you run the exec, you must obtain a copy of the current user directory. If you do not use a directory manager (such as DirMaint), the directory is contained in the file USER DIRECT on PMAINT 2CC. If you use DirMaint, you must run the command **DIRM USER WITHPASS** from a DirMaint administration user ID, and make the resulting USER WITHPASS file available to the 6VMRAC30 user. How we performed this on our system is shown in Example 3-4.

Example 3-4 Run DIRM USER WITHPASS

dirm user withpass

DVHXMT1191I Your USER request has been sent for processing to DIRMAINT
DVHXMT1191I at ITS0VM1.

Ready; T=0.01/0.01 15:39:48

DVHREQ2288I Your USER request for VIC at * has been accepted.

RDR FILE 0065 SENT FROM DIRMAINT PUN WAS 4381 RECS 5673 CPY 001 A NOHOLD NOKEEP

DVHREQ2289I Your USER request for VIC at * has completed; with RC = 0.

receive 65

File USER WITHPASS A0 created from USER WITHPASS A0 received from DIRMAINT at IT
SOZVM1

Ready; T=0.01/0.01 15:39:54

sendf user withpass a to 7vmrac30

File USER WITHPASS A0 sent to 7VMRAC30 at ITS0ZVM1 on 06/13/16 15:40:01

Ready; T=0.01/0.01 15:40:02

On 7VMRAC30, we used the **RECEIVE** command to accept the file that is sent from our administrator user.

You also must access the 7VMRAC30 651 disk, which is where the **RPIDIRCT EXEC** is.

Because **RPIDIRCT EXEC** generates much output, run the **cp term more 0 0** command before running the exec. This makes the exec run without you having to clear the panel repeatedly. However, if you do this, spool your terminal in case an error is encountered and you need to discover what happened. Preparation for running **RPIDIRCT** is shown in Figure 3-2.

```
RDR FILE 0005 SENT FROM VIC          PUN WAS 0069 RECS 5673 CPY 001 A
NOHOLD NOKEEP

receive 5
File USER WITHPASS A0 created from USER WITHPASS A0 received from
VIC at ITS0ZVM1
Ready; T=0.01/0.01 15:46:22

acc 651 e
Ready; T=0.01/0.01 15:48:58

cp spool console * start
Ready; T=0.01/0.01 15:49:14

cp term more 0 0
```

Figure 3-2 Set up to run RPIDIRCT EXEC

When you run the **RPIDIRCT EXEC**, you must provide the file name and file type of the source directory file. It searches for the file on all accessed disks. The default output file mode is *A*.

When the exec starts, it prompts you to change the default group ID. We used the default, so we replied *N* to the question.

Figure 3-3 shows an example of the `rpidirct user withpass` command.

```

USER WITHPASS Filemode defaulted to "*".
Output defaulted to "A" disk.
  Default group ID = SYS1.
  Would you like to change this default?
  Enter Y/N
N
  Default group ID = SYS1.

PROFILE IBMDFLT

PROFILE TCPCMSU

PROFILE TCPGCSU
----- 4277 line(s) not displayed -----

***** 5531 Directory records processed *****
***** RPIDIRCT SYSUT1 CREATED *****

```

Figure 3-3 Run `RPIDIRCT EXEC`

z/VM: Secure Configuration Guide, SC24-6323 suggests that, after running `RPIDIRCT`, you modify the resulting `RPIDIRCT SYSUT1` file in the following ways:

- ▶ Alter the VMRDR profile for MAINT730 to specify UACC (UPDATE).
- ▶ Add any additional PERMITs that are required.

Updating the MAINT730 profile in VMRDR is required for the correct operation of the `SERVICE EXEC`, as described in *Program Directory for RACF Security Server*, GI13-4364-02.

Make the same changes to the following VMs:

TCPMAINT	The TCP/IP daemon VMs spool their console to TCPMAINT.
DIRMAINT	Makes the <code>DIRM SEND</code> command work.
DATAMOVE	Allows DIRMAINT to send files to DATAMOVE (2, 3, and 4, too).
DIRMSATn	Allows the correct DirMaint operation across the SSI cluster.

Other additional permits are required.

RPIDIRCT processing of VMLAN

`RPIDIRCT` detects network connections that are defined by using the `NICDEF` directory control statement. If you use other methods for granting access to Virtual Switches or Guest LANs (such as `SET VSWITCH GRANT` commands in `COMMAND` directory control statements, or command scripts like `AUTOLOG1 PROFILE EXEC`), these are not processed by `RPIDIRCT`. You must analyze these other access control methods, and add appropriate RACF `RDEFINE` and `PERMIT` commands to `RPIDIRCT SYSUT1` to give the required access. It is highly recommended that you execute `CPSYNTAX` against a given user directory entry in order to validate correctness before running `RPIDIRCT`.

`RPIDIRCT` will grant access for that virtual machine based upon the definitions provided. It will not validate whether access to any particular VLAN is appropriate, or whether the Virtual

Switch or Guest LAN specified exists. RPIDIRCT will do neither syntax checking or semantic checking of network configuration. It is highly recommended that you execute CPSYNTAX against a given user directory entry in order to validate correctness before running RPIDIRCT.

- a. Scan the RPIDIRCT SYSUT1 file to see whether an **RDEFINE** command exists for the VLAN ID on the VSWITCH or Guest LAN. If there is none, add the appropriate **RDEFINE** commands to RPIDIRCT SYSUT1 (a separate **RDEFINE** is needed for each VLAN given on the **SET VSWITCH GRANT** command):

```
RDEFINE VMLAN SYSTEM.VSW1.0201 UACC(NONE)
```

- b. Add the appropriate **PERMIT** command (or commands) to RPIDIRCT SYSUT1:

```
PERMIT SYSTEM.VSW1.0201 CLASS(VMLAN) ID(LNXS0006) ACC(UPDATE)
```

Note: If you have many guest virtual network connections or a complex virtual network configuration, you might decide to leave activating the VMLAN class until after the rest of RACF configuration is stabilized. You can defer the activation of VMLAN until a later time by commenting out the **SETROPTS CLASSACT(VMLAN)** command from the RPIDIRCT SYSUT1 file. Resource profiles and permit statements that are contained in RPIDIRCT SYSUT1 are defined to the RACF database, but the class will not be activated, so your existing virtual network permission structure is retained.

Take the time to implement VMLAN at RACF installation time. It might not be feasible to return at a later time and implement the required changes.

Customizing the processing of SMF records

One of the reasons that you run RACF on your z/VM system is to audit who is doing what on the system. This auditing requires the configuration of SMF to record reliably the audit information that is captured by RACF. To use the RACFSMF VM, you must set up the PROFILE EXEC and the SMF CONTROL files by completing the following tasks:

- ▶ Creating the RACFSMF PROFILE EXEC
- ▶ Modifying the SMF CONTROL file

Creating the RACFSMF PROFILE EXEC

You create the PROFILE EXEC by copying the SMFPROF EXEC from the RACFVM 305 minidisk, as shown in Example 3-5.

Example 3-5 Create the PROFILE EXEC for RACFSMF

```
link racfvm 305 305 rr
DASD 0305 LINKED R/O; R/W BY RACFVM   at ITS0ZVM4
Ready;
  acc 305 e
DMSACP723I E (305) R/O
Ready;
  link racfsmf 191 291 mr
Ready;
  acc 291 m
Ready;
  copy smfprof exec e profile exec m
Ready;
```

After you copy the file, modify the **SMFFREQ** and **SMFSWTCH** parameters to match Example 3-6.

Example 3-6 RACFSMF's PROFILE EXEC

```

PROFILE EXEC      M1 V 130 Trunc=130 Size=428 Line=124 Col=1
====>
124 Smfpct      = 80
125 Smfinfo    = 'OPERATOR'      /* Default message \r
126 Smffreq    = ' AUTO '        /* Valid values: DAILY, WEEKLY,
127                                     /*          AUTO
128 Smfday     = 'MONDAY'        /* Valid values: SATURDAY - FRI
129 Smfswtch   = ' NO '          /* Valid values: YES NO
130 /* 1 line deleted
131 hi = '1de8'x
132 lo = '1d60'x

```

Modifying the SMF CONTROL file

The Program Directory tells you to detach the RACFSMF 191 disk when you complete the work on the PROFILE EXEC. However, the next step tells you to link and access this disk again because you need to copy the SMF CONTROL file to several disks. The SMF CONTROL file is on the RACFVM 191 disk. The directions tell you to copy it to the RACFSMF 191 disk, modify it, and then copy it back to the original disk. It is easier to modify the one on the RACFVM disk and then copy it to the two other disks.

Link and access the appropriate disk. Because you still have the RACFSMF 191 disk, you can complete the steps in Example 3-7.

Example 3-7 Access the appropriate disk

```

link racfvm 191 391 mw
DASD 0391 LINKED R/W; R/W BY RACFVM at ITS0ZVM4
Ready;
  link racmaint 191 491 mr
Ready;
  acc 391 n
Ready;
  acc 491 o
Ready;

```

Edit the SMF CONTROL file on the *N* disk (which is the RACFVM 191 disk). Make the change that is shown in Example 3-8 on page 49. The **SEVER** keyword determines RACF behavior if the SMF disks are filled. If **SEVER** is set to NO, then auditing continues with newer SMF data overwriting older audit records. If **SEVER** is set to YES, then RACF ceases operations because it cannot audit security relevant events on the hypervisor. The **SEVER** keyword is initially set to NO. If you choose to set **SEVER** to YES, RACF severs the path between CP and RACF when the SMF disks are full, and RACF cannot continue recording SMF records.

The file contains only one line, so it is split into two lines for readability.

Example 3-8 SMF CONTROL

```
SMF      CONTROL N1 F 100 Trunc=100 Size=2
====>
* * * Top of File * * *
CURRENT 301 K PRIMARY 301 K SECONDARY 302 K
10000 VMSP CLOSE 001 SEVER YES 0 RACFSMF
* * * End of File * * *
```

After modifying this file, you have to copy it to the *M* and *O* disks. Then, the **flist smf control *** command should return results similar to those shown in Example 3-9.

Example 3-9 File list of SMF CONTROL

LVL	0	-----	SMF	CONTROL	*-----	FILE	1	OF	4
SMF	CONTROL	E1	F	100	1	1	11/29/05	12:57	
SMF	CONTROL	M1	F	100	1	1	6/22/16	14:52	
SMF	CONTROL	N1	F	100	1	1	6/22/16	14:40	
SMF	CONTROL	O1	F	100	1	1	6/22/16	14:51	

The SMF CONTROL file on the *E* disk is your original file on the RACFVM 305 disk, and it should not be changed. Now, you can detach the 291, 391, and 491 disks.

Password encryption algorithm

In z/VM 7.3, RACF for z/VM uses a password encryption method that is known as *KDFAES*. This method uses strong encryption, supported by the hardware CPACF feature, to protect the RACF database from an offline attack. As a preferred practice, use KDFAES. To activate KDFAES, run the following command:

```
SETROPTS PASSWORD(ALGORITHM(KDFAES))
```

Note: For more information about enabling and working with KDFAES, including considerations for enabling this mode, see “The RACF KDFAES algorithm” on page 99.

If KDFAES is not used, the RACF exit ICHDEX01 controls whether masking or DES encryption is used for password encryption. If the IBM supplied ICHDEX01 exit is present and active, RACF password masking is used. If the ICHDEX01 exit is deactivated or not present, RACF DES encryption is used. RACF DES encryption is recommended over the masking technique. Before RACF function level 540 (z/VM 5.4) the ICHDEX01 exit had to be deleted to allow RACF DES encryption to take place. From RACF FL540 onward, the ICHDEX01 exist is disabled by default.

You should use the VMSES/E process to create a local modification to this load library. A local copy of the **RPIBLLPA EXEC** should be created and the local modification should be logged in the local version vector table for the product. The local version vector table is nothing more than a log file of the parts you have performed local service for. It is important to complete these steps so that future IBM service to this part does not overlay your local modifications.

The first step in deleting this member of the RACFLPA LOADLIB is to establish the 6VMRAC30 minidisk order. In this example, we used the VMSES/E exec VMFSETUP to perform this step (Example 3-10).

Example 3-10 VMFSETUP for RACF

```
ac 590 t
DMSACC724I 590 replaces T (590)
Ready; T=0.01/0.01 09:15:46
```

vmfsetup 7vmrac30 racf

```

VMFSET2760I VMFSETUP processing started for 7VMRAC30 RACF
VMFUTL2205I Minidisk|Directory Assignments:
          String  Mode  Stat  Vdev  Label/Directory
VMFUTL2205I LOCALSAM  E    R/W  2C2   RAC2C2
VMFUTL2205I APPLY    F    R/W  2A6   RAC2A6
VMFUTL2205I          G    R/W  2A2   RAC2A2
VMFUTL2205I DELTA    H    R/W  2D2   RAC2D2
VMFUTL2205I BUILD0   I    R/W  29E   RAC29E
VMFUTL2205I BUILD6   J    R/W  599   RAC599
VMFUTL2205I BUILD4   K    R/W  505   RAC505
VMFUTL2205I BUILD2   T    R/W  590   RAC590
VMFUTL2205I BASE     U    R/W  2B2   RAC2B2
VMFUTL2205I -----  A    R/W  191   RAC191
VMFUTL2205I -----  B    R/O  5E5   MNT5E5
VMFUTL2205I -----  D    R/W  51D   MNT51D
VMFUTL2205I -----  S    R/O  190   MNT190
VMFUTL2205I -----  Y/S  R/O  19E   MNT19E
VMFSET2760I VMFSETUP processing completed successfully

```

The next step is to determine the highest level of service to the build list for the RACFLPA load library by using the **VMFSIM EXEC** with the **GETLVL** parameter. The exec searches all of the version vector tables for this product and determine the highest level of service. It returns the file name and file type of that part. If you do not run the **VMFSETUP** exec before you run the **VMFSIM** exec, you do not get the correct results.

Example 3-11 shows the **vmfsim getlvl** command. It gives you the file name and file type of the file that you need to copy to create your file.

Example 3-11 The vmfsim getlvl command

```

vmfsim getlvl 7VMRAC30 RACF tdata :part rpibllpa exc (history
:PART RPIBLLPA EXC00000 BASE-FILETYPE
Ready; T=0.06/0.06 09:20:43

```

The output from the **vmfsim getlvl** command lists this element as **BASE-FILETYPE**. In VMSES/E terminology, it means that there has been no service to this part by IBM or locally by a system programmer (no entries in the IBM and Local Version Vector Tables). In our case, we use the **RPIBLLPA EXEC**. You must determine on which disk the base file is. Copy the highest level of the build list to the 2C2 local disk (E-disk).

Use the following syntax:

```
copyfile blist ft * = exclnnnn 2c2_fm
```

Where **blist** is the file name to be copied, **ft** is the file type, **nnnn** is a local tracking number that you supply, and **2c2_fm** is the filemode of the 2C2 minidisk. Because this is the first modification to this file, we use 0001 as the **nnnn** value and file mode e to reflect the 2C2 minidisk, as follows:

```
copyfile rpibllpa exec u = excl0001 e
```

Modify the **RPIBLLPA EXCL0001** on the E disk and comment out the entry for the **ICHRCX02** member, as shown in Example 3-12.

Example 3-12 RPIBLLPA EXCL0001

```
RPIBLLPA EXCL0001 E1 F 80 Trunc=80 Size=749 Line=456 C
====>
456 *
457 *:OBJNAME. ICHRCX02 LEPARMS RENT REUS LET NCAL XREF
458 *:BLDREQ. RPIBLOBJ.ICHRCX02
459 *:OPTIONS. CONCAT SYSLIB RACFOBJ
460 *:OPTIONS. INCLUDE RACFOBJ(ICHRCX02)
461 *:OPTIONS. ENTRY ICHRCX02
462 *:EOBJNAME.
463 *
```

Log this local modification to the **RPIBLLPA EXEC** into the local version vector table. In prior releases of z/VM, the **VMFSIM MODIFY** command was used. Starting with z/VM 5.2.0, you can use the **VMFSIM LOGMOD** command with more user-friendly syntax:

```
vmfsim logmod 7VMRAC30 vvtlcl e tdata :mod lcl0001 :part rpibllpa exc
```

The 2C2 disk should now contain 7VMRAC30 VVTLCL and RPIBLLPA EXCL0001 files. Example 3-13 shows the content of the 7VMRAC30 file.

Example 3-13 File list of the 2C2 disk

```
7VMRAC30 FILELIST A0 V 169 Trunc=169 Size=2 Line=1 Col=1 Alt=0
Cmd  Filename Filetype Fm Format Lrecl  Records  Blocks  Date
      7VMRAC30 VVTLCL  E1 V      32      1      1 6/14/16
      RPIBLLPA EXCL0001 E1 F      80     749     15 6/14/16
```

```
7VMRAC30 VVTLCL  E1 V 80 Trunc=80 Size=1
====>
0 * * * Top of File * * *
1 :PART.RPIBLLPA EXC :MOD.LCL0001
2 * * * End of File * * *
```

Next, generate a new RACFLPA LOADLIB by using the **VMFBLD** command. When you run the command, make sure that you specify the **blist** parameter (in this case, **rpibllpa**). If you do not, then all build lists that are listed in the BLD section of the 7VMRAC30 PPF file will be built (Example 3-14).

Example 3-14 VMFBLD process for loadlib

```

VMFBLD2195I VMFBLD PPF 7VMRAC30 RACF RPIBLLPA ( LOG CNTRL RPIVM NOCKVV
          NOSETUP ALL
VMFBLD2760I VMFBLD processing started
VMFUTL2205I Minidisk|Directory Assignments:
          String  Mode  Stat  Vdev  Label/Directory
VMFUTL2205I LOCALSAM E      R/W  2C2   RAC2C2
----- 13 line(s) not displayed -----
VMFBLD1851I Reading build lists
VMFBLD2182I Identifying new build requirements
VMFBLD2182I New build requirements identified
VMFBLD1851I (1 of 1) VMFBDLLB processing RPIBLLPA EXCL0001 E, target
          is BUILD4 505 (K)
VMFLLB2217I RACFLPA LOADLIB will be rebuilt because all members must
          be rebuilt
----- 66 line(s) not displayed -----
VMFBLD1851I (1 of 1) VMFBDLLB completed with return code 0
VMFBLD2180I There are 0 build requirements remaining
VMFBLD2760I VMFBLD processing completed successfully

```

To place the new local modification into production, you must link to the RACFVM 305 disk and then use the **VMFCOPY** command to copy the files to the production disk (Example 3-15). The **VMFCOPY** updates the VMSES PARTCAT file on the 305 disk.

Example 3-15 Place changes into production

```

link RACFVM 305 305 MR
acc 505 e
acc 305 f
vmfcopy RACFLPA * e = = f (prodid 7VMRAC30%RACF replace oldd)

```

3.2.2 Building the RACF enabled CPLOAD MODULE

Make sure that you have logged off from the RACF product owner VM and logged on to the MAINT730 VM. When the **PROFILE EXEC** completes running, you have all the required disks that are accessed.

The RACF product is shipped on the system in a disabled state. You can use the VMSES/E command **SERVICE** to enable the product, and to generate a CPLOAD MODULE that enables RACF to CP. This new CP nucleus requires that RACF is active on the system to manage authentication. The initial settings for RACF are that if a resource is not defined to RACF, then the decision on the access request is deferred to CP. Later in this setup process, you change this setting to secure the system so that all resources must be defined to RACF or the request for access fails.

Run the **service racf enable** command. The result should be a successful completion.

Note: The new CP nucleus, with the RACF CP parts, is placed on the secondary parm disk (MAINT730 CF2). For your information, a copy of the previous (or currently running) CPLOAD MODULE is still on the primary (CF1) and tertiary (CF3) parm disks as CPLOAD MODULE. It is also saved on the secondary parm disk as CPLOLD MODULE.

When the product is enabled dynamically, the configuring of RACF by the service exec sets a flag in a VMSES/E software inventory table. This flag causes the CP nucleus to be built by using the RACF versions of the HCPRWA, HCPRPD, HCPRPW, HCPRPI, HCPRPG, and HCPRPF files. The **SERVICE EXEC** then generates a new CPLOAD MODULE and places it on the CF2 disk only (it is moved to the other parm disks in a later step).

When the **SERVICE EXEC** completes, issue the **VMFVIEW** command to verify that there are no problems.

Run an IPL of your system with RACF in test mode

To prepare for the next step, you also must find the device address of the volume on which the alternate parm disk is (MAINT730 CF2; on our system, it was on the 730RL1 volume). Shut down your system and then, by using the **LOADPARM** option, run an IPL of your system again. The z/VM stand-alone program loader starts.

Note: When z/VM SSI was introduced, the locations and roles of the parm disks changed. Previously, all of the parm disks were owned by MAINT and contained the CP nucleus, system configuration file, and logo configuration. With SSI, a new parm disk that is owned by the PMAINT user holds the system and logo configuration files, a second parm disk that is owned by the MAINT730 user is used during the service process, and a separate pair of disks that is owned by MAINT on each member of the SSI cluster holds the CP nucleus for that member.

You must start z/VM by using the new RACF-enabled CP nucleus that was generated by the SERVICE process. From the SAPL panel, enter the device address of the alternate parm disk volume.

Note: If Auto_Warm_IPL is coded in your SYSTEM CONFIG file, you must also add the IPL parameter **PROMPT** on the SALIPL panel.

You can verify that you can access the correct module by pressing PF9 to show the file list of the designated parm disk. The file list should look something like Example 3-16.

Example 3-16 File list of the alternate parm disk

```
STAND ALONE PROGRAM LOADER: z/VM VERSION 7 RELEASE 3.0
FILENAME FILETYPE FORMAT LRECL   RECORDS   BLOCKS   DATE       TIME
CPLOAD   MODULE   V      65535     190      3018 2023/06/14 16:53:55
CPLOLD   MODULE   V      65535     190      3011 2023/03/09 15:48:14
```

3=QUIT 4=SORT(TYPE) 5=SORT(DATE) 6=SORT(NAME) 7=BACK 8=FORWARD 11=SELECT

The CPLOAD MODULE has a recent time stamp, and is slightly larger than the CPLOLD MODULE (which is the previous non-RACF CP nucleus). Press PF3 to return to the SAPL panel.

When everything is ready, press PF10 to start the IPL.

During the IPL process, you must perform a **NOAUTOLOG** start and change the time of day if required (Figure). The **NOAUTOLOG** option tells the system *not* to start the AUTOLOG1 VM. Therefore, no other VMs are started automatically.

When the IPL completes, you start RACMAINT VM with the **xautolog racmaint** command. The reason for starting RACMAINT instead of RACFVM is that in a later step you run the **PUT2PROD** exec. This exec copies files to the RACFVM VM disks. RACMAINT links to those disks to run in READ ONLY mode, thus allowing MAINT and the **PUT2PROD** exec to gain write access to the disks owned by RACFVM.

When the RACMAINT VM logs on and runs the **PROFILE EXEC**, it runs **RACSTART EXEC**. This causes this VM to be defined as the ESM for your system. You can ignore the messages about the 591 and 505 disk not being accessed. This does not cause a problem. You can now disconnect from the OPERATOR VM.

3.2.3 Updating the RACF database and options

The following tasks are needed to update the RACF database with information from the CP directory and to set up options for the RACF environment.

Updating the RACF database with an existing CP directory

Log on to the IBMUSER VM. This VM is defined to have RACF special and operations authority in the initial RACF database that was shipped with the system. The password for this VM is *SYSI*, and you must change the password the first time that you log on.

From the VM, complete the following tasks:

1. Set a PF key to retrieve commands.
2. Run **RPIBLDDS** to build the RACF database.
3. Define the security administrator.

Before you can build the RACF database, you must link to several of the product owners' disks and access them (see Figure):

- ▶ 191 - Location of the **RPIDIRCT SYSUT1** file
- ▶ 305 - Location of the **RPIBLDDS EXEC**
- ▶ 29E - Location of the **RAC EXEC**

To do this, run the commands shown in Example 3-17.

Example 3-17 Link to the disks

```
Ready; T=0.01/0.01 15:46:42
set pf12 retrieve
Ready; T=0.01/0.01 15:46:56
link 7vmrac30 505 305 rr
Ready; T=0.01/0.01 15:47:23
link 7vmrac30 191 192 rr
Ready; T=0.01/0.01 15:47:36
link 7vmrac30 29e 29e rr
Ready; T=0.01/0.01 15:47:54
acc 305 c
DMSACP723I C (305) R/O
Ready; T=0.01/0.01 15:48:00
acc 192 b
DMSACP723I B (192) R/O
Ready; T=0.01/0.01 15:48:02
acc 29e d
```

DMSACP723I D (29E) R/O
 Ready; T=0.01/0.01
 15:48:07

The **RPIBLDDS EXEC** is used to modify the RACF DATABASE. It uses the RPIDIRCT SYSUT1 file as input. This file was created earlier by the 7VMRAC30 VM with the **RPIDIRECT EXEC**. It contains all the RACF commands to add users, define resources, and authorize users to resources. Example 3-18 shows RPIBLDDS being run.

Example 3-18 Run RPIBLDDS

rpibldds

```
Using default file RPIDIRCT SYSUT1
Processing batch file RPIDIRCT SYSUT1 using "RAC" command interface
=> RDEFINE VMCMD RACF UACC(READ)
=> RDEFINE VMCMD RAC UACC(READ)
=> ADDGROUP SYSTEM
=> ALTGROUP SYSTEM OVM(GID(0))
=> ADDGROUP STAFF
=> ALTGROUP STAFF OVM(GID(1))
=> ADDGROUP GBIN
. . .

=> RDEFINE VMMDISK MAINT730.5A2 OWNER(MAINT) UACC(NONE)
=> PERMIT MAINT730.5A2 CLASS(VMMDISK) RESET ID(MAINT730) AC(ALTER)
=> RDEFINE VMMDISK MAINT730.5A4 OWNER(MAINT) UACC(NONE)
=> PERMIT MAINT730.5A2 CLASS(VMMDISK) RESET ID(MAINT730) AC(ALTER) =>
=> RDEFINE VMMDISK MAINT730.5A6 OWNER(MAINT) UACC(NONE)
=> PERMIT MAINT730.5A2 CLASS(VMMDISK) RESET ID(MAINT730) AC(ALTER) . . .
. . .

=> PERMIT MAINT730.400 CLASS(VMMDISK) ID(LOHCOST)) ACCESS(READ)
*
=> PERMIT XCAT.191 CLASS(VMMDISK) ID(ZHCP) ACCESS(READ)
=> PERMIT MAINT730.400 CLASS(VMMDISK) ID(ZHCP) ACCESS(READ)
*
=> PERMIT MAINT730.400 CLASS(VMMDISK) ID(XCAT) ACCESS(READ)
Ready;
```

When the **RPIBLDDS EXEC** completes, your RACF database is initialized with all the VMs and resources that were shipped with the z/VM system. Now, you create additional RACF administrators. You must determine what VMs are trusted to manage your secure environment.

The user IDs that are part of the system maintenance process (VMSES/E) must have authority to access minidisks across the system. For this reason, the RACF Program Directory recommends the following VMs be given OPERATIONS authority:

- ▶ MAINT730
- ▶ BLDSEG
- ▶ BLDRACF
- ▶ BLDNUC
- ▶ BLDCMS
- ▶ MIGMAINT

The RACF `altuser` command is used to modify the RACF attributes for a VM (Example 3-19).

Example 3-19 Set RACF attributes

```

rac alu maint730 operations
Ready; T=0.01/0.01 11:49:44
rac alu bldseg operations
Ready; T=0.01/0.01 11:49:53
rac alu bldracf operations
Ready; T=0.01/0.01 11:50:02
rac alu bldnuc operations
Ready; T=0.01/0.01 11:50:04
rac alu bldcms operations
Ready; T=0.01/0.01 11:50:07
rac alu migmaint operations
Ready; T=0.01/0.01 11:50:12

```

Note: A highly experienced RACF administrator with extensive knowledge of VMSES/E might be able to set up RACF profiles and permissions that allow access to the required resources without the OPERATIONS attribute. Because the maintenance of z/VM and its features is of critical importance to the system operation, this is not an area to be taken lightly. For the majority of installations, the recommended approach of using OPERATIONS is the preferred method.

OPERATOR and SPECIAL

It is sometimes suggested that the OPERATOR ID be given the SPECIAL attribute as opposed to the Auditor or Read-Only Audit (ROAUDIT) attributes. It is not a preferred practice because in most installations, access to OPERATOR is broad and uncontrolled. Even with the access controls that are described in 2.1.7, “Role-based access controls and CP privilege classes” on page 18, OPERATOR is visible to users without security management responsibility.

One case that is cited as a reason for giving this access is when an operator inadvertently enters the incorrect time when z/VM is IPLed, resulting in all IDs on the system becoming revoked. This could be mitigated through the use of the `Auto_Warm_IPL` feature statement in `SYSTEM CONFIG`, combined with effective management of the Hardware Management Console (HMC) / SE time-of-day clock to provide accurate time to the LPAR ToD clocks. Alternatively, z/VM supports the Server Time Protocol (STP) hardware feature, which can provide an integrated solution for time-of-day management across all systems running on the z Systems server.

Note: As a preferred practice, before granting the OPERATOR user the SPECIAL attribute, consider all possible alternatives. Giving OPERATOR the system-SPECIAL attribute can greatly impact the overall security and integrity of your z/VM system.

Unloading IBMUSER

After the new RACF administrators are defined, log off from IBMUSER. Log on to MAINT, assuming that you gave MAINT RACF authority, and complete the installation of the product.

Because IBMUSER is a well-known user, it might be a target for unauthorized accesses to your system. To prevent further use of the IBMUSER VM, revoke this VM and remove the operations and special attributes (Example 3-20). *Do not* delete this VM from your system because IBMUSER ran the `exec` to generate the RACF database and it is now listed as the owner of all the other VMs on the system.

Example 3-20 RACF alter user for IBMUSER

```

link 7vmrac30 29e 29e rr
RPIMGR031E RESOURCE 7VMRAC30.29E SPECIFIED BY LINK COMMAND NOT FOUND
Ready; T=0.01/0.01 12:00:18
access 29e l
DMSACP723I L (29E) R/O
Ready; T=0.01/0.01 12:00:23
rac alu ibmuser revoke
Ready; T=0.01/0.01 12:04:01
rac alu ibmuser nospecial
Ready; T=0.01/0.01 12:04:08
rac alu ibmuser nooperation
Ready; T=0.01/0.01 12:04:14

```

Setting RACF options

Now, you should also define which resources should be managed by RACF. The following commands are a good starting point:

```

RAC SETROPTS CLASSACT(VMMDISK)
RAC SETROPTS CLASSACT(VMRDR)
RAC SETROPTS CLASSACT(VMLAN)

```

Other options can be **VMBATC**H and **VMSEGMT**. Also, if your CP directory had **LOGONBY** statements, **RPIDIRCT** created profiles in the SURROGAT class to provide the same function. You must activate the SURROGAT class for your LOGONBY function to work as it did before.

It also is a good task to make the corresponding updates to the VMXEVENT to tailor this entry to your installation. This avoids RACF calls for resources that are not RACF protected and avoids wasting CPU cycles and causing RACF contention. If you are using DirMaint for example, use VMXEVENT to exempt the DirMaint service machines from access checking. Because of the number of users in this example, we create a script to issue the required commands, as recommended in *z/VM: 7.3 Directory Maintenance Facility Tailoring and Administration Guide, SC24-6283*. The script is shown in Example 3-21.

Example 3-21 VMXEVENT EXEC

```

/* REXX */
Parse Upper Arg ID .
If ID = '' Then Do
  Say "Please enter an ID!"
  Exit 1
End
Say "ID" ID "will have a VMXEVENT profile created and populated,"
Say "Enter 'y' to continue:"
Parse Upper Pull Reply
If Left(Reply,1)="Y" Then Do
  Address CMS
  "RAC RDEFINE VMXEVENT USERSEL." || ID
  "RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(LINK/NOCTL)"
  "RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(STORE.C/NOCTL)"
  "RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(TAG/NOCTL)"
  "RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(TRANSFER.D/NOCTL)"
  "RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(TRANSFER.G/NOCTL)"
  "RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(TRSOURCE/NOCTL)"
  "RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(DIAGOD4/NOCTL)"

```

```
"RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(DIAGOE4/NOCTL)"
"RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(RSTDSEG/NOCTL)"
"RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(MDISK/NOCTL)"
"RAC RALTER VMXEVENT USERSEL." || ID || " ADDMEM(APPCPWVL/NOCTL)"
Say "Complete."
End
```

We ran **VMXEVENT EXEC** once for each DirMaint user to be exempted. After the profiles are created for all users, you can activate the VMXEVENT class by using **RAC SETROPTS CLASSACT(VMXEVENT)**. We also issued **RAC SETEVENT REFRESH USERSEL.xxxxxxxx** commands for the logged-on DirMaint service machines (replacing xxxxxxxx for each DirMaint service machine in turn) for the VMXEVENT definition to take place immediately.

Using group permissions rather than exemption

Depending on your security policy, it might not be appropriate to exempt the DirMaint users from checking. Similar to **RPIDIRECT**, a sufficiently experienced RACF administrator can define resource profiles with the correct access lists to avoid having to use exemption. This task is even easier through the use of group-based permissions. For example, a group called **\$DIRMSRV** can be granted appropriate permissions over all the DirMaint server resources, and the DirMaint server user IDs are connected to that group.

This is a task requiring experience in RACF and DirMaint administration, and must not be taken lightly. Follow the installation instructions for DirMaint and use the documented method to exempt the DirMaint users from checking.

Note: The **RAC SETEVENT REFRESH** command must be executed on the z/VM system where the user is logged on to take effect. If the user is not logged on, or is logged on to a different member of the SSI cluster, an error message is received:

```
RPISSET133E SETEVENT FAILED. USER IS NOT CURRENTLY LOGGED ON.
```

To do the refresh, log on to each system in your cluster and issue the refresh for the users who are logged on to that system. Alternatively, restart the affected servers (which can be done remotely from a central system by running the **AT** command).

3.2.4 Placing RACF into production

Important: This step must be repeated for each member of an SSI cluster.

Run **PUT2PROD EXEC** from the MAINT730 VM.

Note: Make sure that you run the **PUT2PROD EXEC** without any parameters because the **\$SERVICE PROD** file on the MAINT730 191 disk already lists the components that must be put into production:

```
SERVICE $PRODS A1 V 80 Trunc=80
 0 * * * Top of File * * *
 1 SERVP2P RACF
 2 SERVP2P CP
 3 * * * End of File * * *
```

When **PUT2PROD** has completed, you should run **vmfview put2prod** to verify that everything was successful.

Setting up AUTOLOG1 and AUTOLOG2

When doing a normal warm start, the IPL process starts the AUTOLOG1 VM. This process is intended to start the VMs that run in your z/VM environment. With RACF in place, it is important to ensure that no VMs are started before RACF is properly initialized. RACF provides an AUTOLOG2 user to accommodate this task. AUTOLOG1 is changed to start only your ESM (RACFVM). After the RACF environment is initialized, RACF runs the **xautolog** command for the AUTOLOG2 VM, which starts the remaining servers for the system.

The existing **PROFILE EXEC** for the AUTOLOG1 VM works perfectly for the AUTOLOG2 VM. So, you can copy it to the appropriate disk. You then must modify **PROFILE EXEC** for AUTOLOG1 to start only the production ESM (RACFVM), as shown in Figure 3-4.

```
link autolog1 191 11 mr
Ready; T=0.01/0.01 12:25:07
link autolog2 191 12 mr
Ready; T=0.01/0.01 12:25:14
ac 11 x
Ready; T=0.01/0.01 12:25:18
acc 12 z
DMSACC724I 012 replaces Z (011)
Ready; T=0.01/0.01 12:25:29
copy profile exec x = z
Ready; T=0.01/0.01 12:25:53

PROFILE EXEC X1 V 130 Trunc=130 Size=7
===>
0 * * * Top of File * * *
1 /*****/
2 /* Autolog1 Profile Exec */
3 /*****/
4 'CP XAUTOLOG RACFVM'
5 'CP LOGOFF'
6 * * * End of File * * *
```

Figure 3-4 Set up the AUTOLOG1 and AUTOLOG2 virtual machines

You should be able to perform an IPL from the CF1 disk (extent 1) and run in production mode.

3.2.5 Using HCPRWAC

Initially, the system is built with non-aggressive authorization checking with the security parameters in the SYSSEC macro. In fact, most of the entries specify the key word *defer*, which means that if the ESM does not know what to do with a request, the request is routed to the system CP for determination. What this looks like in the text of the SYSSEC macro is shown in Figure 3-5.

```

HCPRWA  RPIBASE0 E1 F 80          3 Blks 10/25/06 Line   118 of
====>
      SYSSEC ,                                X
          DISKP=ALLOW,DISKU=DEFER,DISKF=FAIL,DISKW=DEFER,DISKM=ON,X
          RDRP=ALLOW,RDRU=DEFER,RDRF=FAIL,RDRW=DEFER,RDRM=ON,    X
          NODEP=ALLOW,NODEU=DEFER,NODEF=FAIL,NODEW=DEFER,NODEM=ON,X
          CMDP=ALLOW,CMDU=DEFER,CMDF=FAIL,CMDW=DEFER,CMDM=ON,    X
          LANP=ALLOW,LANU=DEFER,LANF=FAIL,LANW=DEFER,LANM=ON,    X
          DEFLTP=ALLOW,DEFLTU=DEFER,DEFLTf=FAIL,DEFLTW=DEFER @L2C
      SPACE 3

```

Figure 3-5 HCPRWA assemble file

This is not a secure model to run the production system. For this reason, after everything is working correctly, change the SYSSEC macro to *fail* instead of *defer*. In the past, this required updating the text of the SYSSEC macro so that it looked like Figure 3-6 and reassembling HCPRWA. To do this before to z/VM 6.3 required the High Level Assembler (HLASM).

```

HCPRWA  RBOL0001 E1 F 80 Trunc=80 Size=137 Line=120 Col=1 Alt=2
====>
      120      SYSSEC ,                                X
      121          DISKP=ALLOW,DISKU=FAIL,DISKF=FAIL,DISKW=FAIL,DISKM=ON, X
      122          RDRP=ALLOW,RDRU=FAIL,RDRF=FAIL,RDRW=FAIL,RDRM=ON,    X
      123          NODEP=ALLOW,NODEU=FAIL,NODEF=FAIL,NODEW=FAIL,NODEM=ON, X
      124          CMDP=ALLOW,CMDU=FAIL,CMDF=FAIL,CMDW=FAIL,CMDM=ON,    X
      125          LANP=ALLOW,LANU=FAIL,LANF=FAIL,LANW=FAIL,LANM=ON,    X
      126          DEFLTP=ALLOW,DEFLTU=DEFER,DEFLTf=FAIL,DEFLTW=DEFER @L2C
      SPACE 3

```

Figure 3-6 Modified HCPRWA assembler

To allow clients that do not have HLASM to move to a more secure configuration, the RACF product is shipped with a pre-assembled version of HCPRWA that contains these changes (among others), known as *HCPRWAC*. The process of how to use HCPRWAC is documented in Appendix D, “Using HCPRWAC”, in *z/VM: Secure Configuration Guide*, SC24-6323.

HCPRWAC is the IBM provided modification of HCPRWA that complies with the requirements of LSPP. This process uses VMFUPDAT to update VM SYSSUF.

Complete the following steps:

1. Run the `vmfupdat syssuf` command. Scroll through the panels until you see the Compname for RACF (Figure 3-7 on page 62).

 *** Update SYSSUF Table Entries ***

Update to any PPF/component name or YES|NO field. To change all occurrences Of a PPF name in the table replace both ***** fields with PPF names.

Component	Prodlev	Prodid	Servlev	Prodlev	Description
RACF		7VMRAC30	000-0000	000-0000	RACF feature of z/VM
:INSTALL	YES	:INSPPF	SERVP2P	RACF	
:BUILD	YES	:BLDPPF	SERVP2P	RACF	
:INCLUDE	CCC	:P2PPPF	SERVP2P	RACFP2P	

Figure 3-7 VMFUPDAT SYSSUF

Note: As of z/VM 6.3, the HLASM is no longer required to assemble HCPRWA.

- After you modify the entry for INCLUDE from YES to CCC, select PF5 to process. This raises a flag in the VM SYSSUF file that indicates that RACF was updated and to set this product to BUILD (Figure 3-8). The CPLOAD MODULE is built with the new HCPRWA file (which is actually the HCPRWAC file). This changes the parameters from *defer* to *fail*.

```

VM      SYSSUF  D1  V 100  Trunc=100 Size=48 Line=40 Col=1 Alt=0
=====
ICKDSFP2P :PRODLEV.RDBKSYC1.RSU-1901 RDBKSYC2.RSU-1901 :CSM_MANAGED.NO.<NON
:PRODID.7VMDIR30%DIRM :SERVLEV.RSU-2301 :DESC.Install/service DirMaint usin
:INSTALL.YES :INSPPF.SERVP2P DIRM :BUILD.YES :BLDPPF.SERVP2P DIRM :P2PPPF.S
:PRODLEV.RDBKSYC1.RSU-2301 RDBKSYC2.RSU-2301 :CSM_MANAGED.NO.<NONE>
:PRODID.7VMRAC30%RACF :SERVLEV.000-0000 :DESC.RACF Feature of z/VM, FL730 :
:INSPPF.SERVP2P RACF :BUILD.YES :BLDPPF.SERVP2P RACF :P2PPPF.SERVP2P RACFP
:PRODLEV.RDBKSYC1.000-0000 RDBKSYC2.000-0000 :CSM_MANAGED.NO.<NONE>
:PRODID.7VMPTK30%PERFTK :SERVLEV.000-0000 :DESC.Performance Tool Kit :INCLU
:INSPPF.SERVP2P PERFTK :BUILD.YES :BLDPPF.SERVP2P PERFTK :P2PPPF.SERVP2P PE
:PRODLEV.RDBKSYC1.000-0000 RDBKSYC2.000-0000 :CSM_MANAGED.NO.<NONE>
:PRODID.7VMHCD30%VMHCD :SERVLEV.RSU-2301 :DESC.VMHCD for z/VM 7.3.0 :INCLUD
:INSPPF.SERVP2P VMHCD :BUILD.YES :BLDPPF.SERVP2P VMHCD :P2PPPF.SERVP2P VMHC
:PRODLEV.RDBKSYC1.RSU-2301 RDBKSYC2.RSU-2301 :CSM_MANAGED.NO.<NONE>
  
```

Figure 3-8 VM SYSSUF file

- Force the building of the CP nucleus by running the following commands:

```

vmfsetup 7vmrac30 racf (link
vmfrep1 rpiblcprn exec 7vmrac30 racf (nocopy $select
vmfsetup detach
  
```

The VMFREPL EXEC is used to support the local modification of replacement maintained parts. VMFREPL can be used to accomplish the following tasks:

- Copy the highest level of a part.
- Copy a specified part.
- Update a Version Vector Table.
- Update a Select Data file.
- Display the highest levels of a part.

RPIBLCPN EXEC is used to build the CPLOAD MODULE by using the RACF files and the version vector tables for RACF. The **\$SELECT** operand adds an entry to the 7VMRAC30 \$SELECT file (Example 3-22) on the RACFVMs apply disk (2A6), which defines to VMSES/E that there has been local service to the RPIBLCPN EXEC.

Example 3-22 7VMRAC30 \$SELECT file

```
7VMRAC30 $SELECT F1 V 80 Trunc=80 Size=2
====>
0 * * * Top of File * * *
1 :APPLYID.07/01/23 09:09:18
2 RPIBLCPN EXC EXC00000 BASE-FILETYPE
3 * * * End of File * * *
```

4. The **SERVICE EXEC** is used again, similar to when you enabled the RACF product. This time, use the **BUILD** operand to create the CPLOAD MODULE by running the following command:

```
service racf build
```

The new CP nucleus, with the RACF CP parts, is placed on the secondary parm disk (default disk address of CF2). For your information, a copy of the previous (or currently running) CPLOAD MODULE is still on the primary (CF1) and tertiary (CF3) parm disks as CPLOAD MODULE. It is also saved on the secondary parm disk as CPLOLD.

5. Shut down the currently running system.
6. Perform an IPL from the MAINT730 CF2 parm disk.
7. Start the system with the **NOAUTOLOG** parameter.
8. Run **XAUTOLOG RACMAINT**.
9. Run the **PUT2PROD EXEC** from the MAINT VM.

This completes the installation and configuration of the RACF product for z/VM 7.3.0.

3.3 RACF management processes

This section describes how to make DirMaint and RACF work together and shows some basic setup in RACF to protect commonly used resources.

3.3.1 DirMaint changes to work with RACF

The DirMaint-RACF connector provides DirMaint exits that allow the DIRMAINT VM to run the appropriate RACF commands to perform the following tasks:

- ▶ Add a user.
- ▶ Define MDISK.

- ▶ Define VMRDR.
- ▶ Define VMPOSIX.
- ▶ Define SURROGAT.
- ▶ Define VMBATCH.

Note: The DirMaint-RACF connector is one of the reasons that you should use DirMaint with your RACF environment. Although it is fairly easy to write your own execs to provide a similar function, the connector is a maintained component of DirMaint.

The code to use this process is shipped with the base system as part of DirMaint. To implement this process, you update your DirMaint configuration (CONFIGxx DATADVH) with the statements that are defined in the CONFIGRC SAMPDVH file (Figure 3-9 on page 64). There is *not* a copy of the CONFIGRC SAMPDVH file on the DIRMAINT minidisks. It is on the 2C2 disk that is owned by the 7VMDIR30 VM. In this example, we run **VMLINK** to access this disk, and then copy the CONFIGRC SAMPDVH file to our A disk.

Note: Here is the exact VMLINK command:

```
VMLINK 7VMDIR30 2C2 (FILEL CONFIGRC *
```

This command made it easy to then run **COPYFi le** to copy the file and give it the name CONFIGRC DATADVH A.

Complete the following steps:

1. Copy the CONFIGRC SAMPDVH file to your A disk as CONFIGRC DATADVH.

An excerpt from the CONFIGRC DATADVH file is shown in Figure 3-9.

```
CONFIGRC DATADVH A2 V 80 Trunc=80 Size=174 Line=117 Col=1 Alt=0
===>
117 /*! Command handler for DASD Change related commands.          */
118 /*!-----*/
119 /USE_RACF= YES DVHRDN EXEC
120 /USE_RACF= NO DVHRDN EXEC
121 ----- 5 line(s) not displayed -----
126 RACF_ADDUSER_DEFAULTS= UACC(NONE)
127 RACF_DISK_OWNER_ACCESS= ACC(ALTER)
128 RACF_RDEFINE_VMPOSIX_POSIXOPT.QUERYDB= UACC(READ)
129 RACF_RDEFINE_VMPOSIX_POSIXOPT.SETIDS= UACC(NONE)
130 RACF_RDEFINE_SURROGAT_DEFAULTS= UACC(NONE) AUDIT (FAILURES (READ))
131 RACF_RDEFINE_VMBATCH_DEFAULTS= UACC(NONE) AUDIT (FAILURES (READ))
132 RACF_RDEFINE_VMRDR_DEFAULTS= UACC(NONE) AUDIT (FAILURES (READ))
133 RACF_RDEFINE_VMMDISK_DEFAULTS= UACC(NONE) AUDIT (FAILURES (READ))
134 ----- 10 line(s) not displayed -----
144 TREAT_RAC_RC.4= 0 | 4
145 ----- 4 line(s) not displayed -----
149 PW_WARN_MODE= MANUAL
150 PW_LOCK_MODE= MANUAL
151 ----- 9 line(s) not displayed -----
160 ESM_PASSWORD_AUTHENTICATION_EXIT= DVHXPA EXEC
161 ----- 14 line(s) not displayed -----
```

Figure 3-9 Part of CONFIGRC DATADVH

The activation of the function for all supported operations is done by the following line:

USE_RACF= YES ALL

- The operation of the function can be altered by changing the parameters in the file. If you have no changes to make, it can be used as is. Run the DirMaint **file** command to store a copy of the CONFIGRC DATADVH file.

Important: This file does not exist on the DIRMAINT user, so specify the filemode on the DirMaint **file** command. Other DirMaint CONFIGxx DATADVH files are on DIRMAINT's D disk, so storing the following one there too:

```
DIRM FILE CONFIGRC DATADVH A = = D
```

- Complete the activation of the connector by running the DirMaint commands to refresh data and configuration files (**DIRM RLDD** and **DIRM RLDC**). You also must give the DIRMAINT and DATAMOVE VMs the RACF *special* attribute (Example 3-23).

Example 3-23 RACF authorization for DIRMANT and DATAMOVE

```
rac alu dirmaint special
Ready; T=0.01/0.01 11:47:25
```

```
rac alu datamove special
Ready; T=0.01/0.01 11:47:33
```

After completing this work, when you add a user or minidisk with DirMaint, it is added automatically to the RACF database. For more information, see “Adding virtual machines with DirMaint” on page 66.

3.3.2 RACF authorization concepts

Resources are defined to RACF/VM as profiles in the RACF database. There are profiles for all the resources that are defined to a RACF enabled z/VM system (vmmdisk, vmrdr, vmlan, and so on). These profiles can be *generic* (MAINT.19*, where the asterisk is one or more characters) or *discrete* (MAINT.CF1). See Figure 3-10.

```

Discrete Profiles

RDEFINE VMMDISK MAINT.CF1 OWNER(MAINT) UACC(NONE)
PERMIT MAINT.CF1 CLASS(VMMDISK) RESET ID(MAINT) AC(ALTER)
RDEFINE VMMDISK MAINT.CF2 OWNER(MAINT) UACC(NONE)
PERMIT MAINT.CF2 CLASS(VMMDISK) RESET ID(MAINT) AC(ALTER)
RDEFINE VMMDISK MAINT.CF3 OWNER(MAINT) UACC(NONE)

RDEFINE VMMDISK MAINT.CF1 OWNER(MAINT) UACC(NONE)
PERMIT MAINT.CF1 CLASS(VMMDISK) RESET ID(MAINT) AC(ALTER)
RDEFINE VMMDISK MAINT.CF2 OWNER(MAINT) UACC(NONE)
PERMIT MAINT.CF2 CLASS(VMMDISK) RESET ID(MAINT) AC(ALTER)
RDEFINE VMMDISK MAINT.CF3 OWNER(MAINT) UACC(NONE)

Generic Profiles

RDEFINE VMMDISK MAINT.CF% OWNER(MAINT) UACC(NONE)
PERMIT MAINT.CF% CLASS(VMMDISK) RESET ID(MAINT) AC(ALTER)
RDEFINE VMMDISK MAINT.190 OWNER(MAINT) UACC(READ)
PERMIT MAINT.190 CLASS(VMMDISK) RESET ID(MAINT) AC(ALTER)
RDEFINE VMMDISK MAINT.19E OWNER(MAINT) UACC(READ)
PERMIT MAINT.19E CLASS(VMMDISK) RESET ID(MAINT) AC(ALTER)

```

Figure 3-10 Discrete and generic profiles

The **RPIDIRCT EXEC** that was used to create the commands to define the RACF database during the installation and configuration process used discrete profiles. Your installation must determine whether you want to continue with this practice or use generic profiles. Both methods or a combination of methods work. Make sure that you run **SETROPTS GENERIC(VMMDISK)** before you define the generic profiles.

3.3.3 Adding virtual machines and resources to the system and the RACF database

This section describes how to add VMs and resources to the system and the RACF database.

Adding virtual machines with DirMaint

This example uses DirMaint as the tool to add VMs to the system. Using DirMaint allows you to take advantage of the DirMaint-RACF connector.

Complete the following steps:

1. When you need to add a VM to the system, first make sure that the VM was not defined previously (Example 3-24).

Example 3-24 Verification of a virtual machine

```

rac lu userbob
ICH30001I UNABLE TO LOCATE USER   ENTRY USERBOB
Ready(00004); T=0.01/0.01 08:43:53
dirm for userbob get no lock
DVHXTM1191I Your GET request has been sent for processing.
Ready; T=0.03/0.03 08:44:09
DVHREQ2288I Your GET request for USERBOB at * has been accepted.
DVHBDG6209E Specified user USERBOB does not exist, request GET failed.
DVHGET3212E Unexpected RC= 6209, from: EXEC DVHBDGT USERBOB DIRECT A0
DVHREQ2289E Your GET request for USERBOB at * has failed; with RC =
DVHREQ2289E 3212.

```

2. To create a VM, create a file on the A disk of a DirMaint administrator, which contains new VM definition (see Figure 3-11).

```

USERBOB DIRECT   A0  F 80  Trunc=72  Size=5  Line=0
====>
 0 * * * Top of File * * *
 1 USER USERBOB TEXAS  32m  100m  BCDG
 2   INCLUDE IBMDFLT
 3   IPL CMS PARM AUTOCR
 4   MACHINE XA
 5   LINK TCPMAINT 0592 0592 RR
 6 * * * End of File * * *

```

Figure 3-11 *USERBOB DIRECT*

3. Run the command **dirm add**. It displays a panel similar to the one that is shown in Figure 3-12.

```

-----DirMaint ADD-----
Add a new directory entry for a new USERID, PROFILE, SUBCONFIG, or IDENTITY.
Fill in the USERID, PROFILE, SUBCONFIG, or IDENTITY being added:
    ==> userbob
Optionally fill in the following when using a prototype:
    LIKE ==> _____ (file name of prototype)
    PW   ==> _____ (password for new user)
    VPW  ==> _____ (password again for verification)
    ACCT ==> _____ (account value for new user - optional)
    BUILD ON ==> _____ (SSI node)
    IN   ==> _____ (identity)
Notes:
- If a value is given for any one of PW, VPW, or ACCT,
  then a value is required for LIKE.
- If a value is given for either PW or VPW,
  then a value is required for both of them.
- BUILD and IN fields can be used for subconfigs only.
- If a value is given for either BUILD or IN
  then a value is required for both of them

5741-A07 (c) Copyright IBM Corporation 1979, 2011.
1= Help      2= Prefix Operands      3= Quit      5=Submit      12=Cursor
==>

```

Figure 3-12 DIRMAINT ADD

4. After filling in the name of the VM, press PF5. You receive the messages that are shown in Example 3-25.

Example 3-25 DirMaint Output

```

PUN FILE 0013 SENT TO DIRMAINT RDR AS 0037 RECS 0013 CPY 001 0 NOHOLD NOKEEP
DVHXTM1191I Your ADD request has been sent for processing to DIRMAINT at
DVHXTM1191I ITS0ZVM1.
Ready; T=0.07/0.08 08:51:11
DVHREQ2288I Your ADD request for USERBOB at * has been accepted.
DVHBIU3450I The source for directory entry USERBOB has been updated.
DVHBIU3424I The next ONLINE will take place immediately.
DVHDRC3451I The next ONLINE will take place via delta object directory.
DVHRLA3891I Your DSATCTL request has been relayed for processing.
DVHRLA3891I Your DSATCTL request has been relayed for processing.
DVHRLA3891I Your DSATCTL request has been relayed for processing.
DVHRLA3891I Your DMVCTL request has been relayed for processing.
DVHRLA3891I Your DMVCTL request has been relayed for processing.
DVHBIU3428I Changes made to directory entry USERBOB have been placed
DVHBIU3428I online.
DVHBIU3450I The source for directory entry USERBOB has been updated.
DVHBIU3424I The next ONLINE will take place immediately.
DVHDRC3451I The next ONLINE will take place via delta object directory.
DVHRLA3891I Your DSATCTL request has been relayed for processing.
DVHRLA3891I Your DSATCTL request has been relayed for processing.
DVHRLA3891I Your DSATCTL request has been relayed for processing.
DVHRLA3891I Your DMVCTL request has been relayed for processing.
DVHRLA3891I Your DMVCTL request has been relayed for processing.
DVHBIU3428I Changes made to directory entry USERBOB have been placed
DVHBIU3428I online.
DVHREQ2289I Your ADD request for USERBOB at * has completed; with RC

```

DVHREQ2289I = 0.

If you run **rac lu** and **dirm for userbob get no!ock**, you find that the VM is defined. The **rac lu output** is shown in Example 3-26.

Example 3-26 RACF List User (RAC LU) command output

```

rac lu userbob
USER=USERBOB NAME=UNKNOWN OWNER=DIRMAINT CREATED=16.179
DEFAULT-GROUP=SYS1   PASSDATE=00.000 PASS-INTERVAL= 30 PASSPHRASEDATE=N/A
ATTRIBUTES=NONE
REVOKE DATE=NONE   RESUME DATE=NONE
LAST-ACCESS=UNKNOWN
CLASS AUTHORIZATIONS=NONE
NO-INSTALLATION-DATA
NO-MODEL-NAME
LOGON ALLOWED      (DAYS)          (TIME)
-----
ANYDAY              ANYTIME
GROUP=SYS1   AUTH=USE   CONNECT-OWNER=DIRMAINT   CONNECT-DATE=16.179
CONNECTS=    00 UACC=NONE   LAST-CONNECT=UNKNOWN
CONNECT ATTRIBUTES=NONE
REVOKE DATE=NONE   RESUME DATE=NONE
SECURITY-LEVEL=NONE SPECIFIED
CATEGORY-AUTHORIZATION
NONE SPECIFIED
SECURITY-LABEL=NONE SPECIFIED
Ready; T=0.01/0.01 08:54:10

```

When you add a minidisk to this user, the minidisk address is added to the RACF database as well. In this example, we ran the **rac rlist** command both before and after adding a minidisk by using the **DIRM AMD** command, and the results are shown in Example 3-27.

Example 3-27 RACF profile added for a DirMaint added minidisk

```

rac rlist vmmdisk userbob.191 auth
ICH13003I USERBOB.191 NOT FOUND
Ready(00004); T=0.01/0.01 08:54:49
. . .
<added minidisk using DirMaint AMDISK command>
. . .
rac rlist vmmdisk userbob.191 auth
CLASS      NAME
-----    ----
VMMDISK    USERBOB.191

LEVEL  OWNER      UNIVERSAL ACCESS  YOUR ACCESS  WARNING
-----  -----  -
00     USERBOB      NONE              NONE         NO

INSTALLATION DATA
-----
NONE

APPLICATION DATA
-----

```

NONE

SECLEVEL

NO SECLEVEL

CATEGORIES

NO CATEGORIES

SECLABEL

NO SECLABEL

AUDITING

FAILURES(READ)

NOTIFY

NO USER TO BE NOTIFIED

USER	ACCESS	ACCESS COUNT
-----	-----	-----
USERBOB	ALTER	000000

USERBOB ALTER 000000

ID	ACCESS	ACCESS COUNT	CLASS	ENTITY	NAME
-----	-----	-----	-----	-----	-----

NO ENTRIES IN CONDITIONAL ACCESS LIST

Ready; T=0.01/0.01 08:55:18

Note: The values for the universal access and audit properties of the created minidisk resource profile are set in the **RACF_RDEFINE_VMMDISK_DEFAULTS** parameter in the CONFIGRC DATADVH file. You can also set the default access level that is given to the owner of a disk by using the **RACF_DISK_OWNER_ACCESS** parameter.

Similar parameters exist for the other resource types that are managed by the DirMaint-RACF connector.

At the time of writing, the DirMaint-RACF connector does not manage links to minidisks. It also does not manage virtual network protection (the RACF VMLAN class). Both of these enhancements were announced for z/VM 6.4.

Adding virtual machines without DirMaint

If you decide not to use the DirMaint product on your system, then there is an automated process that also updates the RACF database. This method is not as automated as the **dirm add** command, but it might be suitable for your installation.

You use the same processes that you use to build the initial RACF database. The processes are the **RPIDIRECT** and **RPIBLDDS** execs. These processes can be completed from the MAINT VM because MAINT has the authority to write to the CP directory (and has access to the USER DIRECT file found on the PMAINT 2CC disk).

Complete the following steps:

1. Add the new user to the USER DIRECT file (Figure 3-13).

```

USER      DIRECT  C1  F 80  Trunc=80 Size=5509 Line=5503 Col=1
===>
5503 *
5504 USER USERBOB 18FUMDIM 32M 100M BCDG
5505     INCLUDE IBMDFLT
5506     IPL CMS PARM AUTOCR
5507     MACHINE XA
5508     LINK TCPMAINT 0592 0592 RR
5509     MDISK 191 3390 2220 10 ZVMUSR MR ALL GO4IT WHYNOT
5510 * * * End of File * * *
    
```

Figure 3-13 USER DIRECT on the 2CC disk

2. Put the directory online with the **directxa** command and copy the directory entry for the new user to the user ID DIRECT A file.

Now, the new VM is added to the system directory. However, if you try to log on to the VM, it fails (as shown in Example 3-28) because the VM is not defined in the RACF database and because you are no longer deferring the request to CP.

Example 3-28 Log on to USERBOB

```

logon userbob
HCPLGA053E USERBOB not in CP directory
    
```

Enter one of the following commands:

```

LOGON userid          (Example: LOGON VMUSER1)
DIAL userid           (Example: DIAL VMUSER2)
MSG userid message    (Example: MSG VMUSER2 GOOD MORNING)
LOGOFF
UNDIAL
    
```

3. Update the RACF database with information about this VM. To do so, link and access the 651 disk that is owned by 7VMRAC30. You need this disk because that is where the **RPIDIRCT** and **RPIBLDDS** execs are.
4. Run the **RPIDIRCT EXEC** against the USERBOB DIRECT file (Example 3-29) to generate an RPIDIRCT SYSUT1 file.

Example 3-29 Run RPIDIRCT

```

rpidirct userbob direct
USERBOB DIRECT Filemode defaulted to "*".
Output defaulted to "A" disk.
  Default group ID = SYS1.
  Would you like to change this default?
  Enter Y/N
n
  Default group ID = SYS1.

*****
                          DEFINITION pass begins.....
*****

USER USERBOB XXXXXXXX 32M 100M BCDG
INCLUDE IBMDFLT
    
```

```

MDISK 191 3390 30049 1 ZAOL01 MR READ WRITE MULTIPLE
Missing ACIGROUP for userid USERBOB - Defaulted to SYS1
*****
DEFINITION pass complete - PERMIT command generation begins...
NOTE: This EXEC will "PERMIT" only up to 4 indirect LINKS
*****
processing LINK TCPMAINT 592 592 READ for user USERBOB
*** Cannot PERMIT TCPMAINT 592 for Userid USERBOB - no Minidisk
***** scan ended *****
***** 7 Directory records processed *****
***** RPIDIRCT SYSUT1 CREATED *****

```

The generated RPIDIRCT SYSUT1 file is shown in Figure 3-14.

```

RPIDIRCT SYSUT1  A1  V 80  Trunc=80 Size=16 Line=0 Col=1 Alt=0
===>
0 * * * Top of File * * *
1 ***** USERBOB
2 *
3 ADDUSER USERBOB DFLTGRP(SYS1) UACC(NONE) PASSWORD(TEXAS)
4 RDEFINE VMBATCH USERBOB OWNER(USERBOB) UACC(NONE)
5 PERMIT USERBOB CLASS(VMBATCH) ACCESS(ALTER) RESET
6 RDEFINE VMRDR USERBOB UACC(NONE) OWNER(USERBOB)
7 PERMIT USERBOB CLASS(VMRDR) ID(USERBOB) ACCESS(ALTER) RESET
8 RDEFINE VMMDISK USERBOB.191 OWNER(USERBOB) UACC(NONE)
9 PERMIT USERBOB.191 CLASS(VMMDISK) RESET ID(USERBOB) AC(ALTER)
10 *
11 *****
12 *
13 *                PERMIT DIRECTORY LINKS                *
14 *
15 *****
16 *
17 * * * End of File * * *

```

Figure 3-14 New RPIDIRCT SYSUT1 file

RPIDIRCT did not process the LINK statement in the user definition (see the Cannot PERMIT message in the output of **RPIDIRCT**, and the missing **PERMIT** for TCPMAINT 592 in the **RPIDIRCT SYSUT1** output). This appears to happen because **RPIDIRCT** has support for resolving indirect minidisk links, which adds the **PERMIT** for the actual resource correctly. It does this by creating an index of all minidisks that are defined in the provided directory listing so that it can dereference indirect links. When working with a full directory, this works as designed, but it fails with a single user's directory entry.

There are two ways you can resolve this:

- Add a directory fragment to the user id **DIRECT** file defining the other user and its minidisk. In this example, we add the following two lines to **USERBOB DIRECT** to have **RPIDIRCT** correctly build the required **PERMIT** command:

```

USER TCPMAINT NOLOG
MDISK 592 3390 1 1 ABC123 MR READ

```

The extent that is defined on this **MDISK** statement was irrelevant; it just needed to be there to allow **RPIDIRCT** to build the required **PERMIT** for **USERBOB**.

- Manually add **PERMIT** commands to the **RPIDIRCT SYSUT1** file in response to any Cannot PERMIT messages.

As a preferred practice, use the latter approach. Although having the utility create the correct **PERMIT** automatically is convenient, the directory fragment that is needed to create this **PERMIT** adds a full set of RACF commands to `RPIDIRCT SYSUT1` for that other user. You manually must remove all those other commands simply to run `RPIBLDDS` error-free. The issue is compounded if the user you are adding has links to minidisks of many users: All of the other users and their minidisks must be defined in directory fragments, and many unnecessary commands must be cleaned up from `RPIDIRCT SYSUT1`.

In this example, we manually add the appropriate **PERMIT** to the end of the `RPIDIRCT SYSUT1` file to allow the directory link.

5. Run the **RPIBLDDS** exec by using the new `RPIDIRCT SYSUT1` file and update the RACF database with the commands that re shown in Figure 3-15.

```

rpibldds rpidirect
Processing batch file RPIDIRCT SYSUT1 using "RAC" command interface
*
=> ADDUSER USERBOB DFLTGRP(SYS1) UACC(NONE) PASSWORD(TEXAS)
=> RDEFINE VMBATCH USERBOB OWNER(USERBOB) UACC(NONE)
=> PERMIT USERBOB CLASS(VMBATCH) ACCESS(ALTER) RESET
=> RDEFINE VMRDR USERBOB UACC(NONE) OWNER(USERBOB)
=> PERMIT USERBOB CLASS(VMRDR) ID(USERBOB) ACCESS(ALTER) RESET
=> RDEFINE VMMDISK USERBOB.191 OWNER(USERBOB) UACC(NONE)
=> PERMIT USERBOB.191 CLASS(VMMDISK) RESET ID(USERBOB) AC(ALTER)
=> PERMIT TCPMAINT.592 CLASS(VMMDISK) ID(USERBOB) AC(READ)

Ready; T=0.02/0.03 11:11:45

```

Figure 3-15 Run `RPIBLDDS`

6. Run the `rac 1u` command to check how the user is defined to RACF. In this example, we found that the result looked the same as that achieved by using the `DirMaint-RACF` connector (shown in Example 3-26 on page 69).

3.3.4 Securing your minidisks with RACF

You can use RACF to control who can link the minidisks by using profiles in the `VMMDISK` resource class. `z/VM` calls RACF for an authorization check when a user tries to link another user's minidisk. All devices in `z/VM` except users and groups are considered to be general resources in RACF. So, defining profiles in RACF for resources other than users and groups is done by using the RACF command **RDEFINE**.

You may protect resources by defining the following profiles:

- ▶ Discrete profiles
- ▶ Generic profiles

Discrete profiles are used to protect explicitly a single resource. For example, if a resource requires special access authorization or unique logging information, you may protect it with a discrete profile, as shown in Example 3-30.

Example 3-30 Protect MDisk 191 with a discrete profile

```
RDEF VMMDISK klausm.191 uacc(none) ow(klausm)
```

Note: IBM provides the DirMaint-RACF connector, which takes on the work of defining RACF profiles whenever there is a change to your directory by DIRM commands. This is done if a user is added or deleted, for example, and when adding minidisk definitions to virtual guests. However, the DirMaint-RACF connector just creates discrete profiles, which provide a basic security implementation and makes sure that resources are protected.

However, in many installations, the preferred way to protect resources is by defining generic profiles. Generic profiles must contain one or more generic characters. This might be an appropriate way to protect all resources of the same type of a certain user by just defining one or two profiles.

Note: Valid generic characters are percent(%), the single asterisk(*) and double asterisk (**).

Specify percent(%) in profile names to match any single non-blank character on the same position of the resource name.

Specify the single asterisk(*) or double asterisk (**) in the profile name to match more than one single character in the same position of the resource name.

For more information, see Chapter 6, “Defining Resources”, in *z/VM RACF Security Server Security Administrator’s Guide*, SC24-6218.

Additionally, you may choose to grant permits to groups rather than users. Defining groups to the RACF database is a way to reflect definitions and permissions to your businesses organizational structure and your security policy. It gives you additional flexibility. So you may, as shown in the following examples, insert groups into the **ID** keyword of the RACF **PERMIT** command rather than single user IDs. If a user then newly joins a given organizational unit (that is, the DBADMN unit), then connecting this user ID to the defined group shall provide the user with all the access rights the user needs to do the work. The advantages of using group permissions rather than user permissions are described in “Advantages of using groups” on page 75.

To learn more about RACF group structure and security objectives, see Chapter 2, “Organizing for RACF Implementation”, in *z/VM RACF Security Server Security Administrator’s Guide*, SC24-6311.

Note: If you decide to use generic profiles for class VMMDISK, you should *genlist* this class. Run the following command:

```
SETROPTS GENLIST (VMMDISK)
```

This command causes one copy of each generic profile for the VMMDISK class to be kept in the RACFVM service machine. Changes made to generic minidisk profiles are not reflected until a **SETROPTS** refresh command is issued:

```
SETROPTS GENERIC (VMMDISK) REFRESH
```

Linux on IBM Z guests often need to have many database volumes that are attached to their VMs, and have volumes that are the same kind and have the same protection level needs. You can do this configuration by defining profiles as shown in Example 3-31 and Example 3-32.

Example 3-31 Protect database volumes with a generic profile

```
RDEF VMMDISK LNX1.* UACC(NONE) OW(LINX1)
```

Example 3-32 Permit access to a database volume by using a generic profile access list

```
PERMIT LNX1.* CLASS(VMMDISK) ID(DBADMN) ACC(UPDATE)
```

If your system MDisks should not be updated by **DBADMN** but by **SYSPROGS**, and the virtual addresses of these types of minidisks start with 20, then use the commands that are shown in Example 3-33.

Example 3-33 Generic profile and group permission example

```
RDEFINE VMMDISK LNX1.20* uacc(none) ow(LINX1)
PERMIT LNX1.20* CLASS(VMMDISK) ID(SYSPROG) ACC(UPDATE)
```

Advantages of using generic profiles

There are several advantages of using generic profiles:

- ▶ The number of profiles in the RACF database are reduced significantly.
- ▶ No RACF administrator action is needed when MDisks are added or removed.
- ▶ The principle of least privilege is met.
- ▶ There is always a good overview of the security setup in your RACF database, which might be helpful when showing security concepts to auditors.

This principle can be used for almost all of the general resource profiles except VMLAN VSWITCH devices.

Advantages of using groups

There are several advantages of using groups:

- ▶ Access lists in resource profiles have fewer entries.
- ▶ Changes in your companies business organization can easier be reflected in permission structures.
- ▶ If people change departments in your organization, accesses are easily withdrawn and granted just by removing them from a group and connecting them to another group.
- ▶ RACF-DB is provided with a structure that is adopted to your business needs.
- ▶ They are a good overview of the security setup in your RACF database.

3.3.5 Securing guest LANs and virtual switches with RACF

RACF can be used to protect VLANs and virtual switches by using profiles in the VMLAN class. After defining the appropriate profiles, be sure to activate your VMLAN class by running the following command:

```
SETROPTS CLASSACT(VMLAN)
```

The VMLAN class contains two sets of profiles to protect LANs:

- ▶ Base profiles control the ability of a z/VM user to use a LAN.
- ▶ VLAN-ID qualified profiles are used to assign a user to one or more IEEE VLANs.

Base profiles

Base profiles are called `userid.name`, where `userid` is the LAN owner and `name` is the name of the LAN. Both qualifiers are a maximum of 8 characters. In case of a VSWITCH, `userid` will be always SYSTEM. These profiles control authorization and auditing of attempts by any user to **COUPLE** to a guest LAN of virtual switch. A user must have UPDATE access to the profile to be authorized for the **COUPLE** command.

VLAN-ID qualified profiles

There are two types of virtual switches: user-based and port-based. The default is user-based. Access to the virtual switch is on a user ID basis. All ports for a guest have the same attributes and VLAN IDs.

If a virtual switch is VLAN-aware (which is done by setting the **VLAN defvid** parameter), then a secondary set of VLAN ID-qualified VMLAN profiles are used to control the ability of user IDs to connect to a particular IEEE VLAN. Profiles of this type are named `SYSTEM.name.vid`, where `name` is the name of the virtual switch and `vid` is a VLAN ID of the value 1 - 4096, inclusive. In this case, the `vid` must consist of four digits.

A user who wants to connect to a virtual switch of this type must have UPDATE access to the qualified profile. The VLAN-Id qualified profiles are checked only if the user has UPDATE access to the base profile protecting the virtual switch.

Note:

1. VLAN-Id qualified profiles must be discrete; generic profiles are ignored.
2. Global access checking cannot be used for VLAN ID-qualified profiles.

For more information about protecting VLAN resources, see Chapter 10, “Protecting z/VM Resources”, in *z/VM RACF Security Server Security Administrator's Guide*, SC24-6311.

Base profiles control the ability of a guest to connect to the LAN (either automatically through the directory **NICDEF** statement or by using the CP **COUPLE** command), and VLAN-ID qualified profiles to control access to specific VLANs on IEEE VLAN-aware virtual switches. To couple to a guest LAN or a virtual switch, a user must have UPDATE access to the profile.

For example, to control access to guest LAN NET100, which is owned by klausm, you must define the profile that is shown in Example 3-34.

Example 3-34 Authorize virtual guest LNX01 to couple to a LAN

```
RDEF VMLAN KLAUSM.NET100 UACC(none) OWNER(KLAUSM)
PERMIT KLAUSM.NET100 CLASS(VMLAN) ID(LNX01) ACC(UPDATE)
```

For more information about guest LANs and virtual switches, see *z/VM Connectivity*, SC24-6267.

For IEEE VLAN-aware virtual switches, the mechanism to get access is much the same, although the profile looks different. For this type of virtual switch, you must define the VLAN-ID in the protecting profile. Profiles of this type are set up as `SYSTEM.name.vid`, where `name` is the name of the virtual switch and `vid` is a VLAN ID having a value 1 - 4094, inclusive.

The *vid* qualifier must consist of four decimal digits, and leading zeroes must be entered for VLAN IDs with fewer than four digits.

In Example 3-35, a user-based virtual switch named VSWINT (virtual switch for internal use only) is defined. Additionally the VLAN IDs 10 and 20 are assigned to different user IDs (can even be group IDs). Suppose VLAN ID 10 is used by the segment NETADMINS and VLAN ID 20 is used by LNXBANK (Linux guests for running a banking application).

Example 3-35 Defining the base profile

```
RDEFINE VMLAN SYSTEM.VSWINT UACC(NONE)
PERMIT SYSTEM.VSWINT CLASS(VMLAN) ID(NETADMN LNXBANK) ACC(UPDATE)
RDEFINE VMLAN SYSTEM.VSWINT.0010 UACC(NONE)
PERMIT SYSTEM.VSWINT.0010 CLASS(VMLAN) ID(NETADMNS) ACC(UPDATE)
RDEFINE VMLAN SYSTEM.VSWINT.0020 UACC(NONE)
PERMIT SYSTEM.VSWINT.0020 CLASS(VMLAN) ID(LNXBANK) ACC(UPDATE)
```

By this means, VLAN accesses can be separated from each other.

Accessing multiple VLANs from a guest

z/VM Virtual Switch supports both access ports (where the guest is VLAN-unaware and the VSWITCH handles all VLAN tagging) and trunk ports (where the guest must be VLAN-aware and process its own VLAN tagging).

Without RACF, access to VLANs is controlled by the **GRANT** option of the CP **SET VSWITCH** command (**MODIFY VSWITCH** in SYSTEM CONFIG). For a given user, a set of VLANs can be granted on a VSWITCH by listing them in the **VLAN** parameter. If more than one VLAN is specified, the **PORTTYPE** parameter must also be set to TRUNK. If a list of VLANs is given but **PORTTYPE ACCESS** is used, an error occurs, as shown in Example 3-36.

Example 3-36 SET VSWITCH GRANT with multiple VLANs and PORTTYPE ACCESS

```
set vswitch vlantst grant tcpip vlan 10 20 30
HCPSWS2847E PORTTYPE ACCESS is not allowed when the user is authorized
HCPSWS2847E for more than one VLAN
```

With RACF in place and the VMLAN class active, **SET VSWITCH GRANT** is not used. Instead, when a user network interface card (NIC) attempts to connect to a VSWITCH that is VLAN-aware, CP requests the list of all profiles to which the user has permission. If this list returns more than one VLAN profile, CP treats this the same as multiple VLAN numbers on the **SET VSWITCH GRANT VLAN** option and expects the **PORTTYPE** to be TRUNK.

This behavior can create unexpected results when you are using group-based access management, as described in 3.3.4, “Securing your minidisks with RACF” on page 73. You might want all of a set of Linux systems to belong to a particular group for DASD management, for example, but if they attach to different VLANs on a given VSWITCH, then you cannot use the same group for VLAN management. Have different group structures for different resource types to allow for different access mappings between those resource types.

SYSSEC considerations of guest LANs

The SYSSEC macro, which is coded in the RACF module HCPRWA, can influence the final result of resource requests in the VMLAN class. If a VLAN is not protected by a RACF profile, if RACF is active on the system, SYSSEC can be coded to let RACF do one of the following tasks:

- ▶ Allow access
- ▶ Deny access
- ▶ Defer access decision to a z/VM

To check on the settings of your SYSSEC macro and for more information about the SYSSEC macro, see *z/VM: RACF Security Server Macros and Interfaces*, SC24-6309.

3.3.6 Labeled security and mandatory access control

RACF supports the use of security labels, allowing an installation to implement a security policy that employs *mandatory access control* (MAC). Standard RACF profiles and ACLs are a form of *discretionary access control* (DAC), where individual resources are protected explicitly by the ACLs that are defined in their profile. MAC uses security labels to classify users and resources into security zones and classify access to those zones.

Note: z/VM 7.3, with RACF and security labels in place, has been evaluated against the Common Criteria Labeled Security Protection Profile (LSPP). The evaluated configuration received an Evaluation Assurance Level of EAL4+. The evaluated configuration is described in *z/VM: Secure Configuration Guide*, SC24-6323.

Using labeled security

Labeled security is implemented in RACF for z/VM by using the SECLABEL class. *z/VM RACF Security Server Security Administrator's Guide*, SC24-6311 describes the use of security labels in achieving a security model employing MAC. In addition, the specific implementation of security labeling that was used in the evaluation of z/VM 7.3 against the LSPP can be found in *z/VM: Secure Configuration Guide*, SC24-6323. Either of these documents provide thorough examples about how to use the SECLABEL class in RACF for MAC.

Labeled security itself does not provide a more secure system. In fact, it can be argued that using MAC alone provides less security over individual resources. The reason this is the case is that MAC does not focus on the specific resources in a configuration, but rather on the categories and zones to which the resources belong. Instead of permissions being granted to specific discrete resources (as happens in a DAC model), permissions are granted across the security zone with MAC.

SECLABEL and Linux virtual machines

In the case of a Linux on z/VM environment, using MAC might result in individual Linux VMs being able to access a wider set of resources than DAC. For example, say that SECLABEL was used to protect the disks that are attached to a set of database server guests. The data that is contained in these databases is assessed as being at the same security level, so all of the database minidisks get the same label applied and the Linux guest IDs are assigned that label. Now, where before in a DAC model each server had access to its own disks only, using MAC alone means that any of these servers can access any of the database disks.

Combining DAC and MAC

MAC can bring a higher level of security to a Linux on z/VM configuration. In our example configuration, we have a set of database servers holding sensitive customer data and another set of database servers with less sensitive data. These database servers are allocated with the appropriate SECLABELs that reflect the different security zones of the data under management.

Now, suppose a malicious system administrator (with sufficient authority to manage discrete resource profiles for the Linux guests) wanted to access sensitive data by using one of the servers with less stringent controls. This operator issues **PERMIT** commands to allow a less secure server to access physically the sensitive data disks. In a system with DAC alone, this is all that is required for the less secure server to link the disks and access the data. When MAC is active, the request is rejected regardless of the discrete **PERMIT** commands because the SECLABELs of the servers and minidisks do not allow the access. In this way, SECLABELs provide an additional layer of security protection.

Note: Implement MAC that uses the RACF SECLABEL class as an additional security protection over and above standard DAC rather than as a security model in its own right.

3.3.7 Backing up the RACF database

The default configuration of RACF provides a primary and a backup database. As supplied, RACFVM uses a data set that is called RACF.DATASET (which is on the virtual device 200) as its primary database, and a data set called RACF.BACKUP (which is on the virtual device 300) as its backup database. Also, RACFVM keeps the backup database up to date with changes that are made to the primary database (except for the recording of statistics). These specifications are set in the RACF database name table (ICHRDSNT). RACF for z/VM comes with a default ICHRDSNT that defines these settings.

Both the RACF primary and backup databases are accessed from the time RACFVM starts. This allows RACFVM to keep the backup in-step with the primary, and also allows the active database to be switched if needed. However, it makes it slightly more difficult to make a copy of the database because a RACF database should be copied only when it is not active.

For most installations, the backup copy of the database as kept by RACFVM might not be sufficient. It does not protect the database from being lost if a disk subsystem is lost or a disaster occurs, for example. Every installation of RACF should implement a method to back up the database, and keep that backup separate from the running system.

Making an additional backup

Creating backup RACF databases in Chapter 2 of the *z/VM RACF Security Server System Programmer's Guide, SC24-6312* provides examples about how to use the RACF database utilities IRRUT200 and IRRUT400 to perform backups of RACF databases. This scenario is based on an IRRUT400 example entitled "Copying a RACF database to a larger volume without shutting down the RACFVM server" from the *z/VM RACF Security Server System Programmer's Guide, SC24-6312*.

Note: Take this kind of backup during a period of as little system activity as possible.

Complete the following steps:

1. Log on to the RACMAINT user.

2. Send a message to RACFVM to detach the F200 and F300 disks so that RACMAINT can link to them.
3. Link to the F200 disk of RACFVM (the original supplied RACF database primary disk) as a staging area for the backup.
4. Because IRRUT400 requires system CMS to run, perform an IPL of the CMS saved system.
5. Run RACUT400 to copy the database.

Example 3-37 shows these steps.

Example 3-37 Use IRRUT400 to back up the RACF database

SEND CP RACFVM DET F200 F300

Ready; T=0.01/0.01 16:29:45

LINK RACFVM F200 400 W

Ready; T=0.01/0.01 16:29:55

IPL CMS

z/VM V6.3.0 2016-05-18 16:18

DMSACP723I D (192) R/0

DMSACP723I B (305) R/0

DMSACP723I T (190) R/0

DMSACP725I 190 also = S disk

Ready; T=0.01/0.01 17:04:33

RACUT400

This exec is used to Split/Merge or Create a copy of a RACF data base.

Press Enter to continue....

<Enter>

Do you wish to SPLIT a RACF data set into multiple extents?

or

Do you wish to MERGE multiple RACF data sets into 1 or more extents?

or

Do you wish to COPY one RACF data set into another extent?

Enter SPLIT or MERGE or COPY or QUIT

copy

A single Racf Data set is to be copied to another extent.

Enter the single input device address

200

Enter the single output device address

400

DMSACC724I 200 replaces R (200) - OS

DMSACC723I R (0200) R/W - OS

DMSACC724I 400 replaces X (400) - OS

DMSACC723I X (0400) R/W - OS

The following are the Input Racf Data Set(s)

"RACF.DATASET" (vaddr = 200)

The following are the Output Racf Data Set(s)

"RACF.DATASET" (vaddr = 400)

Do you wish to continue?

Enter YES or NO

yes

You will now be prompted for Input Parameters to 'IRRUT400'

A series of panels containing a full description of these Parameters can be viewed by entering HELP

Enter HELP for a description of input Parameters

or

Enter CONT to continue without the Parameter description

or

Enter QUIT to terminate

cont

Enter Input Parameter one at a time for 'IRRUT400'

or

Enter END to use default values

noinput

Enter Next Parameter for 'IRRUT400'

or

Enter END to specify end of input

or

Enter QUIT to terminate.

end

Processing begins

All output will be placed in the 'UT400 OUTPUT' file on the 'A' disk.

Program 'IRRUT400' is being executed - Please wait -

Processing completes

Return code from 'IRRUT400' = 0

Ready; T=0.01/0.04 17:11:44

The primary RACF database is copied to the RACFVM F200 disk. You can now perform other operations on this copy, such as reporting or making further backups by using DDR or other facilities.

Using the RACUT200 and RACUT400 tools

The RACUT200 and RACUT400 execs that start the RACF utilities are sensitive to the types of disks that are used, and make assumptions about the type of device to expect based on the device addresses used.

In this example, when we attached the F200 minidisk by using F200 as the virtual device address, the device address was rejected by the utility as invalid. Only the common device addresses that are used for RACF database minidisks (200, 300, and 400) are accepted by the tools.

3.3.8 RACF recovery options

If a system availability issue occurs, it might be necessary to recover RACF data from a backup. There might also be circumstances that prevent the RACFVM server from starting. This section introduces some basic methods to use to perform recovery of RACF.

Note: Chapter 7, “Recovery procedures”, in *z/z/VM RACF Security Server System Programmer’s Guide*, SC24-6312 outlines full details of the recovery procedures for events that can compromise RACF operation. For more information about RACF recovery, or for any specific scenarios that we have not covered here, see that book.

Recovery of the RACF primary database

If the RACF primary database is unavailable or in error, there are a couple of options available:

- ▶ If the backup database is valid, you can use RACUT200 to copy the valid backup to the primary volume.
- ▶ If there is no backup, you can restore the most recent dump of the database by using either a DDR or RACF utility.

We illustrate a scenario where we must recover the RACF primary database disk from the backup we took by using the procedure in “Making an additional backup” on page 79.

If RACF cannot start

RACF has an operation mode called *failsoft processing* that it adopts if there are no primary databases available. In failsoft processing, if RACF cannot authorize an access request by using in-memory tables, it prompts the operator for a decision on the access request.



Security policy management on IBM z/VM

Most organizations have a security policy that typically states the rules for controlling access to data. There also are statements for data ownership and there are rules about granting the least access that is necessary for each role.

However, there might be few instructions about the practical scenario of implementation. There might be little mention of any of the IT platforms that are involved. Thus, there might be little or no link between that policy and the security procedures that must exist.

Organizations find a great benefit in having documentation that relates the policy to the platform, and for each software product that needs security-related configuration. It should be possible to see the line from policy to procedures, and see that the policy is enforced in the implementation environment.

This chapter provides an overview of how to implement some of the common statements that are defined on a security policy.

This chapter describes the following topics:

- ▶ User ID management
- ▶ Communication encryption
- ▶ Single system image security
- ▶ Auditing

4.1 User ID management

User ID management is closely related to how the security policy is described. All the management of user ID identity, access, and entitlement should be in accordance with each of the policies that are described in the company's security policy.

This section describes some mechanisms that are available on z/VM to control user IDs and their accesses and entitlements.

4.1.1 Least privilege principle

In an operating system, some operations are privileged and the permission to perform these operations are restricted to authorized users. These privileged operations usually include tasks such as restarting the system, adding and modifying privileges to other users, adding and deleting users, and modifying the system date and time.

A system that is secure requires that each user should be granted only those privileges that are necessary to complete its task. Privileges provide the advantage that only users that require certain privileges need to be granted these privileges. This restriction of privileges is known as the *principle of least privilege*, and it is useful in limiting damage to the system that can result from an accident, error, or malicious administrators and operators, and is useful when the system must be audited. The audit of a privileged task is reduced to those users that are allowed to run that task.

CP privilege classes

As described in 2.1.7, "Role-based access controls and CP privilege classes" on page 18, one of the ways to control privileges for a user is through z/VM privilege classes. Every user that is defined in the z/VM User Directory has one or more privilege classes. When the system security policy follows the enterprise security policy, privilege classes represent jobs or roles on the system and are associated with an enterprise security policy job or role. The privilege classes are used in z/VM to implement *role-based access control (RBAC)*.

There are seven privilege classes that are defined by default in z/VM, which are represented by A - G. These letters represent the specific roles in the z/VM operating environment, ranging from System Operator to General User. Using the default classes, a privileged user is any user with a class other than class G authority on the system.

It is possible to create privilege classes that meet the enterprise security policy according to the roles that are described in it. These classes can be represented by I - Z, or 1 - 6. Example 4-1 changes the **SHUTDOWN** command from privilege class A to privilege class S. In this situation, only users with privilege class S are authorized to shut down the system.

Example 4-1 Change the SHUTDOWN command to privilege class S

```
q cpcmd shutdown
Command: SHUTDOWN
  Status:      Enabled      Not Silent
  IBM Class:   A            PrivClasses: A
  CMBK Address: 009EEBF0    Entry Point: HCPSHUTD
Ready;

cp modify command shutdown privclasses s
Ready;

q cpcmd shutdown
```

```

Command: SHUTDOWN
  Status:      Enabled   Not Silent
  IBM Class:   A         PrivClasses: S
  CMDBK Address: 009EEBF0  Entry Point: HCPSHUTD
Command: -----
  Status:      Enabled   Not Silent
  IBM Class:   A         PrivClasses: A
  CMDBK Address: 01E00020  Entry Point: HCPSHUTD
Ready;

```

In Example 4-1 on page 84, the privilege class modification was done dynamically. If a restart is done on the system, the change is lost. To make the change permanent, update SYSTEM CONFIG to reflect the changes. The entry in the SYSTEM CONFIG file looks like the following string:

```
Modify cmd SHUTDOWN ibm A priv A
```

To determine which classes to which a user has access, run the **QUERY PRIVCLASS** command. To determine what CP commands and diagnostic instructions to which a user has access, run **QUERY COMMANDS**. Example 4-2 shows user RAMPAZZO privilege class and the commands that are available to it.

Example 4-2 Privilege class and commands that are available for default classes G and ANY

query privclass

```

Privilege classes for user RAMPAZZO
  Currently: G
  Directory: G
Ready; T=0.01/0.01 16:43:49

```

query commands

```

ADJUNCT      ADSTOP      ATTN        BEGIN       CHANGE      CLOSE
COMMANDS    COUPLE      CPFORMAT    CPU         DEFINE      DETACH
DIAL        DISCONNECT  DISPLAY     DUMP        ECHO        EXTERNAL
FOR         INDICATE    IPL         LINK        LOADVFCB    LOCATEVM
LOGON       LOGOFF      MESSAGE     NOTREADY    ORDER       PURGE
QUERY       READY      REDEFINE    REQUEST     RESET       RESTART
REWIND      SCREEN     SEND        SET         SIGNAL      SILENTLY
SLEEP       MSG        SPOOL       SPXTAPE     STOP        STORE
SYSTEM      TAG        TERMINAL    TRACE       TRANSFER    UNCOUPLE
UNDIAL      VDELETE    VINPUT      VMDUMP     XAUTOLOG    XSPPOOL
DIAG00     DIAG08     DIAG0C     DIAG10     DIAG14     DIAG18
DIAG20     DIAG24     DIAG28     DIAG40     DIAG44     DIAG48
DIAG4C     DIAG54     DIAG58     DIAG5C     DIAG60     DIAG64
DIAG68     DIAG70     DIAG7C     DIAG88     DIAG8C     DIAG90
DIAG94     DIAG98     DIAG9C     DIAGA0     DIAGA4     DIAGA8
DIAGB0     DIAGB4     DIAGB8     DIAGBC     DIAGC8     DIAGD0
DIAGDC     DIAGE0     DIAGE4     DIAGEC     DIAGF0     DIAGF8
DIAG204    DIAG210    DIAG214    DIAG218    DIAG220    DIAG224
DIAG238    DIAG23C    DIAG240    DIAG244    DIAG248    DIAG250
DIAG254    DIAG258    DIAG260    DIAG264    DIAG268    DIAG26C
DIAG270    DIAG274    DIAG278    DIAG27C    DIAG280    DIAG288
DIAG29C    DIAG2A0    DIAG2A4    DIAG2A8    DIAG2C4    DIAG2E0
DIAG2FC    DIAG308
Ready; T=0.01/0.01 16:46:09

```

The COMMAND directory statement

In some cases, a user might need to run a privileged command during logon to set up a user, but does not need to have authorization to run all the commands of the privilege class of this command. One of the solutions is to move this command to a new privilege class and grant access to this new class for the user.

Another solution where you do not need to create a privilege class is to place the **COMMAND** statement into the user directory. The **COMMAND** statement is part of a user directory entry. This statement, which supports up to 255 characters, can run a privileged command after the instantiation of a VM but before the guest has formally undergone an IPL. This command bypasses the need to give a user a specific clearance level while allowing flexibility in configuration.

When using the **COMMAND** statement, make sure it is defined before any device statement and any command operands are specified upper case. In Example 4-3, user RAMPAZZO has **QUERY CHPIDS** specified at its directory. This command is available just to privilege classes B and E, and during the logon process, the user can run the command.

Example 4-3 Run the COMMAND directory statement

```
USER RAMPAZZO LNX4ITSO 64M 96M G
  COMMAND QUERY CHPIDS
  SPOOL 000C 2540 READER *
  SPOOL 000D 2540 PUNCH A
  SPOOL 000E 1403 A
  CONSOLE 009 3215 T
```

Log on process:

```
LOGON RAMPAZZO
z/VM Version 6 Release 3.0, Service Level 1601 (64-bit),
built on IBM Virtualization Technology
There is no logmsg data
FILES: 0001 RDR, NO PRT, NO PUN
LOGON AT 14:10:36 EDT TUESDAY 06/21/16
  0 1 2 3 4 5 6 7 8 9 A B C D E F
0x + + + + + + + + + + + + + + +
1x + + + + + + + + + + + + + + +
2x + + + + + + + + + + + + + + +
3x + + + + + + + + + + + + + + +
4x + + + + + + + + + + + + + + +
5x + + + + + + + + + + + + + + +
6x + + + + + + + + + + + + + + +
7x + + + + + + + + + + + + + + +
8x + + + + + + + + + + + + + + +
9x + + + + + + + + + + + + + + +
Ax + + + + + + + + + + + + + + +
Bx + + + + + + + + + + + + + + +
Cx + + + + + + + + + + + + + + +
Dx + + + + + + + + + + + + + + +
Ex + + + + + + + + + + + + + + +
Fx + + + + + + + + + + + + + + +

+ Available
- Offline
. Not configured
```

Although the **COMMAND** statement is limited to 255 characters, multiple statements can exist for a single user definition.

IBM Resource Access Control Facility optional user attributes

When a system is IBM Resource Access Control Facility (RACF) protected, it is possible to assign attributes to users by running RACF commands. User attributes describe various extraordinary privileges, restrictions, and processing environments that can be assigned to specified users.

It is possible to assign attributes at either the system level or at the group level. When assigned at the system level, attributes are effective for the entire RACF protected system. When assigned at the group level, their effect is limited to profiles that are within the scope of the group. The scope of control of a group-level attribute is inherited to the group-ownership structure to its subgroups until a subgroup is owned by a user, rather than a superior group.

Figure 4-1 shows an example of how the attributes are inherited through subgroups. In this figure, GROUP1 owns GROUP2, GROUP2 owns GROUP3 and USER1, and so on. A user who is connected to GROUP1 with the group-SPECIAL attribute has an explicit scope of control as shown in the figure. That is, the user cannot modify any profiles that are owned by GROUP5.

Following the least privilege principle, SPECIAL, AUDITOR, and OPERATIONS attributes should be assigned to a minimum number of people in the system to administer security.

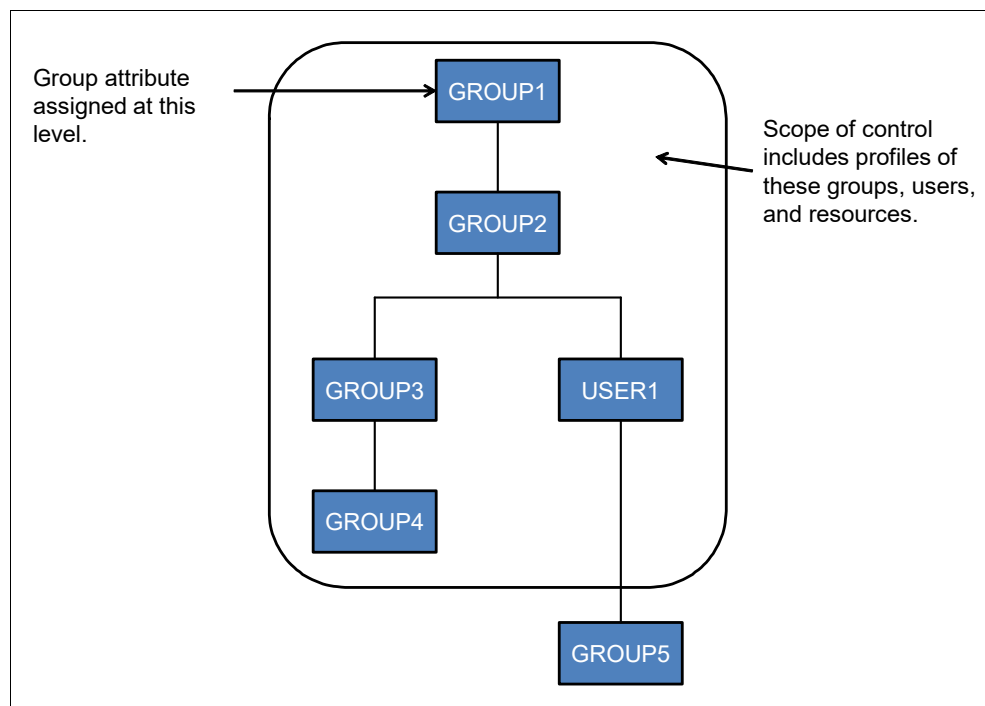


Figure 4-1 Scope of control of an attribute at group level

Table 4-1 lists the user attributes that are available in RACF and its descriptions.

Table 4-1 User attributes

User attribute	Description
SPECIAL	The SPECIAL attribute gives the user full control over all the RACF profiles in the RACF database when assigning it at the system level. At the system level, the SPECIAL attribute allows the user to issue all RACF commands. When you assign the SPECIAL attribute at the group level, the group-SPECIAL user has full control over all resources that are within the scope of the group, and cannot issue RACF commands that have a global effect on RACF processing.
AUDITOR	When assigning the AUDITOR attribute at the system level, it gives the user full responsibility for auditing the security controls and the use of system resources across the entire system. With it, the user can specify logging options on the RACF commands, can list the auditing options of any profiles by using the RACF commands, and can control additional logging to SMF for detecting changes and attempts to change the RACF database or for detecting accesses and attempted accesses of RACF protected resources. When assigning the AUDITOR attribute at the group level (that is, when assigning the group-AUDITOR attribute), authority is restricted to resources that are within the scope of the group.
ROAUDIT	When assigning the ROAUDIT attribute at the system level, it gives the user the authority to list auditing information using the LISTDSD, RLIST, LISTUSER, LISTGRP, SETROPTS LIST, and SEARCH commands, as well as the IRRUT100 utility. The user who has the ROAUDIT attribute can list all of the profile information that is available to the SPECIAL user, as well as information that is available to auditors.
OPERATIONS	When assigning this attribute at the system level, it allows the user to perform any maintenance operations, such as copying, reorganizing, cataloging, and scratching, on RACF protected resources. At the group-OPERATIONS level, the authorization to perform these operations is restricted to the resources that are within the scope of the group.
CLAUTH	The CLAUTH (class authority) attribute allows the user to define profiles in a specific RACF class. A user can have class authority for the USER class and any of the classes that are defined in the class descriptor table (CDT).
REVOKE	This attribute excludes the RACF defined user from entering the system. Revoke can be assigned at the group level, in which case the user cannot enter the system that is connected to that group.
PROTECTED	A protected user ID cannot be used to enter the system by any method that uses a supplied password, such as CP logon, rlogin, or FTP. Also, a protected user ID cannot be revoked through inactivity or unsuccessful attempts to access the system by using an incorrect password or password phrases. A protected user ID is defined by assigning the NOPASSWORD and NOPHRASE attributes through the ADDUSER or ALTUSER command.

To show the attributes of a user, list the user's profile. Example 4-4 show attributes SPECIAL and OPERATIONS that are assigned to user WILLIANR.

Example 4-4 Display attributes on a user

```
rac lu willianr
USER=WILLIANR NAME=UNKNOWN OWNER=IBMUSER CREATED=23.167
DEFAULT-GROUP=SYS1 PASSDATE=23.167 PASS-INTERVAL= 30 PHRASEDATE=N/A
ATTRIBUTES=SPECIAL OPERATIONS
REVOKE DATE=NONE RESUME DATE=NONE
```



```

LAST-ACCESS=23.172/15:14:17
CLASS AUTHORIZATIONS=NONE
NO-INSTALLATION-DATA
NO-MODEL-NAME

```

To give an attribute to a user, run the **ALTUSER** command. Example 4-5 shows the attribute **SPECIAL** being added to user **RAMPAZZO**.

Example 4-5 Add attribute SPECIAL to user RAMPAZZO

rac lu rampazzo

```

USER=RAMPAZZO NAME=UNKNOWN OWNER=IBMUSER CREATED=23.167
DEFAULT-GROUP=SYS1 PASSDATE=23.167 PASS-INTERVAL= 30 PHRASEDATE=N/A
ATTRIBUTES=NONE
REVOKE DATE=NONE RESUME DATE=NONE
LAST-ACCESS=23.168/15:26:13
CLASS AUTHORIZATIONS=NONE
NO-INSTALLATION-DATA
NO-MODEL-NAME
LOGON ALLOWED (DAYS) (TIME)
-----
ANYDAY ANYTIME
GROUP=SYS1 AUTH=USE CONNECT-OWNER=IBMUSER CONNECT-DATE=23.167
CONNECTS= 02 UACC=NONE LAST-CONNECT=16.168/15:26:13
CONNECT ATTRIBUTES=NONE
REVOKE DATE=NONE RESUME DATE=NONE
SECURITY-LEVEL=NONE SPECIFIED
CATEGORY-AUTHORIZATION
NONE SPECIFIED
SECURITY-LABEL=NONE SPECIFIED
Ready;

```

rac alu rampazzo special

Ready;

rac lu rampazzo

```

USER=RAMPAZZO NAME=UNKNOWN OWNER=IBMUSER CREATED=23.167
DEFAULT-GROUP=SYS1 PASSDATE=23.167 PASS-INTERVAL= 30 PHRASEDATE=N/A
ATTRIBUTES=SPECIAL
REVOKE DATE=NONE RESUME DATE=NONE
LAST-ACCESS=16.168/15:26:13
CLASS AUTHORIZATIONS=NONE
NO-INSTALLATION-DATA
NO-MODEL-NAME
LOGON ALLOWED (DAYS) (TIME)
-----
ANYDAY ANYTIME
GROUP=SYS1 AUTH=USE CONNECT-OWNER=IBMUSER CONNECT-DATE=23.167
CONNECTS= 02 UACC=NONE LAST-CONNECT=16.168/15:26:13
CONNECT ATTRIBUTES=NONE
REVOKE DATE=NONE RESUME DATE=NONE
SECURITY-LEVEL=NONE SPECIFIED
CATEGORY-AUTHORIZATION
NONE SPECIFIED
SECURITY-LABEL=NONE SPECIFIED

```

Ready;

To remove an attribute from a user, run the ALTUSER command. Example 4-6 shows removal of the SPECIAL attribute from user RAMPAZZO.

Example 4-6 Remove the SPECIAL attribute from user RAMPAZZO

```

rac lu rampazzo
USER=RAMPAZZO NAME=UNKNOWN OWNER=IBMUSER CREATED=23.167
DEFAULT-GROUP=SYS1 PASSDATE=23.167 PASS-INTERVAL= 30 PHRASEDATE=N/A
ATTRIBUTES=SPECIAL
REVOKE DATE=NONE RESUME DATE=NONE
LAST-ACCESS=16.168/15:26:13
CLASS AUTHORIZATIONS=NONE
NO-INSTALLATION-DATA
NO-MODEL-NAME
LOGON ALLOWED (DAYS) (TIME)
-----
ANYDAY ANYTIME
GROUP=SYS1 AUTH=USE CONNECT-OWNER=IBMUSER CONNECT-DATE=23.167
CONNECTS= 02 UACC=NONE LAST-CONNECT=16.168/15:26:13
CONNECT ATTRIBUTES=NONE
REVOKE DATE=NONE RESUME DATE=NONE
SECURITY-LEVEL=NONE SPECIFIED
CATEGORY-AUTHORIZATION
NONE SPECIFIED
SECURITY-LABEL=NONE SPECIFIED
Ready;

```

```

rac alu rampazzo nospecial
Ready;

```

```

rac lu rampazzo
USER=RAMPAZZO NAME=UNKNOWN OWNER=IBMUSER CREATED=23.167
DEFAULT-GROUP=SYS1 PASSDATE=23.167 PASS-INTERVAL= 30 PHRASEDATE=N/A
ATTRIBUTES=NONE
REVOKE DATE=NONE RESUME DATE=NONE
LAST-ACCESS=16.168/15:26:13
CLASS AUTHORIZATIONS=NONE
NO-INSTALLATION-DATA
NO-MODEL-NAME
LOGON ALLOWED (DAYS) (TIME)
-----
ANYDAY ANYTIME
GROUP=SYS1 AUTH=USE CONNECT-OWNER=IBMUSER CONNECT-DATE=23.167
CONNECTS= 02 UACC=NONE LAST-CONNECT=16.168/15:26:13
CONNECT ATTRIBUTES=NONE
REVOKE DATE=NONE RESUME DATE=NONE
SECURITY-LEVEL=NONE SPECIFIED
CATEGORY-AUTHORIZATION
NONE SPECIFIED
SECURITY-LABEL=NONE SPECIFIED
Ready;

```

More information about RACF attributes can be found in *RACF Security Server Security Administrator's Guide*, SC24-6218.

4.1.2 RACF passwords and password phrases

Since RACF FL 530, it is possible to define password phrases for z/VM user IDs. With APAR VM65719 from September 2015, many password and security policy enhancements were introduced.

It is important to understand that *passwords* and *password phrases* are two different things. *Passwords* are upper case by default or can be mixed case, if enabled with the **RAC SETROPTS PASSWORD(MIXEDCASE)** command, and *password phrases* are mixed case by default. Passwords are 1 - 8 characters, and password phrases that use the default installation can be 14 - 100 characters. A user can be assigned a password, a password phrase, or both.

The default operation when creating a user profile is to not have a default value that is assigned to either the password or the password phrase. The user is a protected user and cannot log on. This is the preferable situation for disconnected service machines or guests user IDs.

For human IDs, the enterprise security policy defines what kind of authenticator should be used. The initial password or password phrase of a user is not assigned by them. When assigned a password or password phrase, the user can change that value at any time, but will not be able to remove it. When assigning the value for a user for the first time, make sure it is difficult to guess so the user has enough time to change it before someone else does. By default, the user ID is forced to change this initial value the first time it is used.

This section demonstrates how to implement both functions.

Password and password phrases rules

Your organization's security policy is likely to have a section describing the rules that govern system passwords. On z/VM with RACF installed, these rules are implemented with the **RAC SETROPTS** commands by a user with the SPECIAL attribute. There are several parameters that control password requirements:

- ▶ Password change interval
- ▶ Inactive virtual machine (VM) intervals
- ▶ When access is revoked because of unsuccessful login attempts
- ▶ Password history (password reuse)

For example, here is a list of password and password phrases policies:

- ▶ **RAC SETROPTS PASSWORD(INTERVAL(90))** defines the change interval to 90 days.
- ▶ **RAC SETROPTS PASSWORD(MINCHANGE(5))** specifies that users cannot change their passwords more than once in 5 days, for example).
- ▶ **RAC SETROPTS INACTIVE(30)** revokes a user ID if it is unused for more than 30 days.
- ▶ **RAC SETROPTS PASSWORD(REVOKE(4))** defines the limit of successive incorrect use of passwords or password phrases before revoking the user.
- ▶ **RAC SETROPTS PASSWORD(HISTORY(6))** defines the number of previous passwords and password phrases that RACF saves for each user to avoid duplication.

Password syntax rules

Password syntax rules include (up to eight syntax rules) the following items:

- ▶ Password length
- ▶ Password character requirements (vowels, numbers, and so on)
- ▶ Password in mixed case

For example, here is a list of password policies:

- ▶ **RAC SETROPTS PASSWORD(MIXEDCASE)** allows mixed-case passwords.
- ▶ **RAC SETROPTS PASSWORD(SPECIALCHARS)** allows special characters.

Here is a list of rules for password verification and control to define the syntax of the new passwords for your installation:

- ▶ **RAC SETROPTS PASSWORD(RULE1(LENGTH(6:8) ALPHA(1) ALPHANUM(3:8)))** and **RAC SETROPTS PASSWORD(RULE2(LENGTH(8)))**
- ▶ **RAC SETROPTS PASSWORD(RULE1(LENGTH(8) VOWEL(1,3,5:8) NUMERIC(2,4)))** and **RAC SETROPTS PASSWORD(RULE2(LENGTH(8) MIXEDALL(1:8)))**

The RACF **SETROPTS LIST** command displays the password settings that are shown in Example 4-7.

Example 4-7 RACF SETROPTS LIST to display password settings

```

PASSWORD PROCESSING OPTIONS:
  PASSWORD CHANGE INTERVAL IS  90 DAYS.
  MIXED CASE PASSWORD SUPPORT IS IN EFFECT
  6 GENERATIONS OF PREVIOUS PASSWORDS BEING MAINTAINED.
  AFTER  4 CONSECUTIVE UNSUCCESSFUL PASSWORD ATTEMPTS,
    A USERID WILL BE REVOKED.
  NO PASSWORD EXPIRATION WARNING MESSAGES WILL BE ISSUED.
INSTALLATION PASSWORD SYNTAX RULES:
  RULE 1  LENGTH(6:8)  A*LLLLLL
  RULE 2  LENGTH(8)   *****

LEGEND:
  A-ALPHA C-CONSONANT L-ALPHANUM N-NUMERIC V-VOWEL W-NOVOWEL *-ANYTHING
  c-MIXED CONSONANT m-MIXED NUMERIC v-MIXED VOWEL $-NATIONAL

```

Although the password verification is done by RACF when it is active, some user CP directory entries still have meaning. Here are some examples:

- ▶ **NOLOG**: The user cannot log on to the system.
- ▶ **AUTOONLY**: The user can only be XAUTOLOGed. Having a user who is defined with NOPASSWORD and NOPHRASE attributes has the same effect.
- ▶ **NOPASS**: The user can log on without using a password. When the FACILITY class is not activated, or the IRR.NOPASS profile is not defined on the FACILITY class, any NOPASS user can log on without specifying a password. The security administrator should take extra care when using the **NOPASS** statement.

Password phrases

A password phrase is a character string consisting of mixed-case letters, numbers, and any special characters, including blanks. Consisting of all those possibilities, password phrases have security advantage over passwords.

It is possible to specify the **NOPASSWORD** attribute in either **ADDUSER** or **ALTUSER** so that a user can authenticate only with a password phrase, which is stronger than a password.

Password phrases are implemented by default in RACF with a basic set of syntax rules. These syntax rules apply to all password phrases and cannot be altered or removed. However, it is possible to enhance the rules installing the ICHPWX11 exit. This section provides information about how to implement the exit.

RACF has the option of using the new password phrase exit, ICHPWX11, to enhance RACF function when validating a new password phrase. This exit runs a REXX exec **IRRPHREX**. A sample is shipped by IBM in source form on the RACFVM 305 disk and consists of the exit itself, ICHPWX11, and a REXX exec named **IRRPHREX**. ICHPWX11 must be installed as described in *RACF Security Server System Programmer's Guide*, SC24-6219. As shipped, all the checks are disabled and the exec is functionally equivalent to having no exit, but the following checks can be enabled in the REXX exec:

- ▶ Minimum length
- ▶ Maximum length
- ▶ List of allowable characters
- ▶ Leading blanks that are allowed or not
- ▶ Trailing blanks that are allowed or not
- ▶ Words in user name that is allowed or not
- ▶ Triviality checks
- ▶ Minimum unique characters by position from old password phrase
- ▶ Minimum unique words from old password phrase
- ▶ Dictionary check (hard coded list of words)

The exit gains control when a new password phrase is processed. It can examine the value that is specified for the password phrase and enforce installation rules in addition to the RACF rules. For example, although RACF does not allow the user ID to be part of the password phrase, the exit can perform more complex tests such disallow the company name, the names of months, and the current year in the password phrase.

The user of the new password phrase exit *augments* the RACF rules, but cannot override them. Be sure that the exit and the RACF rules do not contradict each other. For example, if the exit requires that the pass phrases contain all alphabetic characters, users cannot create password phrases because RACF requires at least two non-alphabetic characters. If you try to assign a phrase that conflicts the password rules, RACF does not accept the new phrase and displays the following message:

```
ICH21039I NEW PASS PHRASE REJECTED BY RACF RULES
```

The interval value that is specified on the **PASSWORD** command applies to both passwords and password phrases. It continues to be processed by the new password exit, ICHPWX01, and is not passed to the ICHPWX11 exit.

The steps to implement password phrases for RACF are documented in *RACF Security Server System Programmer's Guide*, SC24-6149. The HLASM product is required to assemble the ICHPWX11 file. If HLASM is not available, IBM provides a TEXT file already assembled that can be used, as described on step 4.

Complete the following steps on the 6VMRAC30 VM:

1. Run **access 590 t**.
2. Run **vmfsetup 6vmrac30 racf**.
3. Run **copy ichpwx11 assemble k = = e**.
4. If HLASM is not available, then complete the following steps:
 - a. Run **copy ichpwx11 text k = txt00000 e**.
 - b. Go to step 11 on page 95.

5. Remove the following comments by running `rpibllpa exec v`:


```
*:OBJNAME. ICHPWX11 LEPARMS RENT REUS LET NCAL XREF SIZE 100K,80K
*:OPTIONS. IGNORE
*:PARTID. ICHPWX11 TXT
*:EOBJNAME.
```
6. Run `vmfh1asm ichpwx11 6vmrac30 racf ($select outmode e.`
7. Run `rename ichpwx11 txt00000 e = txt10001 e.`
8. Run `rename ichpwx11 assemble e = asm10001 e.`
9. Run `vmfsim logmod 6VMRAC30 vvt1cl e tdata :mod 1cl0001 :part ichpwx11 txt.`
10. Run `mfsim logmod 6VMRAC30 vvt1cl e tdata :mod 1cl0001 :part ichpwx11 asm.`
11. Run `vmfblld ppf 6vmrac30 racf (serviced.`

Put the code into production (the copy files are created by VMFBLD to the RACFVM 305 disk).

Note: The process that is documented in *RACF Security Server System Programmer's Guide*, SC24-6219 does not work as documented. When you link to the RACFVM 305 disk, you cannot get it in write mode because RACFVM has the disk in write mode. If you force off RACFVM, then you have no external security manager (ESM) and you cannot autolog RACMAINT after you have forced RACFVM. This section describes how you can put the code into production.

For this process, you must give 6VMRAC30 the privilege class A or C so that it can run the `set secuser` command. You can use your normal processes to change the privilege class and then place the directory online. You have to log off and then log on to the 6VMRAC30 VM to pick up the directory change. Then, run the `vmfsetup 6vmrac30 racf` command to reestablish your disk search order.

Perform the task that is shown in Example 4-8 to gain write access to the RACFVM 305 disk.

Example 4-8 Write access to the RACFVM 305 disk

```
set secuser racfvm 6vmrac30
HCPCFX6768I SECUSER of RACFVM initiated.
Ready; T=0.01/0.01 15:07:06
send cp racfvm det 305
Ready; T=0.01/0.01 15:07:14
RACFVM : DASD 0305 DETACHED
link racfvm 305 305 mr
RACFVM : (OPERATOR) ICH408I USER(6VMRAC30) GROUP(SYS1 ) NAME(#####)
#####)
RACFVM : (OPERATOR) RACFVM.305 CL(VMMDISK )
RACFVM : (OPERATOR) INSUFFICIENT ACCESS AUTHORITY
RACFVM : (OPERATOR) ACCESS INTENT(CONTROL) ACCESS ALLOWED(NONE)
RPIMGRO32E YOU ARE NOT AUTHORIZED TO LINK TO RACFVM.305
HCPLNM298E RACFVM 0305 not linked; request denied
Ready(00298); T=0.01/0.01 15:07:22
send cp racfvm link * 305 305 mr
RACFVM : DASD 0305 LINKED R/W
Ready; T=0.01/0.01 15:07:53
send racfvm acc 305 b/a
RACFVM : DMSACC724I 305 replaces B (305)
Ready; T=0.01/0.01 15:08:03
```

As shown, there is a security violation with the `link` command. To solve it, use one of your systems RACF administrators and run the `racf permit` command to allow 6VMRAC30 to have *control* access to the RACFVM 305 disk:

```
rac permit racfvm.305 class(vmmdisk) id(6vmrac30) ac(control)
```

Now, you can complete the task of moving files to the RACFVM 305 disk, as shown in Example 4-9.

Example 4-9 Move files to the RACFVM 305 disk

```
send racfvm det 305
RACFVM : DASD 0305 DETACHED
RACFVM : CST
Ready; T=0.01/0.01 15:17:45
link racfvm 305 305 mr
Ready; T=0.01/0.01 15:17:55
acc 305 z
Ready; T=0.01/0.01 15:18:01

vmfcopy * * k = = z (prodid 6vmrac30%racf oldd replace
Ready; T=0.25/0.33 15:19:35
det 305
DASD 0305 DETACHED
Ready; T=0.01/0.01 15:19:46
send racfvm link * 305 305 mr
RACFVM : CST
Ready; T=0.01/0.01 15:19:57
send racfvm access 305 b/a
RACFVM : DMSACC724I 305 replaces B (305)
Ready; T=0.01/0.01 15:20:07
RACFVM : DMSACP723I B (305) R/O
RACFVM : CST
```

Then, run the RACFVM `ipl 490` command that restarts RACF, as shown in Example 4-10. You cannot perform an IPL of CMS or 190 in RACFVM, or RACF does not start correctly.

Example 4-10 RACF performs an IPL of 490

```
send cp racfvm ipl 490 clear parm autocr
Ready;
RACFVM : RACFVM CMS XA Rel. 27 2011-10-18
RACFVM : DMSACP723I B (305) R/O
RACFVM : DMSACP723I T (190) R/O
RACFVM : RACF is defined to the Z/VM system and the current product status is E
NABLED
RACFVM :
RACFVM : RACF
RACFVM : Feature for z/VM
RACFVM : Version 6.3.0
RACFVM :
RACFVM : Licensed Materials - Property of IBM
RACFVM : 5741-A07
RACFVM : (C) Copyright IBM CORP. 1981, 2012 All Rights Reserved.
RACFVM :
RACFVM : DMSACC723I R (0200) R/W - OS
RACFVM : DMSACC723I Q (0300) R/W - OS
RACFVM : CSTSET001I CMS SUB-TASKING SUPERVISOR INITIALIZED.
RACFVM : CSTINT003I INITIATOR ACTIVATED.
```



```

RACFVM : ICH508I ACTIVE RACF EXITS: ICHRCX02
RACFVM : ICH520I RACF 6.3.0 IS ACTIVE.
RACFVM : RPISTR001I Program CSTDYNST Initiated.
15:37:15 * WNG FROM RACFVM : RACF/VM SERVICES ARE NOW AVAILABLE.
RACFVM : * WNG FROM RACFVM : RACF/VM SERVICES ARE NOW AVAILABLE.
RACFVM : RPISTR002I Program CSTDYNST Ended. Completion code = 000000.
RACFVM : RPISTR003I Subtask RPIMSG Initiated.
RACFVM : RPISTR003I Subtask RPIINIT Initiated.
RACFVM : RPICLS104W - DEFAULT SETTINGS WERE MADE FOR ALL AUDITABLE AND
RACFVM : CONTROLLABLE VM EVENTS.
RACFVM : RPICLS123I RACF Extended password support registered with CP
RACFVM : RPIMGR003I 15:37:15: CONNECTION COMPLETE TO CP ON PATHID 0000
RACFVM : RACF AUTHORIZATION COMMUNICATION INTERFACE READY
set secuser racfvm reset

```

Note: This process was the only way that you can allow the RACFVM 305 disk to be updated without a system outage. If you can accept the outage, then you should shut down the system and perform an IPL with the **NOAUTOLOG** parameter. Then, start RACMAINT as described previously.

This completes the instructions about how to install the exit. At this point, the sample exit does not perform any additional function compared to having no exit. You should now adjust the exit to reflect your installation requirements.

Password phrase syntax rules

Here are password phrase syntax rules:

- ▶ Maximum length: 100 characters
- ▶ Minimum length:
 - Nine characters when ICHPWX11 is present and allows the new value.
 - Fourteen characters when ICHPWX11 is not present.
- ▶ Must not contain the user ID (as sequential uppercase or sequential lowercase characters).
- ▶ Must contain at least two alphabetic characters (A - Z, a - z).
- ▶ Must contain at least two non-alphabetic characters (numerics, punctuation, or special characters).
- ▶ Must not contain more than two consecutive characters that are identical.
- ▶ Must be enclosed in single quotation marks, with single quotation marks within the password phrase doubled. The quotation marks must be removed from the password phrases when RACF prompts at logon.
- ▶ Must not contain forward slashes, nulls (X'00'), or leading or trailing blanks.

Only a RACF administrator can assign the initial phrase. When assigned, the user can modify the phrase, and is prompted to change it by default the first time it is used to log on.

To disable the password function and enable a phrase, run the following command:

```
rac alu willianr nopassword phrase('it is friday')
```

When the VM WILLIANR logs on to the system, it is prompted to change the password. When changing the password from the logon prompt, do not use the quotation marks (for example, 'red white blue' should be red white blue).

If the VM wants to change the phrase while logged on to the system, run the following command:

```
rac phrase phrase('red white blue' 'howdy to everyone in vm land')
```

Although it looks like a mistake, the command is correct. It is **phrase** and it has an operand of **phrase**.

It is possible to adjust the z/VM logo to accept more than eight characters in the password field, so the use of the command line is not needed for password phrases. IBM provides a utility program that is called **DRAWLOGO** and a sample XEDIT macro called X\$DRWL\$X at CP sample disk, 2C2, on the MAINT630 user. To use the utility, rename **DRAWLOGO** **SAMPEXEC** to **DRAWLOGO EXEC** and X\$DRWL\$X **SAMPXEDI** to X\$DRWL\$X **XEDIT**.

Open the input file (the default is INPTAREA SAMPLE on PMAINT CF0 disk) with the DRAWLOGO utility:

```
drawlogo INPTAREA SAMPLE B
```

Press PF5 and use the Settings menu to select the length of use ID and password input area. Place the cursor in the position you want the password input field to start and use PF4 to access the Input menu. Pressing PF4 again fills the password input area with the characters for password input. Press PF11 to display the results.

RACF user passwords encryption

RACF provides three algorithms for authenticating passwords and password phrases:

- ▶ Masking
- ▶ Data Encryption Standard (DES) algorithm
- ▶ Key Derivation Function with AES256 (KDFAES) algorithm for passwords

The masking algorithm is the original algorithm that is provided with RACF. The RACF DES algorithm provides a higher level of security than the masking algorithm and is identified in the Federal Information Processing Standard 46-1 of the Computer Systems Laboratory in Gaithersburg, Maryland, of the National Institute of Standards and Technology of the United States Government. DES is accepted as a national and international standard. The KDFAES algorithm provides the highest level of security, and is designed to be resistant to offline attacks. When installing RACF on your system, the DES algorithm is the default algorithm.

RACF also supports an installation-defined method that is implemented that uses the ICHDEX01 exit. For more information about ICHDEX01, see "RACF Installation Exits", in *RACF Security Server System Programmer's Guide*, SC24-6219.

To display the current enabled algorithms, use the **RACF SETROPTS LIST** command. Example 4-11 show an excerpt from the command output.

Example 4-11 Password excerpt from RACF SETROPTS LIST command

```
PASSWORD PROCESSING OPTIONS:
THE ACTIVE PASSWORD ENCRYPTION ALGORITHM IS LEGACY
PASSWORD CHANGE INTERVAL IS 30 DAYS.
PASSWORD MINIMUM CHANGE INTERVAL IS 0 DAYS.
MIXED CASE PASSWORD SUPPORT IS NOT IN EFFECT
SPECIAL CHARACTERS ARE NOT ALLOWED.
NO PASSWORD HISTORY BEING MAINTAINED.
USERIDS NOT BEING AUTOMATICALLY REVOKED.
NO PASSWORD EXPIRATION WARNING MESSAGES WILL BE ISSUED.
NO INSTALLATION PASSWORD SYNTAX RULES ARE PRESENT.
```

Regarding encryption programs, in general it is about a two-way process: encryption and decryption.

Encryption process uses the data and an encryption key to create the new encrypted form of the data.

Decryption is the reverse operation, and uses the encryption key and the encrypted form of the data to recreate the original data.

RACF, when configured to do so, uses the encryption algorithms to encrypt the password and store it on the database. As RACF does not store the password that is used as the encryption key, until now, there is no way to reconstruct the original data, meaning that there is no way to decrypt the password that is encrypted and stored in the RACF database. With this one-way process, RACF provides a high level of security.

This does not mean any user on the system can have READ access to the RACF database. Use the Least Privilege Principle and give READ access only to the users that really need it for their jobs.

By default, by using the DES algorithms to authenticate a user on the system, RACF uses the password or password phrase as an encryption key to encrypt the user ID and store it in the RACF database. When a user must log in, RACF again encrypts the user ID by using the password or password phrase that is provided during the login and compares it with the encrypted data in the RACF database. If the data matches, the password or passphrase is valid.

The RACF KDFAES algorithm

The KDFAES algorithm is one of the available encryption algorithms in RACF that is used to encrypt password and password phrases. It requires enablement of CPACF, which is a no-charge feature on your hardware (FC 3863). This algorithm is preferred among others that are available because it is more secure to offline attacks due to incorporating the following properties:

- ▶ Each instance of a RACF password uses randomly generated text in the encryption process, which prevents the use of pre-computed password hashes. An offline attack must perform the full encryption process for every password guess, as opposed to simply comparing the password hash against a list of pre-computed values. This configuration slows down the attack, making it take much longer to guess passwords.
- ▶ Thousands of hash operations are performed against the password and random text to generate a key, which is then used to encrypt the user ID, which also serves to slow down an offline attack, which must perform the same number of operations for each password guess. However, the authorized user logging on to the system that uses their clear text password does not notice the increased processing impact.

To enable the KDFAES algorithm for password and password phrases, run the SETROPTS command, as shown in Example 4-12.

Example 4-12 Enable the KDFAES encryption algorithm

```
rac setropts password(algorithm(kdfaes))
Ready;
```

```
rac setropts list
```

```
...
```

```
PASSWORD PROCESSING OPTIONS:
```

```
THE ACTIVE PASSWORD ENCRYPTION ALGORITHM IS KDFAES
```

```
PASSWORD CHANGE INTERVAL IS 30 DAYS.
```

```
PASSWORD MINIMUM CHANGE INTERVAL IS 0 DAYS.
MIXED CASE PASSWORD SUPPORT IS NOT IN EFFECT
SPECIAL CHARACTERS ARE NOT ALLOWED.
NO PASSWORD HISTORY BEING MAINTAINED.
USERIDS NOT BEING AUTOMATICALLY REVOKED.
NO PASSWORD EXPIRATION WARNING MESSAGES WILL BE ISSUED.
NO INSTALLATION PASSWORD SYNTAX RULES ARE PRESENT.
```

```
...
Ready;
```

Make sure that you review “Planning Considerations for Enabling KDFAES” in *RACF Security Server System Programmer’s Guide*, SC24-6219 before you enable KDFAES.

After enabling the KDFAES algorithms, existing passwords that are encrypted with the DES algorithm continue to be evaluated properly by RACF. User passwords do not need to be changed. When the users change their passwords, the process is encrypted by using the KDFAES algorithm. The **PWCONVERT** operand of the **ALTUSER** command can be used to transform a password that is encrypted with the DES algorithm, but not a password phrase, into a password that is encrypted with KDFAES without requiring the password to be changed.

If you have backups of the RACF database containing passwords that were encrypted by using DES or masking, they are more susceptible to offline attacks. If the hash represents the same clear text password as the user’s current password, and an attacker can guess the value, it can be used to log on to the user’s account even if the current password is encrypted by using KDFAES. The **EXPIRED** operand of the **ALTUSER** command can be used to mark a password as expired, requiring it to be changed at the next logon. This can help accelerate the password change process.

If previous passwords were encoded by using the masking algorithm, they must be changed. They will not be properly evaluated when KDFAES is enabled, and cannot be converted to KDFAES by using the **PWCONVERT** function.

4.1.3 Implementing RACF LOGONBY

RACF has support for the LOGONBY function with the SURROGAT class facility, but is not limited to the maximum of eight surrogate VMs. The RACF LOGON BY acts the same way as the CP LOGONBY function, allowing authorized VMs to log on to a shared VM by using their own password.

To implement the RACF LOGON BY facility, complete the following steps:

1. Run the **setropts** command to activate the CLASSACT(SURROGAT) class:

```
rac setropts class(surrogat)
```

2. Verify that the SURROGAT class is active:

```
rac setr list
```

Example 4-13 shows the output of the command.

Example 4-13 Enable the SURROGAT class

```
rac setropts class(surrogat)
Ready;
rac setr list
ATTRIBUTES = INITSTATS NOWHEN(PROGRAM)
```

```

STATISTICS = NONE
ACTIVE CLASSES = DATASET USER GROUP VMMDISK VMRDR VMBATCH VMLAN VMSEGMT
                FACILITY SURROGAT VXMBR VMXEVENT XFACILIT GXFACILI

```

3. Define the profiles of the form LOGONBY.shared_userid in the SURROGAT class for each user ID that is shared.
4. Permit specific users for the appropriate SURROGAT profiles.
5. List the information by running the **RLIST** command.

LOGON BY processing

As a preferred practice, create a sample file from which to copy to implement the LOGON BY function, as shown in Example 4-14, where you change *shrduser* and *surrogat-id1*.

Example 4-14 RPIDIRCT SURROGAT

```

RPIDIRCT SURROGAT A1 F 80 Trunc=80 Size=5 Line=0 Col=1 Alt=0
====>
0 * * * Top of File * * *
1 RDEFINE SURROGAT LOGONBY.shrdusr UACC(NONE) AUDIT(ALL)
2 PERMIT LOGONBY.shrdusr CL(SURROGAT) RESET(ALL)
3 PERMIT LOGONBY.shrdusr CL(SURROGAT) ACC(READ) ID(surrogat-id1)
4 PERMIT LOGONBY.shrdusr CL(SURROGAT) ACC(READ) ID(surrogat-id2)
5 RL SURROGAT LOGONBY.shrdusr AUTH
6 * * * End of File * * *

```

When you need to add surrogate users to the RACF database, copy this file to RPIDIRECT SYSUT1 on your A disk and then modify that file, as shown in Example 4-15.

Example 4-15 RPIDIRCT SYSUT1 before the changes

```

RPIDIRCT SYSUT1 A1 F 80 Trunc=80 Size=5 Line=0 Col=1 Alt=0
====> ch /shrdusr/MAINT/* *
0 * * * Top of File * * *
1 RDEFINE SURROGAT LOGONBY.shrdusr UACC(NONE) AUDIT(ALL)
2 2 PERMIT LOGONBY.shrdusr CL(SURROGAT) ACC(ALTER) ID(shrdusr) RESET(ALL)
3 PERMIT LOGONBY.shrdusr CL(SURROGAT) ACC(READ) ID(surg-id1)
4 PERMIT LOGONBY.shrdusr CL(SURROGAT) ACC(READ) ID(surg-id2)
5 RL SURROGAT LOGONBY.shrdusr AUTH
6 * * * End of File * * *

```

If you want to add SURROGAT support for the MAINT VM, tailor the file to look like Example 4-16.

Example 4-16 RPIDIRCT SYSUT1 after the changes

```

RPIDIRCT SYSUT1 A1 F 80 Trunc=80 Size=8 Line=0 Col=1 Alt=0
====>
0 * * * Top of File * * *
1 ALTUSER MAINT NOPASSWORD NOPHRASE
2 RDEFINE SURROGAT LOGONBY.MAINT UACC(NONE) AUDIT(ALL)
3 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(ALTER) ID(MAINT) RESET(ALL)
4 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(PWNOVAK)
5 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(PACOSTA)
6 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(BADER)
7 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(EDI)

```

```

8 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(VIC)
9 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(KLAUSM)
10 PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(WILLIANR)
11 RL SURROGAT LOGONBY.MAINT AUTH
12 * * * End of File * * *

```

ALTUSER MAINT NOPASSWORD NOPHRASE is a good way to protect the MAINT user ID from being revoked because of too many attempts with the wrong password. Before z/VM 5.3, MAINT could be revoked by logging on directly with too many incorrect passwords. Since the 5.3 release, if you set **MAINT NOPASSWORD**, the ID is protected from this type of attack. In our example, we show the **PERMIT** for each user, although defining the permission by group (for example, ITSOGRP) is a preferred practice. Run **RPIBLDDS EXEC** again to run these definitions, as shown in Example 4-17.

Example 4-17 Output of RPIBLDDS

rpibldds rpidirect sysut1

```

Processing batch file RPIDIRCT SYSUT1 using "RAC" command interface
=> RDEFINE SURROGAT LOGONBY.MAINT UACC(NONE) AUDIT(ALL)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(ALTER) ID(MAINT) RESET(ALL)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(PWNOVAK)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(PACOSTA)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(BADER)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(EDI)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(VIC)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(KLAUSM)
=> PERMIT LOGONBY.MAINT CL(SURROGAT) ACC(READ) ID(WILLIANR)
=> RL SURROGAT LOGONBY.MAINT AUTH

```

```

CLASS      NAME
-----
SURROGAT  LOGONBY.MAINT
LEVEL  OWNER      UNIVERSAL ACCESS  YOUR ACCESS  WARNING
-----
00    IBMUSER      NONE              READ         NO
INSTALLATION DATA
-----
NONE
APPLICATION DATA
USER      ACCESS  ACCESS COUNT
-----
IBMUSER  ALTER   000000
PWNOVAK  READ    000000
PACOSTA  READ    000000
BADER    READ    000000
EDI      READ    000000
VIC      READ    000000
KLAUSM   READ    000000
WILLIANR READ    000000

```

4.2 Communication encryption

Correctly implementing and managing security controls for the z/VM hypervisor is a mandatory cornerstone, no matter how large or small your enterprise is. Your security posture is only as strong as the weakest point, which means that the correct encryption of traffic must be implemented at all layers. Connectivity to the hypervisor layer and well-secured guests on an unsecured hypervisor are critical exposures. Furthermore, in nearly all circumstances, encrypting traffic as a default practice is common sense. Encryption requirements might also be mandated by company policy, clients, partners, vendors, industry regulations, or governing bodies.

The use of encrypted communication can increase the security of the IT infrastructure and should always be listed in the company security policy. By default, Telnet 3270 session data flows unencrypted over the network, in clear text, meaning that anyone who dumps the network traffic can see what is happening between the Telnet client and the z/VM 3270 connection.

Transport Layer Security (TLS), and its predecessor, Secure Sockets Layer (SSL), are cryptographic protocols to provide end-to-end encrypted communication. Digital certificates and trust hierarchies can be implemented to use encrypted communication. Dynamic SSL/TLS connections are supported by the following z/VM TCP/IP application servers and clients, which are updated to accommodate this support:

- ▶ TCP/IP server
- ▶ SSL server
- ▶ FTP server
- ▶ FTP client
- ▶ Telnet server (internal to the TCP/IP server)
- ▶ Telnet client
- ▶ Simple Mail Transfer Protocol (SMTP) server

When talking about SSL/TLS for z/VM, SSL* is a pool of CMS VMs that provide encrypted communication to clients connecting to z/VM. Its code is preinstalled as part of a standard z/VM installation and can be customized and enabled to provide SSL/TLS connections.

Most of the TCP/IP stack service machines can have security that is controlled by RACF. This allows RACF to process user ID authentication and authorization to the system and to resources, increasing the level of security on the system.

For more information about how to customize and enable encrypted communications to and from z/VM, see Chapter 4, “Installing and configuring z/VM”, in [The Virtualization Cookbook for IBM Z Volume 1: IBM z/VM 7.2, SG24-8147](#).

4.3 Single system image security

This section covers the security implications of using z/VM 6.3 with Single System Image (SSI) and live guest relocation (LGR).

This z/VM feature was introduced with z/VM 6.2 and it provides additional flexibility for your environment by allowing Linux guests to be moved from one logical partition (LPAR) to another. It also provides a set of shared resources for member systems and their Linux guests. Rather than managing security of a single implementation on a single device, administrators can manage the security of two or more operating systems. This control of access is a useful mechanism for helping to protect your data. In your SSI cluster, use storage

area network (SAN) zoning and logical unit number (LUN) masking to ensure that data is available only for servers that should access it.

This section also explains the concept of relocating domains to control the relocation of Linux on IBM Z guests to provide flexibility and availability to meet user demands for security and manageability.

4.3.1 Overview

VMs allow quick turnaround and flexibility for multiple projects and environments. To benefit from VMs, z/VM uses virtualization and gives administrators the power to manage their resources on the IBM Z platform.

With the IBM z/VM SSI, which was introduced with z/VM v6.2, a running Linux on IBM Z VM can be relocated from one member system to any other, a process known as *LGR*. Support for LGR allows you to move Linux virtual servers without disruption to the business, thus helping you to avoid planned outages. The z/VM systems are aware of each other and can benefit from their combined resources.

LGR enables clients to avoid loss of service due to planned outages by relocating guests from a system requiring maintenance to a system that remains active during the maintenance period. This capability can be used to move workloads from one z/VM LPAR to another when needed. It also helps to reduce planned outages during hardware changes or a z/VM initial program load (IPL). However, the environment becomes more complex and requires special attention with the shared resources. With this feature in place, it is important to know how to manage efficiently the configuration in a secure manner.

LGR brings more flexibility to your environment, not just Linux availability. Now, you can use this new feature to build a reliable and secure infrastructure for Linux guests running under z/VM by workload balancing. Additionally, hardware and z/VM changes can be run without affecting service availability.

4.3.2 Background information

This section provides background information about equivalency identifiers (EQIDs) and their association, which you need to understand before setting up an SSI cluster and user LGR.

Equivalency identifiers

With an SSI cluster, you use EQIDs. EQIDs are used to ensure that all members of the cluster use both the same physical devices and the devices that are attached over IBM Fibre Channel Connection (IBM FICON®). During z/VM IPL, the EQID number is automatically generated and assigned to various devices, such as DASDs. However, for Fibre Channel Protocol (FCP) devices, you must explicitly set the EQID on the system config file on the PMAINT CF0 disk so that all cluster members can see the device as one device.

Before a Linux guest gets relocated to a different z/VM LPAR, the guest configuration is checked on the destination LPAR (Device condition) to ensure that the devices have the same EQIDs. Ensure that all necessary FCP configuration is planned to avoid problems when relocating your Linux guests. To update the NPIV devices, review and if necessary update your EQIDs as well.

For the list of conditions, see *z/VM: CP Planning and Administration*, SC24-6178.

4.3.3 Relocation domains

A relocation domain defines a set of members of an SSI cluster among which VMs can relocate freely. A domain can be used to define the subset of members of an SSI cluster to which a particular guest can be relocated. Relocation domains can be defined for business or technical reasons.

For example, a domain can be defined that has all of the architectural facilities necessary for a particular application, or a domain can be defined to allow access only to systems with a particular software tool. Whatever the reason for the definition of a domain, CP allows relocation among the members of the domain without any change to architectural characteristics or CP functions as seen by the guest.

The relocation domain for a VM can be defined with the **VMRELOCATE** directory statement. When the user ID logs on, CP assigns a virtual architecture level to the VM that is the maximal common subset of the architectural features (hardware architecture facilities and CP-supplied features) of all the members of the SSI cluster that belong to that relocation domain. The guest cannot use architectural features that are not included in this virtual architecture level. This ensures that the guest can be freely relocated to other members of the domain because they provide the same architectural features. A feature must be supported in every relevant component (processor, channel, and device hardware, and the z/VM software level) on every domain member to be usable to the guest.

Two types of relocation domains are defined implicitly:

- ▶ A domain that includes all of the members of the SSI cluster. The name of this domain is SSI.
- ▶ A domain that includes one member of the SSI cluster. A single-member domain is defined for each member. The name of the domain is the member's system name.

When a user ID that is defined by a single-configuration VM definition logs on, the default associated relocation domain is the entire SSI cluster (domain SSI), unless a different relocation domain is set by a **VMRELOCATE** statement in the user's VM definition.

If relocation of the VM has been disabled on the **VMRELOCATE** statement and no relocation domain is specified, the default relocation domain is the single-member domain of the system where the user logs on, and the user is assigned a virtual architecture level that is the set of all the architectural features of that system.

Note: When a Linux guest is allowed to relocate to only a subset of the members in a cluster with the respective relocation domain, it can be overruled with the force option of the `vmrelocate` command.

4.3.4 RACF in an SSI cluster

When RACF is installed in a z/VM SSI environment, it is mandatory that the RACF database is shared. To ensure database integrity, the following requirements must be met:

- ▶ The RACF database DASD must be defined as shared in the I/O configuration.
- ▶ Both the primary RACF database (device 200) and the backup database (device 300) must be defined on full-pack minidisks.
- ▶ It is also required that these devices have virtual reserve/release enabled.

Use the **DEVNO** operand of the **MDISK** directory statement to define the DASD as full-pack minidisks.

If you are following the preferred practice of using the same real device numbers across LPARs to reference DASD, the **MDISK** statements for the RACF database disks can be placed in the identity entry for the RACF server. If the real device numbers are not the same across LPARs, the **MDISK** statements must be placed in the relevant subconfiguration entries.

4.4 Auditing

A defined information security policy is worthless if there is no way to assess whether the policies are effective, meaning that it was adhered to by all employees and they are playing the roles that they are expected to.

Tracking changes and authorized and unauthorized accesses is a way to make sure that the information security policy is followed. But again, with the increase of servers that are managed on the IT infrastructure, the amount of audit data that is generated makes it impossible for a human to analyze all of it, find a threat, and act on it while the intrusion is still happening. For that reason, define during the planning stage of the IT infrastructure which actions must be logged for audits.

The complexity in auditing is reduced when defined roles are available in the information security policy. Users under one role should not have access to override the mandatory access controls (MACs) and should not be able to manipulate the controls that are under the jurisdiction of another job role. With the separation of duties, the functions of the systems and integrity of audit logs are not compromised.

In z/VM, audit trails are generated by several CP command journaling options. They can be used to identify unsuccessful attempts of a CP command use. When journaling is turned on, more information is recorded with unsuccessful and successful attempts of specific CP commands. For a comprehensive audit trail, the use of an ESM is recommended. In this book, we cover the auditing with the use of RACF/VM. It can audit every command and security-relevant event happening within the hypervisor, in accordance with a predefined security policy.

4.4.1 Auditing with journaling

z/VM offers a mechanism to track unauthorized **LOGON** attempts and unauthorized **LINK** commands. By enabling journaling, it is possible to configure how the system records **LOGON** and **LINK** attempts. Although it is fine for exploring **LOGON** attempts and unauthorized **LINK** commands, it really is not sufficient for the modern enterprise.

Enabling journaling

To use z/VM journaling, you must enable it in `SYSTEM CONFIG` and the system must have an IPL performed with the new configuration.

Example 4-20 shows an excerpt from a `SYSTEM CONFIG` file that is used to enable journaling (line numbers are not part of the `SYSTEM CONFIG` and are used to explain the statements on the lines).

Example 4-20 Configure journaling in SYSTEM CONFIG

```

1. Journaling,
2.   Facility      on,
3.   Set_and_Query on,
4. Logon,
5. Message after 3 attempts to willianr,
6.   Account after 5 attempts,
7.   VM_Logo after 7 attempts,
8.   Lockout after 9 attempts for 10,
9. Link,
10. Message after 3 attempts to willianr,
11.   Account after 4 attempts,
12.   Disable after 5 attempts

```

Here is an explanation of the lines:

- ▶ Line number 1 starts the journaling configuration statement in the `SYSTEM CONFIG` file.
- ▶ Line number 2 enables or disables journaling when the system undergoes an IPL.
- ▶ Line number 3 enables or disables the ability to set and query journaling. When disabled, the only configuration that takes effect is the configuration in the `SYSTEM CONFIG` file. It is not possible to use **query journaling** or **set journaling** commands, as shown in Example 4-21.

Example 4-21 Query and set journaling when Set_and_Query is off

```

q journal
HCPJRL003E Invalid option - JOURNAL
Ready(00003);

```

```

set journal link off
HCPJRL003E Invalid option - JOURNAL
Ready(00003);

```

```

set journal logon off

```

HCPJRL003E Invalid option - JOURNAL
Ready(00003);

- ▶ The journaling statement of z/VM allows the CP to control two kinds of actions: **LOGON** and **LINK**. The **LOGON** parameter starts on line 4 of Example 4-20 on page 108 and the **LINK** parameter starts on line 9 of the same example. Although the parameter is called **LOGON**, it also tracks successive tentatives of **AUTOLOG** and **XAUTOLOG** with an incorrect password in addition to the **LOGON** command.

For both parameters, it is possible to configure two options: **MESSAGE** and **ACCOUNT**. The **MESSAGE** parameter sets up the number of possible tries before a user receives an information message. Although any user can be set to receive the information message, setting a user that has the console logged is preferred as it is possible to look for the information later after the event happened.

In Example 4-22, user **RAMPAZZO** tries to log on repeatedly with an incorrect password. The **MESSAGE** parameter was set to user **WILLIANR**.

Example 4-22 Repeated logon attempts with incorrect password

#Logon tried repeatedly, but just one output is shown:

```
1 rampazzo
ENTER PASSWORD (IT WILL NOT APPEAR WHEN TYPED):

HCPLGA050E LOGON unsuccessful--incorrect password
```

Enter one of the following commands:

```
LOGON userid          (Example: LOGON VMUSER1)
DIAL userid          (Example: DIAL VMUSER2)
MSG userid message   (Example: MSG VMUSER2 GOOD MORNING)
LOGOFF
```

#After third try, user **willianr** receives the information message:

```
HCPJRL145I User RAMPAZZO at 9.12.5.143 issued a LOGON command with an invalid password 003 times. The limit is 003.
```

The same happens with successive **LINK** command attempts with an incorrect password to access a protected minidisk. Example 4-23 shows user **RAMPAZZO** trying to link to the 191 protected minidisk of user **WILLIANR** with an incorrect password.

Example 4-23 User RAMPAZZO try to link a protected minidisk

```
link willianr 191 191 rr
ENTER READ PASSWORD:
```

```
HCPLNM114E WILLIANR 0191 not linked; mode or password incorrect
Ready(00114); T=0.01/0.01 16:30:21
```

```
link willianr 191 191 rr
ENTER READ PASSWORD:
```

```
HCPLNM114E WILLIANR 0191 not linked; mode or password incorrect
Ready(00114); T=0.01/0.01 16:30:30
```

```
link willianr 191 191 rr
ENTER READ PASSWORD:
```

HCPJRL145I WILLIANR 0191 not linked; mode or password incorrect
Ready(00114); T=0.01/0.01 16:30:35

#After third try, user willianr receives the information message:

HCPJRL145I User RAMPAZZO at 9.12.5.143 issued a LINK command with an invalid password 003 times. The limit is 003.

#All successive try will generate an information message:

HCPJRL145I User RAMPAZZO at 9.12.5.143 issued a LINK command with an invalid password 004 times. The limit is 003.

HCPJRL145I User RAMPAZZO at 9.12.5.143 issued a LINK command with an invalid password 005 times. The limit is 003.

The **ACCOUNT** parameter sets up the number of possible tries before CP detects that a user has entered enough **LINK** commands to a protected minidisk that is not owned by the user with an invalid password that reaches or exceeds an installation-defined threshold value recording a type 06 accounting record and a type 04 accounting record. Then, CP detects that a user has entered enough **LOGON**, **AUTOLOG**, or **XAUTOLOG** invocations with an invalid password that reaches or exceeds an installation-defined threshold value. A type 05 accounting record is generated when CP detects that a user has successfully entered a **LINK** command to a protected minidisk that is not owned by the user.

In Example 4-24, user RAMPAZZO continues repeatedly to try to log on with an incorrect password. The accounting record is created after the fifth try.

Example 4-24 Repeatedly try to log on and generate type 04 accounting records

#Logon tried repeatedly, but just one output is shown:

```
l rampazzo
ENTER PASSWORD (IT WILL NOT APPEAR WHEN TYPED):
```

HCPJRL145I LOGON unsuccessful--incorrect password

Enter one of the following commands:

```
LOGON userid          (Example: LOGON VMUSER1)
DIAL userid          (Example: DIAL VMUSER2)
MSG userid message   (Example: MSG VMUSER2 GOOD MORNING)
LOGOFF
```

#All the successive logon attempts generate an information message:

HCPJRL145I User RAMPAZZO at 9.12.5.143 issued a LOGON command with an invalid password 004 times. The limit is 003.

HCPJRL145I User RAMPAZZO at 9.12.5.143 issued a LOGON command with an invalid password 005 times. The limit is 003.

HCPJRL145I User RAMPAZZO at 9.12.5.143 issued a LOGON command with an invalid password 006 times. The limit is 003.

#After the fifth try, an accounting record is created:

RAMPAZZO	060916170056L00412	0505	TCPIP	090C058F04
RAMPAZZO	060916170118L004TESTE	0605	TCPIP	090C058F04

In Example 4-25, user RAMPAZZO continues repeatedly to try to link to the 191 protected minidisk of user WILLIANR with an incorrect password.

Example 4-25 Repeatedly try to link to a protected minidisk and generate type 06 accounting records

link willianr 191 191 rr

ENTER READ PASSWORD:

HCPLNM114E WILLIANR 0191 not linked; mode or password incorrect
Ready(00114); T=0.01/0.01 16:30:35

#After the fourth try, an accounting record is created:

RAMPAZZORAMPAZZO060916163447L006PASSWORDWILLIANR 0404 0191 TCPIP 090C058F06

For more information about the accounting record format, see Chapter 7, “Setting Up Service Virtual Machines”, in *Accounting Record Formats z/VM V6.3 CP Planning and Administration*, SC24-6178.

The **LOGON** statement has two more parameters: **VM_Logo** and **Lockout**. When **VM_Logo** is set, after the number of attempts that are specified by using the wrong password to log on, the user is redirected back to the z/VM Logo panel. When the number of attempts by using the wrong password reaches the **LOCKOUT** number, this user ID cannot be logged on for the number of minutes specified on the **LOCKOUT** parameter. In our example, after nine uses of the wrong password, the user ID cannot be logged on for 10 minutes. The accounting record is still recorded, the information message is sent to the listed user, and the user trying to log on receives a message stating the maximum number of attempts were exceeded, as shown in Example 4-26.

Example 4-26 User who is locked out after excessive logon attempts

l rampazzo

HCPJRL780E Maximum password attempts exceeded, try again later.

Accounting records:

RAMPAZZO	060916170126L004123	0705	TCPIP	090C058F04
RAMPAZZO	060916170142L005	0805	TCPIP	090C058F04
RAMPAZZO	060916170148L005123	0905	TCPIP	090C058F04

Analogous to the **LOCKOUT** parameter for **LOGON**, it is possible to set the parameter **DISABLE** for **LINK** to disable the **link** command for the user that reached the maximum number of incorrect passwords while trying to link a protected minidisk. Accounting information is still recorded and information message sent to the user ID listed on the Message parameter. The user that is disabled from running a **LINK** command receive a message like the one shown in Example 4-27.

Example 4-27 User who is disabled from running LINK command after excessive link attempts

link willianr 191 191 rr

HCPLNM115E LINK invalid; excessive incorrect passwords
Ready(00115); T=0.01/0.01 16:35:04

Accounting records:

RAMPAZZORAMPAZZO060916163453L006PASSWORDWILLIANR 0504 0191 TCPIP 090C058F06

When a user reaches the maximum number of attempts with a wrong password when trying to link a protected minidisk, this user cannot use the **LINK** command during the current session.

When the **Set_and_Query** parameter is set to on, it is possible to control the Journaling by using the **set CP** command. Example 4-28 shows some examples of **query** and **set journal**.

Example 4-28 Query and set journal

q journal

Journal: LOGON- on , LINK- on
Ready;

set journal logon off

Ready;

q journal

Journal: LOGON- off, LINK- on
Ready;

set journal link off

Ready;

q journal

Journal: LOGON- off, LINK- off
Ready;

set journal logon on

Ready;

q journal

Journal: LOGON- on , LINK- off
Ready;

set journal link on

Ready;

q journal

Journal: LOGON- on , LINK- on
Ready;

For more information about CP Journaling, see *CP Planning and Administration*, SC24-6178.

4.4.2 Auditing with RACF

Certain user roles or tasks are common to all users. At any installation, different users have different levels of responsibility for security or different needs to access resources. Some people might have extensive responsibility for security, and others might have little or none. Some users might require almost unlimited access to resources, and others might need only limited access. Some might be barred from entering the system at all.

The primary means of defining a user's responsibility for security is the RACF user attribute. The separation of powers is necessary because it is the security administrator's job to establish RACF controls, and it is the auditor's job to test the adequacy and effectiveness of these controls.

The auditor's responsibility is to verify that RACF is meeting the installation's security goals, such as access control and accountability. The job of a RACF auditor is essentially the same, regardless of whether it is the AUDITOR attribute (with responsibility for checking RACF controls on a user or system-wide, level) or the group-AUDITOR attribute (with responsibility for checking RACF controls for a group and its subgroups).

An effective audit of security goals depends on how the events are logged. Logging all the necessary information and events improves the effectiveness of an audit.

Enabling auditing

You can enable (audit) or disable (noaudit) functions dynamically to meet the needs of your installation. When you enable collection of the audit records, SMF records are generated. This was an optional step in the configuration of your RACF environment, as described in "Customizing the processing of SMF records" on page 47. If you elected not to perform that step previously, you must implement it now before continuing.

RACF always logs information about certain events that are essential to an effective data-security mechanism. Here are the events that RACF always logs:

- ▶ Every use of the **RVARY** or **SETROPTS** command.
- ▶ Every time a **RACROUTE REQUEST=VERIFY** request fails.
- ▶ Every time the console operator grants access to a resource as part of the failsoft processing that is performed when RACF is inactive.

RACF never logs some events because knowing about these events is not essential to effective data security. RACF never logs any use of the following RACF commands:

- ▶ **LISTDSD**
- ▶ **LISTGRP**
- ▶ **LISTUSER**
- ▶ **RLIST**
- ▶ **LDIRECT**
- ▶ **LFILE**
- ▶ **SRFILE**
- ▶ **SRDIR**
- ▶ **SEARCH**

In addition to the events that RACF always logs and never logs, there are other events RACF can log optionally. Optional logging is under the control of either a resource-profile owner or the auditor.

The first step in establishing the auditing environment is to activate the RACF class for auditing with the **SETROPTS** command. With this command, you specify what functions within the AUDIT facility you want to monitor (above what RACF always monitors). These functions include the following ones:

- ▶ **USERS**
- ▶ **VMMDISK**
- ▶ **VMLAN**
- ▶ **VMRDR**
- ▶ **VMCMD**
- ▶ **VMNODES**
- ▶ **SURROGAT**

Use the **SETROPTS LIST** command as a user with the AUDITOR attribute to determine your current AUDIT environment, as shown in Example 4-29 on page 114.

Example 4-29 AUDIT CLASS functions

```

rac lu rampazzo
USER=RAMPAZZO NAME=UNKNOWN OWNER=IBMUSER CREATED=23.167
DEFAULT-GROUP=SYS1 PASSDATE=23.167 PASS-INTERVAL= 30 PHRASEDATE=N/A
ATTRIBUTES=AUDITOR
REVOKE DATE=NONE RESUME DATE=NONE
LAST-ACCESS=23.174/15:00:22
CLASS AUTHORIZATIONS=NONE
NO-INSTALLATION-DATA
NO-MODEL-NAME
LOGON ALLOWED (DAYS) (TIME)
-----
ANYDAY ANYTIME
GROUP=SYS1 AUTH=USE CONNECT-OWNER=IBMUSER CONNECT-DATE=23.167
CONNECTS= 06 UACC=NONE LAST-CONNECT=23.174/15:00:22
CONNECT ATTRIBUTES=NONE
REVOKE DATE=NONE RESUME DATE=NONE
SECURITY-LEVEL=NONE SPECIFIED
CATEGORY-AUTHORIZATION
NONE SPECIFIED
SECURITY-LABEL=NONE SPECIFIED
Ready; T=0.01/0.01 15:14:44

```

```

rac setropts list
ATTRIBUTES = INITSTATS NOWHEN(PROGRAM) SAUDIT CMDVIOL NOOPERAUDIT
STATISTICS = NONE
AUDIT CLASSES = NONE
ACTIVE CLASSES = DATASET USER GROUP VMMDISK VMRDR VMBATCH VMLAN VMSEGMT
FACILITY SURROGAT VXMBR VMXEVENT XFACILIT GFXACILI
GENERIC PROFILE CLASSES = NONE
GENERIC COMMAND CLASSES = NONE
GENLIST CLASSES = NONE
GLOBAL CHECKING CLASSES = NONE
RACLIST CLASSES = NONE

```

As shown in this example, auditing for RACF classes is not enabled. Before enabling any of the functions, you must start the RACFSMF VM and update the **PROFILE EXEC** for the AUTOLOG2 VM to start RACFSMF when the system is IPLed.

There are two main utilities that are used to manage the RACF generated SMF records in the z/VM environment:

- ▶ RACF Report Writer
- ▶ RACF SMF Data Unload

The Report Writer utility supports audit records for RACF 1.9.2 and earlier. It does not support most of the audit records that were introduced in RACF 1.10 for z/VM or later releases. RACF Report Writer requires the use of *tdisk* space on your system. You must discuss with your z/VM system programmer whether *tdisk* space has been defined on your system. If it has not, then it must be added.

These utilities are on the RACFVM 305 disk, and the disk must be linked and accessed before execution.

You start by turning on a few other AUDIT features on the z/VM system before running these programs. Enable AUDIT on classes on which you intend to log security events. An example is shown in Example 4-30.

Example 4-30 Enable AUDIT

```

rac setropts audit (user group vmmdisk vmrdr vmlan surrogate)
OUTPUT FROM RACFVM ON SYSTEM ITS0ZVM3
ICH14004I UNABLE TO OPEN RACF DATA SET RACF.DATASET.
END OF OUTPUT FROM RACFVM ON SYSTEM ITS0ZVM3
OUTPUT FROM RACFVM ON SYSTEM ITS0ZVM2
ICH14004I UNABLE TO OPEN RACF DATA SET RACF.DATASET.
END OF OUTPUT FROM RACFVM ON SYSTEM ITS0ZVM2
Ready; T=0.01/0.01 15:24:28

rac setropts list
ATTRIBUTES = INITSTATS NOWHEN(PROGRAM) SAUDIT CMDVIOL NOOPERAUDIT
STATISTICS = NONE
AUDIT CLASSES = USER GROUP VMMDISK VMRDR VMLAN SURROGAT
ACTIVE CLASSES = DATASET USER GROUP VMMDISK VMRDR VMBATCH VMLAN VMSEGMT
                  FACILITY SURROGAT VXMBR VMXEVENT XFACILIT GXFACILI
GENERIC PROFILE CLASSES = NONE
GENERIC COMMAND CLASSES = NONE
GENLIST CLASSES = NONE
GLOBAL CHECKING CLASSES = NONE
RACLIST CLASSES = NONE

```

RACF Data Security Monitor Utility

RACF Data Security Monitor Utility (RACDSMON) is a program that produces reports on the status of the security environment of your installation and the status of resources that RACF controls. You can use the reports to audit the status of your installation's system security environment by comparing the actual system characteristics and resource-protection levels with the intended characteristics and levels. You can also control the reporting that RACDSMON does by specifying control statements that request certain functions for user input.

Before running the **RACDSMON EXEC**, you must meet the following requirements:

- ▶ Have READ access to the RACF service's 305 and 490 minidisks and the primary and backup RACF databases.
- ▶ Have the AUDITOR attribute.
- ▶ Have at least 20 MB of virtual storage available for your user ID.
- ▶ Perform an IPL of the 490 disk.
- ▶ Access the 305 disk.

Perform the steps in Example 4-31 when you perform an IPL of the 490 disk. Depending upon what CMS commands are run from the **PROFILE EXEC**, you might receive some errors. You can disregard those error messages.

Example 4-31 Prepare to run RACDSMON EXEC

```

link racfvm 490 490 rr
DASD 0490 LINKED R/O; R/W BY RACFVM at ITS0ZVM4
Ready; T=0.01/0.01 15:37:47

```

```

link racfvm 305 305 rr
DASD 0305 LINKED R/O; R/W BY RACFVM   at ITS0ZVM4
Ready; T=0.01/0.01 15:38:12

```

```

ipl 490
RACFVM CMS XA Re1. 27 2011-10-18
Ready; T=0.01/0.01 15:38:50

```

```

acc 305 1
DMSACP723I L (305) R/O
Ready; T=0.01/0.01 15:39:28

```

```

acc 190 t
DMSACP723I T (190) R/O
Ready; T=0.01/0.01 11:42:47

```

During the example tests, the exec ran with some problems:

- ▶ In the example environment, there was not a temp disk that was large enough to hold the same disk size of the RACF database. The environment was created with four SSI members, which means you must allocate a full pack DASD for the RACF database. To overcome this situation, and knowing that the size that the RACF database uses is less than the full pack disk, create a smaller copy of the RACF database on a temporary disk by using DDR. Example 4-32 shows the output of this process.

Example 4-32 Create a smaller copy of the RACF database

```

def t3390 200 100
DASD 0200 DEFINED
Ready; T=0.01/0.01 10:27:41

def t3390 300 100
DASD 0300 DEFINED
Ready; T=0.01/0.01 10:27:45

link racfvm 200 f200 rr
DASD F200 LINKED R/O; R/W BY RACFVM   at ITS0ZVM4
Ready; T=0.01/0.01 10:29:06

link racfvm 300 f300 rr
DASD F300 LINKED R/O; R/W BY RACFVM   at ITS0ZVM4
Ready; T=0.01/0.01 10:29:13

ddr
z/VM DASD DUMP/RESTORE PROGRAM
ENTER:
in f200 dasd
ENTER:
out 200 dasd
ENTER:
sys cons
ENTER:
copy 0 99
HCPDDR711D VOLID READ IS RACF
DO YOU WISH TO CONTINUE?  RESPOND YES, NO OR REREAD:
yes

```

ENTER NEXT EXTENT OR NULL LINE
ENTER:

HCPDDR716D NO VOL1 LABEL FOUND
DO YOU WISH TO CONTINUE? RESPOND YES, NO OR REREAD:

yes

COPYING RACF

COPYING DATA 06/23/16 AT 14.32.50 GMT FROM RACF

INPUT CYLINDER EXTENTS OUTPUT CYLINDER EXTENTS

START STOP START STOP

0 99 0 99

END OF COPY

ENTER:

END OF JOB

Ready; T=0.01/0.02 10:33:26

ddr

z/VM DASD DUMP/RESTORE PROGRAM

ENTER:

in f300 dasd

ENTER:

out 300 dasd

ENTER:

sys cons

ENTER:

copy 0 99

HCPDDR711D VOLID READ IS RACFBK

DO YOU WISH TO CONTINUE? RESPOND YES, NO OR REREAD:

yes

ENTER NEXT EXTENT OR NULL LINE

ENTER:

HCPDDR716D NO VOL1 LABEL FOUND

DO YOU WISH TO CONTINUE? RESPOND YES, NO OR REREAD:

yes

COPYING RACFBK

COPYING DATA 06/23/16 AT 14.34.08 GMT FROM RACFBK

INPUT CYLINDER EXTENTS OUTPUT CYLINDER EXTENTS

START STOP START STOP

0 99 0 99

END OF COPY

ENTER:

END OF JOB

Ready; T=0.01/0.02 10:34:25

det f200

DASD F200 DETACHED

Ready; T=0.01/0.01 10:34:44

det f300

DASD F300 DETACHED

Ready; T=0.01/0.01 10:34:48

- ▶ The **RACDSMON EXEC** must be run while RACFVM 490 disk is running, but this program uses some utilities on CMS 190 disk, and when 490 is running, 190 is not accessed. If the 190 minidisk is not accessed, you might receive the error messages that are shown in Example 4-33.

Example 4-33 Error messages when 190 disk is not accessed while running RACDSMON

Program ICHDSM00 is being executed - Please wait

```

    223 +++ extents = C2D(Storage(load_address,1))      /* save RACF db xtnt
*/
DMSREX475E Error 40 running RACONFIG EXEC, line 223: Incorrect call to routine

```

```

An Error occurred during ICHDSM00 processing
Return code from ICHDSM00 = 20040
Ready(20040); T=0.01/0.01 10:38:17

```

To overcome this situation, after you perform an IPL of 490, access 190. The full output is shown in Example 4-31 on page 115.

- ▶ When **RACDSMON EXEC** runs, the generated output is placed in your virtual printer. You should run the **cp spool print *** command so that you can receive the files when this process completes. (You might want to add this command to your **PROFILE EXEC**.)

The RACFVM 200 and 300 disks in this case are the copy of the original locations of the RACF database. The RACDSMON generated reports are pulled from those disks. When the exec is run, it creates a tdisk of the same disk type as the 200 and 300 disks. You can issue the CP commands **query virtual 200** and **query virtual 300** to determine this information. You can install the z/VM system on 3390 DASD or on a simulated 9330 Fixed Block SCSI disk. Therefore, one of these is the type of tdisk space that you need to define. In this example, install the system on 3390 DASD.

To run the RACDSMON utility, enter the CP command **racdsmon**. It displays several panels. The first panels are only informational in nature. You can use one of them to go into a CMS SUBSET environment, where you can perform tasks such as linking to the disk that you should have linked before running the exec. The first panels where you must provide information is the panel that prompts you for the address of the INPUT RACF database device (see Example 4-34). When the exec runs, these prompts are displayed on three separate panels.

Example 4-34 RACF database input

Enter the INPUT RACF dataset device address one at a time.

Enter END when all input data sets are entered.

or

Enter QUIT to terminate processing.

200

Enter the NEXT INPUT RACF dataset device address .

Enter END when all input data sets are entered.

or

Enter QUIT to terminate processing.

300

Enter the NEXT INPUT RACF dataset device address .

Enter END when all input data sets are entered.

or

Enter QUIT to terminate processing.

end

-
- ▶ The next prompt from the exec asks whether you want to use a tdisk or a minidisk. If your system does not have tdisk space that is defined, then you can use existing minidisk. These disks must be defined in the system directory and must be the same size and geometry as the 200 and 300 disk that is owned by RACFVM. In this example, use tdisk, as shown in Example 4-35. Then, you receive panels displaying messages about the copy of the 200 and 300 disks to the 5FD and 5FE disks.

Example 4-35 Use temporary disk

```
DMSACC723I H (0200) R/W - OS
```

```
Would you like to use TDISK or existing disks for the file to scan?
```

```
Enter "T" to TDISK or "E" for existing disk(s)
```

T

```
The input RACF data set - 200 is being copied over to 5FE
```

```
...Please wait...
```

```
DMSACC724I 300 replaces H (200) - OS
```

```
DMSACC723I H (0300) R/W - OS
```

```
The input RACF data set - 300 is being copied over to 5FD
```

```
...Please wait...
```

-
- ▶ You should receive a message about the ICHDSM00 SYSIN file and have an opportunity to edit the file (Example 4-36). If it is not the first time you are running RACDSMON on this machine, you receive a message saying that the file exists and if you want to overlay it. Answering YES deletes the file on the disk and creates a new file. Accept the default on this panel, and edit the file.

Example 4-36 ICHDSM00 SYSIN file message

The ICHDSM00 SYSIN file will initially contain all DSMON FUNCTION control statements that are applicable to VM .

XEDIT will be invoked in order to tailor the ICHDSM00 SYSIN file.

Please be sure to issue the FILE command when edits are completed.

Press Enter to go into XEDIT

You need to modify the ICHDSM00 SYSIN file. It is shipped with one option that is not supported on RACF for z/VM. Example 4-37 on page 120 shows the correct modifications for this file. After you modify the file, save it. When running RACDSMON in the future, you can respond to the question about editing this file with NO (which then uses the file on your A disk).

Example 4-37 Update ICHDSM00 SYSIN

```

===== * * * Top of File * * *
      |...+....1...+....2...+....3...+....4...+....5...+....6...+....7...
===== FUNCTION SYSTEM
===== FUNCTION RACGRP
===== FUNCTION RACCDT
==d== FUNCTION RACEXT
===== FUNCTION RACGAC
===== FUNCTION RACUSR
===== FUNCTION RACDST
===== * * * End of File * * *

```

After a few minutes, you receive the messages that are shown in Example 4-38.

Example 4-38 RACDSMON completion

Program ICHDSM00 is being executed - Please wait

```

DMSACC723I R (0200) R/W - OS
DMSACC723I Q (0300) R/W - OS
CSTSET001I CMS SUB-TASKING SUPERVISOR INITIALIZED.
CSTINT003I INITIATOR ACTIVATED.
PRT FILE 0012 SENT FROM RAMPAZZO PRT WAS 0012 RECS 0352 CPY 001 A NOHOLD NOKEEP
CSTINT004I PROGRAM 'RACFIPLU' ENDED. COMPLETION CODE = 000000.
CSTINT006I NO MORE SUB-TASKS.
CSTTER001I CST TERMINATED.

```

Return code from ICHDSM00 = 0

```

PRT FILE 0016 SENT FROM RAMPAZZO PRT WAS 0016 RECS 0026 CPY 001 A NOHOLD NOKEEP
Ready; T=0.04/0.05 11:15:12

```

When the **RACDSMON EXEC** completes, you must perform an IPL of the CMS or 190 to have full CMS function. The 490 disk that is owned by RACFVM does not include all of the CMS executable files that you have with a normal CMS. After performing the IPL of the 490 disk, you do not have access to FIELIST, RDRLIST, FULLIST, XEDIT, and so on.

The **RACDSMON EXEC** creates two files in your VMRDR. The file that is named (none) is the actual report generated. You should receive a file that provides a file name and file type that is used by the security audit team. You can discard the file ICHDSM00 \$\$\$\$\$\$. If you forgot to spool the VMPRT, transfer the files from the VMPRT to the VMRDR.

The audit report includes the following information:

- ▶ RACF System Report (Example 4-39)

Example 4-39 RACF System Report

```

RACF DATA SECURITY MONITOR
                                                    S Y S T E M   R E
-----
CPU-ID                                ODDA87
CPU MODEL                             2964
OPERATING SYSTEM/LEVEL                 z/VM Version 6 Release 3.0, service 1
LAST SYSTEM GENERATION                 Generated at 06/16/16 12:07:28 EDT
LAST SYSTEM IPL                        IPL at 06/22/16 16:57:27 EDT
RACF VERSION 6 RELEASE 3 IS ACTIVE
RACF DATA SECURITY MONITOR

```

► RACF Exits Report (Example 4-40)

Example 4-40 RACF Exits Report

```

DSMON   RPT0723  A1  F 132  Trunc=132  Size=356  Line=1
=====
  11   R A C F   E X I T S   R E P O R T
  12  EXIT MODULE           MODULE
  13  NAME                 LENGTH
  14  -----
  15  ICHPWX11             1,520
  16  RACF DATA SECURITY MONITOR
    
```

► Selected User Attribute Report (Example 4-41)

Example 4-41 Selected User Attribute Report

```

S E L E C T E D   U S E R   A T T R
USERID           -----  ATTRIBUTE TYPE -----
                  SPECIAL      OPERATIONS      AUDITOR      REVOKE
-----
$ALLOC$                               SYSTEM
$DIRECT$                               SYSTEM
$PAGE$                                 SYSTEM
$SPOOL$                                SYSTEM
$SYSCKP$                               SYSTEM
$SYSWRM$                               SYSTEM
$TDISK$                                SYSTEM
BLDCMS                                SYSTEM
BLDNUC                                SYSTEM
BLDRACF                               SYSTEM
BLDSEG                                SYSTEM
IBMUSER                                SYSTEM
KLAUSM                                SYSTEM
MAINT                                  SYSTEM
MAINT630                              SYSTEM
MIGMAINT                              SYSTEM
RAMPAZZO                              SYSTEM
VIC                                    SYSTEM
WILLIANR                                SYSTEM
6VMLEN20                               SYSTEM
RACF DATA SECURITY MONITOR
                  S E L E C T E D   U S E R   A T T R I B U T
-----
TOTAL DEFINED USERS:                    156
TOTAL SELECTED ATTRIBUTE USERS:
ATTRIBUTE BASIS      SPECIAL      OPERATIONS      AUDITOR
-----
SYSTEM              5              9
GROUP               0              0
    
```

► RACF Class Descriptor Table Report (Example 4-42)

Example 4-42 RACF Class Descriptor Table

R A C F CLASS NAME	C L A S S STATUS	D E S C R I P T O AUDITING	STATISTICS	DEFAULT UACC
RVARSMBR	INACTIVE	NO	NO	NONE
RACFVARS	INACTIVE	NO	NO	NONE
SECLABEL	INACTIVE	NO	NO	NONE
VMDISK	ACTIVE	YES	NO	NONE
VMRDR	ACTIVE	YES	NO	NONE
VMCMD	INACTIVE	NO	NO	NONE
VMNODE	INACTIVE	NO	NO	NONE
VMBATCH	ACTIVE	NO	NO	NONE
VMDEV	INACTIVE	NO	NO	NONE
FILE	INACTIVE	NO	NO	NONE
DIRECTRY	INACTIVE	NO	NO	NONE
SFSCMD	INACTIVE	NO	NO	NONE
VMPOSIX	INACTIVE	NO	NO	NONE
VMLAN	ACTIVE	YES	NO	NONE
VMMAC	INACTIVE	NO	NO	NONE
VMSEGMT	ACTIVE	NO	NO	NONE

► RACF Global Resource Table Report (Example 4-43)

Example 4-43 RACF Global Resource Table

R A C F CLASS NAME	G L O B A L ACCESS LEVEL	A C C E S S ENTRY NAME
DATASET		-- GLOBAL INACTIVE --
RVARSMBR		-- GLOBAL INACTIVE --
SECLABEL		-- GLOBAL INACTIVE --
VMDISK		-- GLOBAL INACTIVE --
VMRDR		-- GLOBAL INACTIVE --
VMCMD		-- GLOBAL INACTIVE --
VMNODE		-- GLOBAL INACTIVE --
VMBATCH		-- GLOBAL INACTIVE --
VMDEV		-- GLOBAL INACTIVE --
FILE		-- GLOBAL INACTIVE --
DIRECTRY		-- GLOBAL INACTIVE --
SFSCMD		-- GLOBAL INACTIVE --
VMPOSIX		-- GLOBAL INACTIVE --
VMLAN		-- GLOBAL INACTIVE --
VMMAC		-- GLOBAL INACTIVE --
VMSEGMT		-- GLOBAL INACTIVE --

► RACF Group Tree Report (Example 4-44)

Example 4-44 RACF Group Tree Report

R A C F	G R O U P	T R E E
LEVEL	GROUP	(OWNER)
1	SYS1	(IBMUSER)
2	DIRMADMN	
2	DIRMSRV	
2	GADM	(IBMUSER)
2	GBIN	(IBMUSER)
2	GNOBODY	(IBMUSER)
2	GSYS	(IBMUSER)
2	MAIL	(IBMUSER)

RACF SMF Data Unload Utility

The RACF SMF Data Unload Utility (RACFADU), available since RACF/VM 1.10 and RACF FL 530, is the IBM preferred utility for processing RACF audit records. With it, you can create a sequential file from the security relevant SMF data. You can use the sequential file in several ways:

- View the file directly.
- Use the file as input for installation-written programs.
- Manipulate the file with sort/merge utilities.
- Output to an XML-formatted file for viewing with a web browser.

If the output is loaded into a database management system, for example, IBM DB2® or SQL/DS, you can issue your own queries. RACF ships the sample statements that are required to define and load the DB2 tables.

Before you can run the **RACFADU EXEC**, you must meet the following requirements:

- Link and access the RACFVM 305 disk.
- Link the RACFVM 301 and 302 disks.
- Have adequate free space on your A disk for the output file (30 cylinders is acceptable).

You can run **RACFADU EXEC** with or without any parameters. Without any parameters, it opens the RACFADU panel (Example 4-45 on page 124).

Example 4-45 RACF SMF Unload Utility

 RACF SMF Unload Utility - Input Panel

```

. Virtual address of input SMF data minidisk      _____
. Virtual address of output minidisk             _____
. Filename and filetype of sequential            RACFADU  OUTPUT
  output file
. Filename and filetype of XML easily readable   _____  _____
  output file
. Filename and filetype of XML compressed       _____  _____
  output file

```

PF1 = Help PF2 = Execute PF3 = Quit
 ENTER = Verify input fields

Enter CP/CMS Commands below:

====>

Example 4-46 shows the command that is run with all the required options for the command, which bypasses the input panel.

Example 4-46 RACFADU without an input panel

```

racfadu 301 191
RACFADU  OUTPUT
  RPIADU033I SMF unload completed successfully.
  View the RACFADU MESSAGES file for additional details.
Ready; T=0.01/0.01 13:32:28

```

When you run the exec in either mode, two files are created on your A disk by default:

- ▶ RACFADU MESSAGES A1
- ▶ RACFADU OUTPUT A1

The RACFADU MESSAGES file describes how many of each type of SMF records were processed, as shown in Example 4-47.

Example 4-47 RACFADU MESSAGES file

```
* * * Top of File * * *
IRR67652I The utility processed 0 SMF type 30 records.
IRR67652I The utility processed 223 SMF type 80 records.
IRR67652I The utility processed 5 SMF type 81 records.
IRR67655I The utility processed 0 SMF type 83 subtype 1 records.
IRR67655I The utility processed 0 SMF type 83 subtype 2 records.
IRR67655I The utility processed 0 SMF type 83 subtype 3 records.
IRR67655I The utility processed 0 SMF type 83 subtype 4 records.
IRR67655I The utility processed 0 SMF type 83 subtype 5 records.
IRR67655I The utility processed 0 SMF type 83 subtype 6 records.
IRR67653I The utility bypassed 0 SMF records not related to IRRADU00.
IRR67650I SMF data unload utility has successfully completed.
* * * End of File * * *
```

The RACFADU OUTPUT file is the readable output of all the SMF data records (Example 4-48). If this file exists on the output disk, you are prompted to rename or replace the old file before continuing. These files can be used by DB2, SQL/DS, and DFSORT/CMS.

Example 4-48 RACFADU OUTPUT file

```
RACFADU OUTPUT A1 V 5331 Trunc=5331 Size=5043 Line=3972 Col=1 Alt=0
====>
3972 DEFINE SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3973 RDEFINE SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3974 PERMIT SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3975 PERMIT SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3976 PERMIT SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3977 PERMIT SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3978 PERMIT SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3979 PERMIT SUCCESS 11:00:34 2007-07-18 VMSP NO NO NO DETRO SYS1
3980 ACCESS SUCCESS 11:11:44 2007-07-18 VMSP NO NO NO DETRO SYS1
4598 ACCESS SUCCESS 17:18:19 2007-07-18 VMSP NO NO NO DETRO SYS1
4751 ACCESS SUCCESS 17:24:04 2007-07-18 VMSP NO NO NO DETRO SYS1
```

The utility can be used to generate an XML file that is readable with a browser. To create the XML file, you must pass the file name and file type for the XML file. Here are the parameters:

```
OUTXRN filename File name of output XML easily readable file.
OUTXRT filename File type of output XML easily readable file.
OUTXCN filename File name of output XML compressed.
OUTXCT filename File type of output XML compressed.
```

It is much easier to use the panel when generating the XML files from your SMF data (Example 4-49 on page 126). Also, if you are using the XML function, it works better with the compressed version of this process.

Example 4-49 Use the RACF SMF Unload Utility Input panel to generate XML files from SMF data

RACF SMF Unload Utility - Input Panel

```

. Virtual address of input SMF data minidisk      0301
. Virtual address of output minidisk            0191
. Filename and filetype of sequential
  output file
. Filename and filetype of XML easily readable
  output file      _____
. Filename and filetype of XML compressed      RACFADU1 XML_____
  output file

```

```

PF1 = Help   PF2 = Execute   PF3 = Quit
ENTER = Verify input fields

```

Enter CP/CMS Commands below:

====>

After the file is created, use the IBM Personal Communications program or any other method available on your installations to download the file from the A disk to the desktop in *text* mode. After you have downloaded the file, open it with an editor and change the encoding value and XML syntax error on the first line, as shown in Example 4-50 (and as documented in *RACF Security Server Auditor's Guide*, SC24-6143). This is required because of the mismatch between the z/VM use of EBCDIC versus the PC that uses ASCII.

Example 4-50 Change the XML header

```

<xml version='1.0' encoding='IS08859-1'>
<securityEventLog xmlns='http://www.ibm.com/xmlns/zOS/IRRSchema'>

  <rdf:Description rdf:about=''
                    xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'
                    xmlns:dc='http://purl.org/dc/elements/1.1/'>
    <dc:creator>      RACF for z/VM      SMF Unload (HRF6030)</dc:creator>
    <dc:subject>RACF Security Event Log 2016-06-23 13:37:39</dc:subject>
    <dc:language>en</dc:language>
  </rdf:Description>

```

At the bottom of the file, it is missing the close tag for the XML, and some browsers might have problems opening the file. In this case, add the missing tag, as shown in Example 4-51.

Example 4-51 Correct the XML close tag

```

</securityEventLog>
</xml>

```

You can view the audit report on personal computers and workstations by using an XML-capable web browser. Many browsers that are available today can correctly parse and render XML documents. Therefore, when the audit report is on that system, you can read it as easily as any other web document. Simply open a listing of the files and single- or double-click the file to open it in the browser window.

In this example, when this file is opened with Firefox, you receive a message in reference to a missing style file (Figure 4-2). In this case, you must combine this file with a customized style sheet to get the browser to filter and display the windows in a more acceptable format.

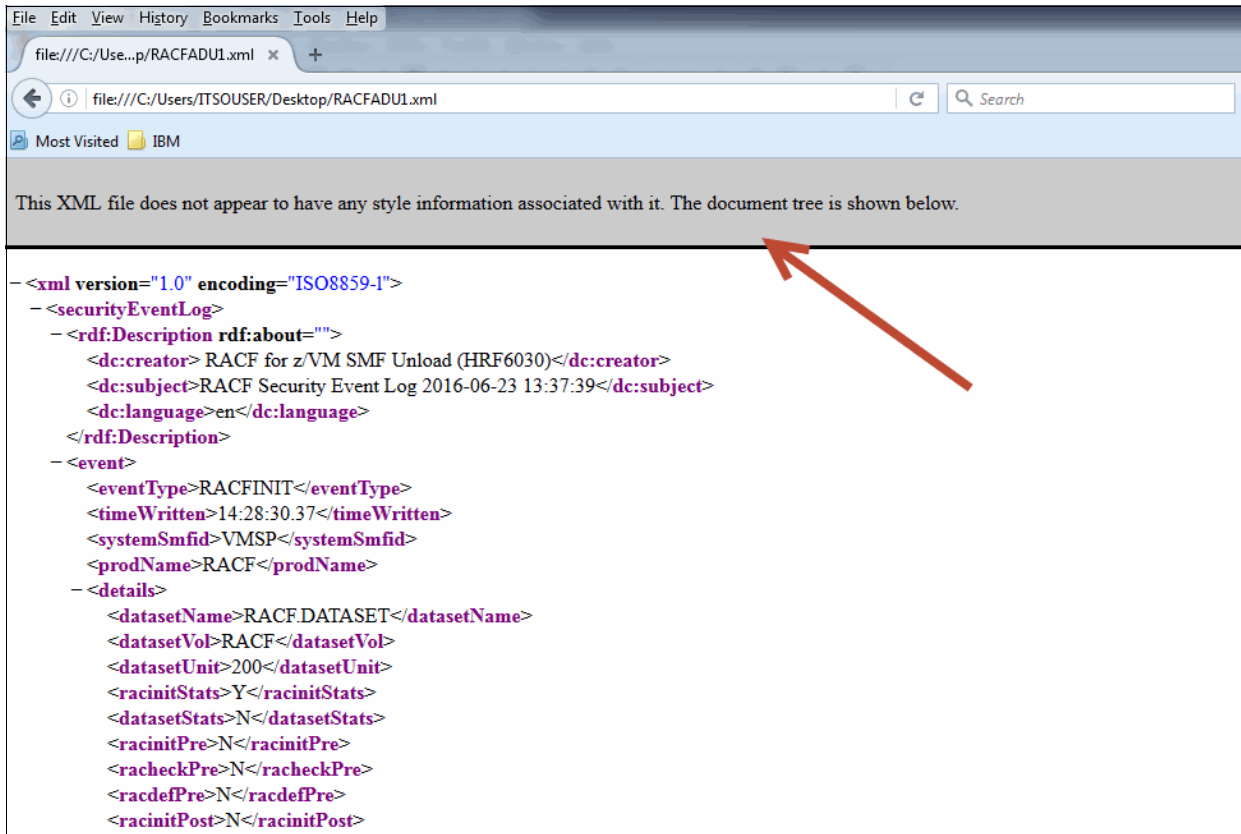


Figure 4-2 Opening an XML file with Firefox

Internet Explorer opens the file without any message, as shown in Figure 4-3 on page 128.

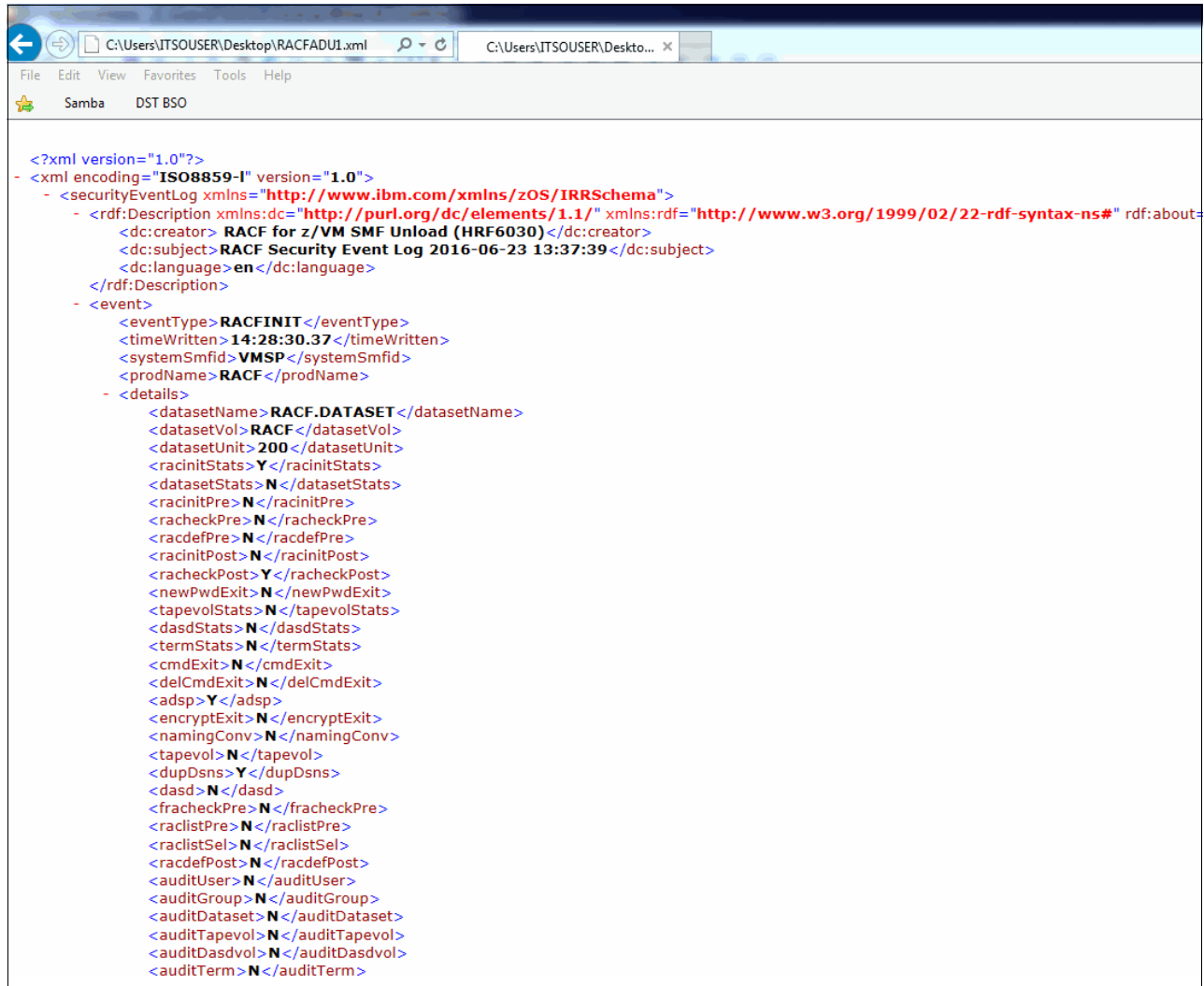


Figure 4-3 Opening an XML file with Internet Explorer

RACF Report Writer Utility

Note: The RACF Report Writer Utility (RACFRW) is no longer the IBM preferred utility for processing RACF audit records. The RACF SMF data unload utility is the preferred reporting utility. The RACFRW does not support many of the audit records that are introduced after RACF 1.9.2.

The RACFRW lists the contents of System Management Facilities (SMF) records in a format that is easy to read. SMF records are in the SMF data file. You can also tailor the reports to select specific SMF records that contain certain kinds of RACF information. With the RACFRW, you can obtain the following information:

- ▶ Reports that describe attempts to access a particular RACF protected resource in terms of user identity, number and type of successful accesses, and number and type of attempted security violations.
- ▶ Reports that describe user and group activity.
- ▶ Reports that summarize system use and resource use.

The RACF report writer lists the contents of SMF records in a format that is easy to read. It provides a wide range of reports so that you can monitor and verify the use of the system and resources.

The RACF report writer consists of three phases:

1. Command and subcommand processing
2. Record selection
3. Report generation

The steps to perform when running the **RACRPORT EXEC** are similar to the steps in running other RACF utilities. You must link and access several disks that are owned by RACFVM and then run the exec (Example 4-52). Unlike the RACDSMON where you have to link to the RACFVM 200 and 300 disks (the location of the RACF database), this time you need access to the SMF records that are created on the RACFVM 301 and 302 disks.

Example 4-52 Link the necessary disks for RACRPORT

```

link racfvm 191 291 rr
DASD 0291 LINKED R/O; R/W BY RACFVM   at ITS0ZVM4
Ready; T=0.01/0.01 14:22:22

link racfvm 301 301 rr
DASD 0301 LINKED R/O; R/W BY RACFVM   at ITS0ZVM4
Ready; T=0.01/0.01 14:22:29

link racfvm 302 302 rr
Ready; T=0.01/0.01 14:22:36

link racfvm 305 305 rr
DASD 0305 LINKED R/O; R/W BY RACFVM   at ITS0ZVM4
Ready; T=0.01/0.01 14:22:42

acc 305 1
DMSACP723I L (305) R/O
Ready; T=0.01/0.01 14:41:36

```

While working with RACRPORT, we observed that the tdisk used by this utility was hardcoded in the program with virtual address 5FF. If you use that virtual address for something else, you must detach it or redefine the disk to another address.

The **RACRPORT EXEC** generates the reports in your virtual printer. So, spool your printer to your reader to make things easier.

The **SET SECUSER** command is used to change the secondary user ID that is associated with your VM or another user's VM. To run the command for the OPERATOR VM, you must be authorized to run class A privileged commands (Example 4-53 on page 130). This command is the command that additionally authorizes the use of the CP **SEND** command.

Example 4-53 CP query privclass

```

id
WILLIANR AT ITS0ZVM4 VIA *          06/23/16 14:26:59 EDT    THURSDAY
Ready;

```

q priv

Privilege classes for user WILLIANR

Currently: ABCDEFG

Directory: ABCDEFG

The privilege classes are not locked against changes.

Ready;

Before you can run this utility, RACFVM must switch from the primary SMF disk to the alternate SMF disk. This task is accomplished with the RACF **SMF SWITCH** command. During the RACF implementation, there was an optional step to change the Message Routing Table, which allowed you to define additional VMs that would be allowed to request the SMF **SWTICH** of RACFVM. At that time, you did not need to add additional VMs to this list. Now, you are going to implement this process by having the OPERATOR VM issue the **SMF SWITCH**, as shown in Example 4-54.

*Example 4-54 Switch the SMF disk***q secuser racfvm**

```

Secondary
Userid  Userid  Status
RACFVM OPERATOR logged on
Ready;

```

set secuser racfvm *

HPCPFX6768I SECUSER of RACFVM initiated.

Ready;

msg racfvm smf switch

You are not authorized to issue SMSG to a RACF server

Ready;

set secuser racfvm reset

RACFVM : HPCPFX6768I Your SECUSER set to OPERATOR by WILLIANR.

HPCPFX6769I SECUSER of RACFVM terminated.

Ready;

q secuser operator

```

Secondary
Userid  Userid  Status
OPERATOR          not defined
Ready;

```

set secuser operator *

HPCPFX6768I SECUSER of OPERATOR initiated.

Ready;

send cp operator msg racfvm smf switch

Ready;

OPERATOR: RPISMF066I Switched to secondary disk

set secuser operator reset

OPERATOR: HCPCFX6769I Your SECUSER terminated by WILLIANR.
 HCPCFX6769I SECUSER of OPERATOR terminated.
 Ready;

Note: As you can see in Example 4-54, OPERATOR and RACFSMF are the only VMs that are authorized to send messages to RACFVM.

If RACFSMF was not given the authority to link to the RACFVM 301 and 302 disks, **SMF SWITCH** fails. The solution is to issue RACF **PERMITS** commands for those disks:

```
rac permit racfvm.301 class(vmmdisk) id(racfsmf) ac(control)
rac permit racfvm.302 class(vmmdisk) id(racfsmf) ac(control)
rac permit racfvm.191 class(vmmdisk) id(racfsmf) ac(read)
```

Now, when you run the **SMF SWITCH** command through the CP **SEND** command, it is successful. With this step completed, you can run the **RACRPORT** command after you have accessed the 305 disk (Example 4-55).

Example 4-55 Run RACRPORT

The RACFRW CONTROL file cannot be located and is required for execution to continue.

Do you wish to create a RACFRW CONTROL file?
 Please enter YES or NO

yes

XEDIT will be invoked in order to tailor the RACFRW CONTROL file.

Please be sure to issue the FILE command when edits are completed.
 Please press Enter to continue

The RACFRW CONTROL file must contain the input that is required by RACFRW, including the **RACFRW** command and subcommands. This file is on your A disk and is created with XEDIT when **RACFRW** is run. The statements that are included in Example 4-56 generate a detailed report.

Example 4-56 RACFRW CONTROL file

```
RACFRW CONTROL A1 F 80 Trunc=80 Size=7 Line=7 Col=1 Alt=7
DMSXMD587I XEDIT:
```

```
===== * * * Top of File * * *
===== RACFRW TITLE ('PLACE YOUR RACF REPORT TITLE HERE')
===== SELECT VIOLATIONS
===== SELECT SUCCESSES
===== EVENT LOGON
===== EVENT SETROPTS
===== LIST
===== END
      |...+...1...+...2...+...3...+...4...+...5...+...
===== * * * End of File * * *
```

After modifying the RACFRW CONTROL file and saving it to your A disk, you are prompted to define where the work disk is. Your options are on a tdisk or your A disk. Because the A disk is usually a small disk, use the tdisk. Respond to the prompt as shown in Example 4-57.

Example 4-57 Use of tdisk when running RACRPORT

The RACF Report Writer requires Disk Space for a Sort work file. You may wish to use Tdisk for this function.

Note: If Tdisk is not used, the Sort work file will be written on the A disk.

Do you wish to use Tdisk for the Sort work file?

Please enter YES or NO

YES

The **RACRPORT EXEC** does not contain the logic that is in the **RACDSMON** exec, where **RACDSMON** might determine what type of tdisk space was defined on your system. With the **RACRPORT EXEC**, you must specify the tdisk disk type.

The **query tdisk** command (Example 4-58) gives you information about system-defined tdisk space. However, it does not provide the characteristics of the disk device. You must query the devices to obtain the disk type.

Example 4-58 The query tdisk command

q tdisk

```
DASD 3D07 ATTACHED CPVOL 0000 VM3D07
DASD MDISKS NOT FOUND
```

```
DASD 3E07 ATTACHED CPVOL 0001 VM3E07
RAMPAZZO 05FF 00000007
Ready;
```

q 3d07 id

```
DASD 3D07 3390-0A CU: 2107-E8
      3D07 EQID: 002107900IBM7500000000000DVV610D07000000000000D0A
Ready;
```

With this information, you can select the correct type of tdisk to create as the sort disk. The EXEC then provides you with the information about the SMF disk that is being used for the generation of this report (Example 4-59). The requirement is that the sort disk must be the same size or larger than the source disk. As a preferred practice, make the sort disk the same size as the source disk.

Example 4-59 Information about disk containing the SMF DATA file

You will now be prompted for Tdisk space

Since the number of cylinders or blocks required depends on the size of the SMF DATA file, it is recommended that you allocate a temporary disk that is at least as large as the SMF DATA file.

The disk containing the SMF DATA file will be displayed below

LABEL	VDEV	M	STAT	CYL	TYPE	BLKSZ	FILES	BLKS USED-(%)	BLKS LEFT	BLK TOTAL
RCF301	301	C/A	R/O	7	3390	4096	1	33-03	1227	1260

Please enter the number of cylinders or blocks for Tdisk allocation.

7

After you have defined the size of the source disk, the tdisk is created as address 5FF (this address must be available). It then uses the definitions that you created in the RACFRW CONTROL file and generates a console file in your VMRDR. You can peek this file or receive it to disk. If you print it, it should be printed on a printer that supports logical record lengths of 132 characters.

Because of variations from one installation to another, and all different kinds of policies that are used by the companies, it is not possible to identify all of the ways an auditor might use the RACFRW. However, the following list identifies some possibilities, which are described in *RACF Security Server Auditor's Guide*, SC24-6143:

- ▶ Monitoring password violation levels
- ▶ Monitoring access attempts in WARNING mode
- ▶ Monitoring access violations
- ▶ Monitoring the use of RACF commands
- ▶ Monitoring specific users
- ▶ Monitoring SPECIAL users
- ▶ Monitoring OPERATIONS users
- ▶ Monitoring failed accesses to resources protected by a security level
- ▶ Monitoring accesses to resources protected by a security label



Securing a Cloud in the IBM z/VM environment

Today's security requires consistent protection against threats and malware. Enterprises must be flexible while having a secure infrastructure to protect effectively the most valued asset of a company (the data), and their access through the cloud.

Running many distributed servers involves much effort to install, manage, maintain, and provide security for them. To contain this effort, many enterprises are consolidating these servers on IBM Z or LinuxONE by using the z/VM as the hypervisor, taking advantage of the virtualization technologies to use the hardware effectively and to simplify administration tasks.

Implementing the enterprise security policy and following the least privilege principle increases the strength of security in your enterprise cloud.

This chapter describes the security of a Cloud on z/VM environment with its building blocks: z/VM Directory Manager (DirMaint), SMAPI and IBM Cloud Infrastructure Center.

The following topics are included:

- ▶ Cloud on z/VM components -add pages etc 5.1, 5.2
- ▶ DirMaint
- ▶ Systems Management API
- ▶ IBM Cloud Infrastructure Center
- ▶ Securing your cloud components

5.1 Cloud on z/VM components

An enterprise cloud might be composed of various components, depending on its purpose. Implementing an Infrastructure as a Service (IaaS) cloud in z/VM demands the integration of some important components. The components that are listed here play a role in the integration of a cloud in z/VM:

- ▶ The z/VM Directory Manager (DirMaint) or a supported equivalent provides a command driven interface to manage z/VM directory entries.
- ▶ The z/VM Systems Management Application Programming Interface (SMAPI) provides programmatic access for managing many virtual images running on a single z/VM image by using a standard, platform-independent client interface, reducing the number of z/VM-specific programming skills that are required.
- ▶ The IBM Cloud Infrastructure Center is built on OpenStack compatible APIs and enables lifecycle management of virtual infrastructure, as well as deployment of images and policies to maximize resource utilization. It is built to simplify and accelerate cloud deployment through minimal to no specific platform skills requirement for exploitation.
- ▶ Guest LANs and virtual switches enable connectivity between guests within a z/VM system via virtual adapters. A virtual Network Interface Card (NIC) simulates either a HiperSockets device or an OSA-Express device. The guest can operate the virtual adapters using the same software that would be used to drive the equivalent hardware. Virtual switches can bridge guest LANs to associated real LANs connected by an OSA adapter.
- ▶ An External Security Manager (ESM) (such as IBM Resource Access Control Facility (RACF)) provides additional resource protection beyond DIRMAINT and SMAPI authorizations. An ESM is optional, but implementing it might ensure that the company security policy is met. Details about how to implement RACF are described in Chapter 3, “IBM Resource Access Control Facility Security Server for IBM z/VM” on page 35.

5.2 DirMaint

DirMaint provides well-organized and secure interactive facilities for maintaining the z/VM system directory. Directory management is simplified by the DirMaint command interface and automated facilities. DirMaint supports all the z/VM directory statements. Most DirMaint directory commands have the same names and format as the z/VM directory.

Capabilities include, but are not limited to:

- ▶ DirMaint operates as a CMS application and as such used CMS interfaces for CMS and CP services
- ▶ Functions are performed by two disconnected virtual machines operating with an automatic restart facility, thus utilizing the inherent reliability, availability and serviceability of the system architecture
- ▶ User exit routines enable centralized directory maintenance of remote systems. Some exit routines also enable DirMaint to interact with other facilities, such as RACF.
- ▶ The open command structure allows replacing any and all commands with user-written commands

The integrity of CMS files is ensured by preventing new minidisk space from being inadvertently allocated over existing extents.

System security is enhanced by providing the ability to enforce regular password changes. When changing the password, the user is required to enter the new password twice to guard against typographical errors.

An additional level of security can be implemented by using the needpass option to require that a password be entered for every user transaction. This is not the default.

Command authorization is controlled by assigning DirMaint commands to privileged command sets. Users may be authorized to issue commands from multiple command sets. DirMaint provides nine predefined command sets, but up to 36 sets are supported.

5.2.1 DirMaint controls

To work correctly and grant correct authority to DirMaint, it has some control files that must be tailored. This section describes these control files.

When performing a new implementation of the product, you must modify or create the following files:

- ▶ CONFIG DATADVH (shipped with the product)
- ▶ CONFIG nn DATADVH (must be created)
- ▶ AUTHFOR CONTROL (must be updated)
- ▶ RPWLIST DATA (copied from MAINT's 2CC disk)
- ▶ EXTENT CONTROL (must be updated)

CONFIG DATADVH

The CONFIG DATADVH file is the most important file for the DirMaint configuration. It contains all of the tailorable parameters for the product. You should *never* modify this IBM supplied file because it might be updated through the service process and overwrite your changes. To change parameters on this file, create an override file instead where your installation-specific parameters are defined. The override file is named CONFIG nn DATADVH, where the nn can be any two digits you want to assign. The CONFIG DATADVH file is self-documented. For more information, see [z/VM: Directory Maintenance Facility, Tailoring and Administration Guide, SC24-6283](#).

CONFIGSM DATADVH

Note: The CONFIGSM DATADVH file must be on the 11F disk when it is created. It is updated by using the `dirm send` and `dirm file` commands. After changes are made, the DirMaint administrator must run the `dirm rldata` command. This command is used to instruct the DIRMAINT VM to reload all DATADVH files into memory.

The statements that are shown in Example 5-1 are a good starting point for your CONFIGSM DATADVH file. DirMaint accepts nn as AA, BB, and so on. This example uses SM to refer to SMAPI configuration.

Example 5-1 CONFIGSM DATADVH

```
ALLOW_ASUSER_NOPASS_FROM= VSMGUARD *
ALLOW_ASUSER_NOPASS_FROM= VSMWORK1 *
ALLOW_ASUSER_NOPASS_FROM= VSMWORK2 *
ALLOW_ASUSER_NOPASS_FROM= VSMWORK3 *
ALLOW_ASUSER_NOPASS_FROM= WAVEWRKS *
ALLOW_ASUSER_NOPASS_FROM= WAVEWRKC *
```

```

ALLOW_ASUSER_NOPASS_FROM= WAVEWRKL *
ALLOW_ASUSER_NOPASS_FROM= EDI *
ASYNCHRONOUS_UPDATE_NOTIFICATION_EXIT.TCP= DVHXNE EXEC
ASYNCHRONOUS_UPDATE_NOTIFICATION_EXIT.UDP= DVHXNE EXEC

```

This file must be on the same disk as the CONFIG DATADVH file.

Note:

- ▶ The ALLOW_ASUSER_NOPASS_FROM lines allow SMAPI users to issue commands to the Directory Manager by using the **ASUSER** modifier and the password of that user.
- ▶ The ASYNCHRONOUS_UPDATE_NOTIFICATION_EXIT lines activate an exit that notifies SMAPI of changes that are made to the user directory.
- ▶ If privacy of residual data is a concern on your system, use DISK_CLEANUP=YES.
- ▶ The ONLINE= IMMED line sets your changes to be made immediately.
- ▶ The RUNMODE= OPERATIONAL line sets directory changes to be committed. This can be set to TESTING and the changes are not performed.

AUTHFOR control file

This file defines authorized administrators for your system in DirMaint. You can have several administrators that are defined in the AUTHFOR CONTROL file. The file is not shipped with the product and must be created manually. The file *must* be on the DIRMAINT 1DF disk. This file is also case-sensitive and *must* be in upper case.

In Figure 5-1, a set of service VMs are granted full DirMaint authority through DirMaint specific privilege classes ('ADGHOPS'). These privilege classes represent distinct types of DirMaint roles and correspond to particular DirMaint commands and operations. When updating the AUTHFOR file, give careful consideration to the requirements of the VMs being added and the scope of their authority.

```

ALL LNXADMIN * 140A ADGHOPS
ALL LNXADMIN * 150A ADGHOPS
ALL MAINT730 * 140A ADGHOPS
ALL MAINT730 * 150A ADGHOPS
ALL MAINT * 140A ADGHOPS
ALL MAINT * 150A ADGHOPS
ALL VSMGUARD * 140A ADGHOPS
ALL VSMGUARD * 150A ADGHOPS
ALL VSMWORK1 * 140A ADGHOPS
ALL VSMWORK1 * 150A ADGHOPS
ALL VSMWORK2 * 140A ADGHOPS
ALL VSMWORK2 * 150A ADGHOPS
ALL VSMWORK3 * 140A ADGHOPS
ALL VSMWORK3 * 150A ADGHOPS
ALL EDI * 140A ADGHOPS
ALL EDI * 150A ADGHOPS

```

Figure 5-1 Administrators who are authorized in DirMaint

The AUTHFOR CONTROL file specifies which VMs have authority to modify the characteristics of other VMs on the system. This authority can be limited to specific target VMs or to specific attributes of a target VM. This is implemented with DirMaint command sets. The format of this file is column-specific.

RPWLIST DATA

The RPWLIST DATA file is on the MAINT 2CC minidisk. You should link and access this disk and copy the file to the 11F disk that is owned by DIRMAINT. It can be used to disable passwords that you deem to be trivial.

EXTENT CONTROL

The EXTENT CONTROL file defines disks (volumes) to DirMaint for minidisk allocation. It also contains system and device default values that are used during allocation operations. There are two main sections that should be populated:

- ▶ Regions define the actual disks and their sizes to DirMaint. The **AUTOR** keyword can be used in user directory entries to take space from the regions. As a preferred practice, the region name and volume label always should be identical.
- ▶ Groups define pools of disks so that the **AUTOG** keyword can be used to take space from the pools, not from specific disks.

Note: For more information about DIRMAINT, see [z/VM: Directory Maintenance Facility, Tailoring and Administration Guide, SC24-6283](#).

DirMaint-RACF Connector

RACF can coexist with the DirMaint product installed. However, to avoid dual maintenance of password processing (and other RACF functions), complete the following steps:

1. Use the DirMaint supplied sample file CONFIGR SMPDVH. You must copy this file to the 7VMDIR30 11F disk as CONFIGR DATADVH.

Note: For more information about this file, see Chapter 3, “Tailoring the DIRMAINT Service Machine”, in [z/VM: Directory Maintenance Facility, Tailoring and Administration Guide, SC24-6283](#). For this file to take effect, either perform an IPL of DirMaint or run the **DIRM RLDDATA** command.

2. If RACF administration is centralized, you must give the DIRMAINT user ID RACF administrator SPECIAL authority. If RACF administration is decentralized, you must give the DIRMAINT user ID RACF group-SPECIAL authority.
3. If you want to record DirMaint activity in RACF SMF records, enable ESM_LOG_RECORDING_EXIT. To do this, remove the comment from the item ESM_LOG_RECORDING_EXIT in the CONFIGR DATADVH file. For this to take effect, either perform an IPL of DirMaint or run the **DIRM RLDDATA** command.
4. You must also authorize the DirMaint service machines DIRMAINT, DATAMOVE, and DIRMSAT to use the RACROUTE interface.

Note: For more information, see [z/VM: Directory Maintenance Facility, Tailoring and Administration Guide, SC24-6283](#) and [z/VM: Security Server RACROUTE Macro Reference, SC24-6324](#).

5.2.2 Delegating DirMaint authority

There are three components of DirMaint access management:

- ▶ Command privilege classes
- ▶ AUTHFOR CONTROL and AUTHBY CONTROL files
- ▶ Exit routines

These mechanisms provide the management of administrators that are authorized to use DirMaint and the level of authority they have over their own user ID and the IDs of others.

In addition, DirMaint allows for commands to be issued under the authority of another user by using the **ASuser** prefix. Although this method is used when issuing commands to another system, it can also be used as a method for delegation of authority.

Command privilege classes

DirMaint uses a privilege class structure that is similar to that used by CP. Commands are grouped into classes based on the administrative function they perform, and users are then assigned to a class. A command may exist in one or more classes, and a user can also be assigned privileges over more than one class. The 140CMDS DATADVH and 150CMDS DATADVH files contain the mapping of commands into classes.

Custom classes can be created in the 1*0CMDS DATADVH files, which allows for a DirMaint administrator to create groupings of commands that suit the requirements of the installation. The process is described in “Defining a Custom Command Set” in the *z/VM: Directory Maintenance Facility, Tailoring and Administration Guide, SC24-6283*.

AUTHFOR CONTROL and AUTHBY CONTROL

The AUTHFOR CONTROL file on the DIRMAINT 1DF disk maps DirMaint administration users to the users they are allowed to administer and the command privileges they have over those users. An example of the AUTHFOR CONTROL file appears in Example 5-2.

Example 5-2 Example of the AUTHFOR CONTROL file

```
ALL LNXADMIN * 140A ADGHOPS
ALL LNXADMIN * 150A ADGHOPS
ALL LNXMAINT * 140A ADGHOPS
ALL LNXMAINT * 150A ADGHOPS
ALL MAINT * 140A ADGHOPS
ALL MAINT * 150A ADGHOPS
```

In this example, the users LNXADMIN, LNXMAINT, and MAINT are permitted to run commands from both of the DirMaint command levels (140A and 150A) in the classes A, D, G, H, O, P, and S against all users on the system (the **ALL** keyword at the start of the records).

The AUTHFOR CONTROL file can be updated by running the DirMaint **AUTHFOR** command, or by running **DIRM SEND** to send a copy of the file, editing it directly, and running **DIRM FILE** to store it back to DirMaint. If the file is edited directly, the **DIRM RLDCODE** command must be run to refresh DirMaint with the update.

Note: For more information about AUTHFOR CONTROL, see [z/VM: Directory Maintenance Facility, Tailoring and Administration Guide, SC24-6283](#).

Running commands by using ASuser

On the example system, Linux system administrators have the role of maintaining Linux VM definitions by using DirMaint. Currently, the AUTHFOR CONTROL file grants access to these administrators over all the VMs on the system (by using the **ALL** keyword). Suppose that you want to give these administrators access to operate only on the Linux VM users. Using AUTHFOR CONTROL, the only way this can be done is to list explicitly each Linux VM and the command privilege that applies, for each administrator. This introduces the following considerations:

- ▶ Each time a Linux system is added, AUTHFOR CONTROL must be updated to add authority to the new guest for *all Linux administrators*.
- ▶ If an administrator joins or leaves the team, AUTHFOR CONTROL must be modified to add or remove entries for *all the Linux guests*.
- ▶ If the command privilege level that the Linux administrators should be assigned over Linux guests changes, *every* corresponding line in AUTHFOR CONTROL has to be updated.

A method that can be used to implement a group membership approach is to define an administrator ID for each set of Linux guests. Individual administrators then use the **ASuser** prefix keyword on the **DIRM** command to issue their administrative commands to DirMaint under the authority of the group ID:

```
DIRM AS LNX1GRP FOR LNXS0030 REVIEW
```

This process works as a way to reduce the configuration effort because the only ID that appears in the AUTHFOR CONTROL file is the group administrator ID. However, there are a few drawbacks:

- ▶ The group administrator ID must be defined to RACF. It does not have to be defined to the CP directory.
- ▶ The **ASuser** prefix keyword forces a prompt for the administrator password every time it is used.
- ▶ The password that must be provided when **ASuser** is used as the password of the group administrator ID.

Using BYuser

The **ASuser** prefix can be combined with **BYuser** to avoid having to know the password of the administrator ID. Using **BY** with **AS** allows an administrator to override the password prompt that comes from using **AS** with a prompt for their own password, but the administrator must use their own ID as the option on the **BY** prefix. The DirMaint command then appear like this:

```
DIRM AS LNX1GRP BY VIC FOR LNXS0030 REVIEW
```

A DirMaint administrator must be authorized to run commands by using **BYuser** because the password of the administrator *running the command* is used, so administrators on the system must be protected from other admins running commands on their behalf. The authority is managed in a configuration file within DirMaint in a similar fashion to **FOR** by using the file AUTHBY CONTROL. The AUTHBY CONTROL file is maintained in a similar way to AUTHFOR CONTROL, either by using the DirMaint **AUTHBY** command or by directly editing the AUTHBY CONTROL file.

Note: Like AUTHFOR CONTROL, there is no supplied AUTHBY CONTROL file in a DirMaint installation. Use the **AUTHBY** command to create the first AUTHBY entry so that DirMaint creates the file on the correct disk. You can then use the SEND/FILE process to edit the file directly if you want.

To enable the **AUTHBY** command, the LNX1GRP user runs the following command:

```
DIRM AUTHBY VIC
```

If another administrator already has access to run commands on behalf of LNX1GRP, they can run the following command:

```
DIRM FOR LNX1GRP AUTHBY VIC
```

Either of these commands result in a line being added to the AUTHBY CONTROL file, as shown in Example 5-3.

Example 5-3 Line added to AUTHBY CONTROL

```
LNX1GRP VIC
```

Suppressing the password prompt

DirMaint has a configuration option `ALLOW_ASUSER_NOPASS_FROM`, which allows authorized administrators to run commands by using the **ASuser** prefix without being prompted for a password. This option is used only for the SMAPI worker servers; other DirMaint administrators should not be entered in this option. Therefore, it is not possible to suppress the password prompt for a DirMaint administrator by using the **ASuser** prefix.

Exit routines

Chapter 9, "Exit routines", in *Directory Maintenance Facility Tailoring and Administration Guide*, SC24-6135 describes the exits that are available to modify the way DirMaint operates. Many of the exits that are available have an influence over command processing, which is useful because it allows more granular access control than what is provided by command privilege or administrator configuration.

Example exit usage: FOR authorization

The following sections describe an example of how a DirMaint exit can be used. The example implements group-based administration by using **ASuser** and **BYuser** by using a DirMaint exit instead of **AUTHFOR** and **AUTHBY**.

An easier way to achieve the requirement might be to use the DirMaint exit routine for the **FOR** command. As the Linux administrators are using the **DIRM FOR** command to perform operations on the guests they manage, using the exit routine that is called when **FOR** commands are run is a good way to determine programmatically whether the command should be granted.

An example exit routine to achieve the effect is shown in Example 5-4.

Example 5-4 Sample DVHXFA EXEC for authority delegation

```
/* REXX */
/* DVHXFA EXEC */
/* DirMaint FOR Authorisation Checking exit */
Address 'COMMAND'
Parse Upper Arg Asuser NodeID TgtID TgtNode CmdLvl CmdSet Cmd
/* Read in the user file to find the group(s) */
'PIPE < USR2GRP DIRMFILE | ',
  'LOCATE /'TgtID'/ | ',
  'STEM Groups.'
/* Does the user belong to a group? Exit if not */
If Groups.0=0 Then Exit 30
/* For each group the user is a member of, see if the issuer is a member */
```

```

Do counter=1 to Groups.0
  Group=Word(Groups.counter,2)
  'PIPE < GRP2ADM DIRMFIL | ',
  'LOCATE /'Group'/ | ',
  'LOCATE /'Asuser'/ | ',
  'STEM Admin.'
/* If the stem is empty we try again; if not, we got one, we're done */
  If Admin.0=0 Then Iterate; Else Exit 0
End
Exit 30

```

The exec uses two files that are stored on a DirMaint disk, USR2GRP DIRMFIL and GRP2ADM DIRMFIL to provide group-based organization to DirMaint access control. The USR2GRP DIRMFIL file links z/VM user IDs to the group they belong to, and GRP2ADM DIRMFIL maps the administration groups to the DirMaint administrator users who are permitted to operate on them.

Records in USR2GRP DIRMFIL have the following format:

```
Userid Group
```

One space character is sufficient between the user ID and the group.

Records in GRP2ADM DIRMFIL have the following format:

```
Group Adminid [Adminid ...]
```

You can specify the group multiple times if needed to support many administrator IDs.

Implementing the DVHXFA exit

In this example, you implement the **DVHXFA EXEC** exit to ensure it works as expected. Complete the following steps:

1. Install the files onto the DIRMAINT 11F disk by running **DIRM FILE** (specifying the destination filemode of D to make sure that they went to 11F instead of the 191):


```
DIRM FILE DVHXFA EXEC A = = D
DIRM FILE USR2GRP EXEC A = = D
DIRM FILE GRP2ADM EXEC A = = D
```
2. Add the correct entry to the CONFIG* DATADVH file set to activate the exit:


```
FOR_AUTHORIZATION_CHECKING_EXIT= DVHXFA EXEC
```
3. You have a CONFIGAA DATADVH file that contains all the local changes, so add the line there by running **DIRM SEND**, receive, edit, and the run **DIRM FILE**.
4. Activate the altered configuration by running **DIRM RLDData** to put the exit into service.
5. Remove the authorization for the Linux administrators from AUTHFOR CONTROL by using a bulk update by using the SEND-receive-edit-FILE-RLDD method.
6. Ensure that the administrators can do what they needed. In this example, the administrator VIC was permitted to administer only the groups CMSGRP and LNX1GRP. LNX1GRP contained the user LNXS0030, but another user LNXS0038 was in a different group. The CMS user USERBOB was part of CMSGRP.

Example 5-5 shows the results when administrator VIC attempted to work on system user IDs.

Example 5-5 Run DirMaint commands when the DVHXFA exit is in place

dirm for userbob review

DVHXMT1191I Your REVIEW request has been sent for processing to DIRMAINT
DVHXMT1191I at ITS0ZVM1.

Ready; T=0.01/0.01 17:18:40

DVHREQ2288I Your REVIEW request for USERBOB at * has been accepted.

RDR FILE 0237 SENT FROM DIRMAINT PUN WAS 6593 RECS 0028 CPY 001 A NOHOLD NOKEEP

DVHREQ2289I Your REVIEW request for USERBOB at * has completed; with

DVHREQ2289I RC = 0.

dirm for lnxs0030 review

DVHXMT1191I Your REVIEW request has been sent for processing to DIRMAINT
DVHXMT1191I at ITS0ZVM1.

Ready; T=0.01/0.01 17:19:11

DVHREQ2288I Your REVIEW request for LNXS0030 at * has been accepted.

RDR FILE 0241 SENT FROM DIRMAINT PUN WAS 6597 RECS 0045 CPY 001 A NOHOLD NOKEEP

DVHREQ2289I Your REVIEW request for LNXS0030 at * has completed; with RC

DVHREQ2289I = 0.

dirm for lnxs0038 review

DVHXMT1191I Your REVIEW request has been sent for processing to DIRMAINT
DVHXMT1191I at ITS0ZVM1.

Ready; T=0.01/0.01 17:19:17

DVHREQ2287E User VIC at ITS0ZVM1 is not authorized to act for LNXS0038

DVHREQ2287E at *; your request is ignored.

dirm for maint730 review

DVHXMT1191I Your REVIEW request has been sent for processing to DIRMAINT
DVHXMT1191I at ITS0ZVM1.

Ready; T=0.01/0.01 17:36:48

DVHREQ2287E User VIC at ITS0ZVM1 is not authorized to act for MAINT630

DVHREQ2287E at *; your request is ignored.

5.3 Systems Management API

Some IBM products use System Management Application Programming Interface (SMAPI) calls to perform various tasks on the z/VM system. Therefore, it is necessary to make sure that SMAPI is configured and running before you configure any cloud piece that interacts with z/VM. The exact configuration steps for SMAPI might differ from the following sections based on your version and release level of z/VM.

5.3.1 Shared File System (SFS)

The SMAPI request servers and worker servers use directories to access configuration files and other data. SMAPI uses the standard file pool VMSYS and VMPSFS to keep their files. The VSMWORK1 user ID is the owner of some of the SFS directories that have control files, logs and so on.

Security aspects with SFS directories

The SFS directories are defined on SFS file pools. The authorization and ownership for the SFS directories are done by using **ENROLL** commands.

Note: For more information about managing the VMSYS or VMPSFS file pools, see [z/VM: CMS File Pool Planning, Administration, and Operation, SC24-6167](#).

Example 5-6 and Example 5-7 show both the **ENROLL** and **GRANT** commands that are performed automatically during z/VM installation. They are shown here for verification and testing purposes. Also, if you are adding a worker or request server, you can use the appropriate commands from these lists as a guide for enrolling your new server in the correct file pool and then grant SFS authorizations.

Example 5-6 SFS ENROLL command

```
ENROLL USER VSMWORK1 VMSYS: (BLOCKS 6000 STORGROUP 2
ENROLL USER VSMWORK2 VMSYS:
ENROLL USER VSMWORK3 VMSYS:
ENROLL USER VSMREQIN VMSYS:
ENROLL USER VSMREQIU VMSYS:
ENROLL USER VSMGUARD VMPSFS: (BLOCKS 1000 STORGROUP 2
ENROLL USER VSMGUARD VMSYS:
ENROLL USER VSMREQI6 VMSYS:
ENROLL USER VSMEVSRV VMSYS:
ENROLL USER DTCSMAPI VMSYS:
ENROLL USER OPERATNS VMSYS:
ENROLL USER PERSMAPI VMSYS: (BLOCKS 24000 STORGROUP 2
```

If you do not grant access to the specific directory, you cannot access it. Example 5-7 is an example of SFS **GRANT** commands that are automatically performed during z/VM installation.

Example 5-7 SFS GRANT command

```
GRANT AUTHORITY VMSYS:VSMWORK1. TO MAINT (WRITE NEWWRITE
GRANT AUTHORITY VMSYS:VSMWORK1.DATA TO MAINT (WRITE NEWWRITE
GRANT AUTHORITY VMSYS:VSMWORK1. TO VSMGUARD (WRITE NEWWRITE
GRANT AUTHORITY VMSYS:VSMWORK1.DATA TO VSMGUARD (WRITE NEWWRITE
GRANT AUTHORITY VMSYS:VSMWORK1.STATUS TO VSMGUARD (WRITE NEWWRITE
GRANT AUTHORITY VMSYS:VSMWORK1.STATUS TO VSMWORK2 (WRITE NEWWRITE
GRANT AUTHORITY VMSYS:VSMWORK1.STATUS TO VSMWORK3 (WRITE NEWWRITE
GRANT AUTHORITY * * VMSYS:VSMWORK1. TO VSMGUARD (READ
GRANT AUTHORITY VMSYS:VSMWORK1. TO PERSMAPI (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DIRMAINT (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DIRMSAT (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DIRMSAT2 (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DIRMSAT3 (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DIRMSAT4 (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DATAMOVE (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DATAMOV2 (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DATAMOV3 (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO DATAMOV4 (READ NEWREAD
GRANT AUTHORITY VMPSFS:VSMGUARD. TO AUTOLOG1 (WRITE NEWWRITE
GRANT AUTHORITY VMPSFS:VSMGUARD. TO AUTOLOG2 (WRITE NEWWRITE
```

Note: For more information about SMAPI, see [The Virtualization Cookbook for IBM Z Volume 1: IBM z/VM 7.2, SG24-8147](#) and [Systems Management Application Programming, SC24-6234](#).

5.3.2 Looking at other SMAPI user IDs

The interaction with SMAPI happens through a client-server architecture and SMAPI has two types of servers:

- ▶ Request servers
- ▶ Worker servers

Request servers

A listening request server receives a connection request from a client, establishes a connection, and then accepts requests from that client. Here are the request servers:

- ▶ VSMREQIN
- ▶ VSMREQI6
- ▶ VSMREQIU
- ▶ VSMEVSRV

Worker servers

The worker servers process API function requests. Three worker servers are defined in the default installation:

- ▶ VSMWORK1
- ▶ VSMWORK2
- ▶ VSMWORK3

A fourth worker server, VSMGUARD, is also defined. VSMGUARD is a “guard” server that helps provide better resiliency and error recovery. It is described in 5.3.3, “VSMGUARD” on page 146.

Other servers

Additional other servers that can be enabled are as follows.

- ▶ The LOHCOST server is used for caching the system directory contents that are required to satisfy the various query APIs. It is also used to store and retrieve data that is used by the metadata APIs.
- ▶ The DTCSMAPI server is used by several of the SMAPI servers for communication and workload balancing.
- ▶ The PERSMAPI server is used for performance monitoring.
- ▶ The VSMEVSRV server is used to listen for and then propagate VMEVENT and directory updates.
- ▶ The OPERATNS server is used to collect, format, and distribute ABEND dumps.

Note: For more information about SMAPI servers, see [Systems Management Application Programming](#), SC24-6234.

5.3.3 VSMGUARD

The VSMGUARD worker server grants authority to all the other SMAPI servers that are configured to access the SMAPI file space. Therefore, VSMGUARD must be made an administrator of the VMSYS: file pool. This is done by adding VSMGUARD to the list of users that are authorized for ADMIN authority.

Note: In the default environment, this is done by updating the VMSEVS DMSPARMS file on the VMSEVS 191 disk.

VSMGUARD has an important role in the SMAPI environment. When you must recycle all SMAPI user IDs, you do it by recycling VSMGUARD (**force** and **xauto1og**) and it recycles all the other SMAPI user IDs, save the SMAPI segment, and define the vSwitches that are listed in the configuration file.

Note: For more information about VSMGUARD, see [Systems Management Application Programming](#), SC24-6234.

5.3.4 SMAPI controls

To allow services to function properly on z/VM, use XEDIT to edit the DMSSICNF COPY file on the MAINT 193 disk. IBM recommends that you keep at least two previous versions of the file as backups. The following SMAPI configuration property is specified in the DMSSICNF COPY file. The DMSSICNF COPY file contains several global attributes that can be modified to better fit your installation and networking configurations such as IP addresses, gateway, netmask, domain name, and vSwitches

The following SMAPI configuration property must be configured and is specified in the DMSSICNF COPY file.

► DMSSISVR NAMES

DMSSISVR NAMES is a CMS NAMES file that defines each specific request and worker servers in the z/VM environment. This file is on the MAINT 193 MDisk.

Modify the DMSSISVR NAMES file and uncomment the directory manager and the dump handler definitions. You can modify it manually or run the VMSES/E **LOCALMOD** command to change this file.

Note: Using VM/SES helps preserve your configuration changes if IBM makes service updates or future release update in this file.

5.3.5 Security aspects involving SMAPI

An ESM controls who can have access, and what kind of access they can have, to specific resources. If an ESM is implemented at your installation, SMAPI must be given the appropriate access to the disks, SFS directories, and resources you want it to manage. In this example installation, use RACF as the ESM.

Besides the security aspects that you have by using SFS, you have other authority files on SMAPI that lists who is authorized to run commands on SMAPI. Make sure your installation grants access to authorized people only.

VSMWORK1 AUTHLIST

Authenticated users must be authorized to issue API requests. A server authorization file is used for this purpose. The authorization file contains entries that authorize authenticated users to perform specific functions for specific virtual images (target users) or lists of virtual images. The authorization can be granted per requesting VM, per target, or per function. This file is in the VMSYS file pool, under the VSMWORK1 SFS directory and, during the installation, VSMGUARD is granted access to it, as shown in Example 5-8.

Example 5-8 VSMGUARD access to the VSMWORK1 directory

```
grant authority vmsys:vsmwork1. to vsmguard (write newwrite
grant authority vmsys:vsmwork1.data to vsmguard (write newwrite
grant authority * * vmsys:vsmwork1. to vsmguard (read
```

You can use RACF to replace the AUTHLIST, allowing RACF to control and audit what virtual machines have access to which APIs. To do this, you would use XEDIT to edit the DMSSICNF COPY file on the MAINT 193 disk. For more information on this, see the section entitled **Authorization_Policy_EsmAuthlist** on the following website:

<https://www.ibm.com/docs/en/zvm/7.3?topic=smapi-configuration-properties>

Using SMAPI with RACF

RACF for z/VM can be used to enhance the security and integrity of your system in the following ways:

- ▶ Helping you to implement the company's security policy
- ▶ Identifying and authenticating each user
- ▶ Controlling each user's access to sensitive data
- ▶ Logging and reporting events that are relevant to the system's security

Enabling RACROUTE

Enable the SMAPI service machines VSMREQI6, VSMREQIN, VSMREQIU, VSMEVSRV, DTCSMAPI, VSMWORK1, VSMWORK2, and VSMWORK3 to use RACROUTE services, as shown in Example 5-9.

Example 5-9 RACF RACROUTE definitions for SMAPI user IDs

```
RAC SETROPTS CLASSACT(FACILITY)
RAC SETROPTS RACLIST(FACILITY)
RAC RDEFINE FACILITY ICHCONN UACC(NONE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(VSMREQI6) ACCESS(UPDATE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(VSMREQIN) ACCESS(UPDATE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(VSMREQIU) ACCESS(UPDATE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(VSMEVSRV) ACCESS(UPDATE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(DTCSMAPI) ACCESS(UPDATE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(VSMWORK1) ACCESS(UPDATE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(VSMWORK2) ACCESS(UPDATE)
RAC PERMIT ICHCONN CLASS(FACILITY) ID(VSMWORK3) ACCESS(UPDATE)
RAC SETROPTS RACLIST(FACILITY) REFRESH
```

The directory entry for the SMAPI service machines that use this capability must all contain the following statement:

```
IUCV ANY PRIORITY MSGLIMIT 255
```

An MSGLIMIT value of 255 is initially suggested. It may be adjusted as needed.

Making SMAPI user IDs exempt for some RACF checking

The SMAPI service machines (DTCSMAPI, VSMWORK1, VSMWORK2, and VSMWORK3) should be made exempt from access checking. Even if access checking is not active on your system, make the SMAPI service machines exempt from access checking for the **FOR** (privilege class C), and **LINK** commands, as shown in Example 5-10 on page 149.

Example 5-10 Make SMAPI user IDs exempt for FOR and LINK commands

```

RAC SETROPTS CLASSACT(VMXEVENT)
RAC RDEFINE VMXEVENT USERSEL.DTCSMAPI
RAC RALTER VMXEVENT USERSEL.DTCSMAPI ADDMEM(FOR.C/NOCTL)
RAC RALTER VMXEVENT USERSEL.DTCSMAPI ADDMEM(LINK/NOCTL)
RAC SETEVENT REFRESH USERSEL.DTCSMAPI
RAC RDEFINE VMXEVENT USERSEL.VSMWORK1
RAC RALTER VMXEVENT USERSEL.VSMWORK1 ADDMEM(FOR.C/NOCTL)
RAC RALTER VMXEVENT USERSEL.VSMWORK1 ADDMEM(LINK/NOCTL)
RAC SETEVENT REFRESH USERSEL.VSMWORK1
RAC RDEFINE VMXEVENT USERSEL.VSMWORK2
RAC RALTER VMXEVENT USERSEL.VSMWORK2 ADDMEM(FOR.C/NOCTL)
RAC RALTER VMXEVENT USERSEL.VSMWORK2 ADDMEM(LINK/NOCTL)
RAC SETEVENT REFRESH USERSEL.VSMWORK2
RAC RDEFINE VMXEVENT USERSEL.VSMWORK3
RAC RALTER VMXEVENT USERSEL.VSMWORK3 ADDMEM(FOR.C/NOCTL)
RAC RALTER VMXEVENT USERSEL.VSMWORK3 ADDMEM(LINK/NOCTL)
RAC SETEVENT REFRESH USERSEL.VSMWORK3

```

Enabling SMAPI to access DIAGNOSE X'88'

You must enable the SMAPI service machines for DIAGNOSE X'88' access. If RACF is being used to control DIAGNOSE X'88' access, enable DIAGNOSE X'88' access for SMAPI by completing the following steps:

1. Enable RACF/VM profile protection for DIAGNOSE X'88', as shown in Example 5-11.

Example 5-11 Create a profile DIAG88 in VMCMD class

```

RAC RDEFINE VMCMD DIAG088 UACC(NONE)
RAC SETROPTS CLASSACT(VMCMD)

```

Note: Each SMAPI server has the OPTION DIAG88 statement in its directory entry. If you do not enable RACF protection, the checking defaults to the CP directory OPTION DIAG88 entry, which tells CP that the server is authorized to use DIAGNOSE code X'88'.

2. Give the SMAPI server permission to perform password validation (which uses DIAGNOSE X'88' subcode 8), as shown in Example 5-12 through Example 5-14.

Example 5-12 Give authority to the requester servers

```

RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMREQIN) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMREQI6) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMREQIU) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMEVSRV) ACCESS(READ)

```

Example 5-13 Give authority to the worker servers

```

RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMGUARD) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMWORK1) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMWORK2) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(VSMWORK3) ACCESS(READ)

```

Example 5-14 Give authority to these SMAPI user IDs

```

RAC PERMIT DIAG088 CLASS(VMCMD) ID(LOHCOST) ACCESS(READ)

```

```
RAC PERMIT DIAG088 CLASS(VMCMD) ID(DTCSMAPI) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(PERSMAPI) ACCESS(READ)
RAC PERMIT DIAG088 CLASS(VMCMD) ID(OPERATNS) ACCESS(READ)
```

Enabling SMAPI to access needed resources

You must enable the SMAPI service machine for minidisk, reader, and VMBATCH access, as shown in Example 5-15 through Example 5-18.

Example 5-15 For minidisk access: RACF uses to control minidisk access

```
RAC PERMIT MAINT630.5E5 CLASS(VMMDISK) ID(VSMWORK1) ACCESS(READ)
RAC PERMIT MAINT630.51D CLASS(VMMDISK) ID(VSMWORK1) ACCESS(READ)
RAC PERMIT PMAINT.551 CLASS(VMMDISK) ID(VSMGUARD) ACCESS(READ)
```

Example 5-16 Allow VSMWORK1 minidisk authority

```
RAC PERMIT PMAINT.CF0 CLASS(VMMDISK) ACC(CONTROL) ID(VSMWORK1)
RAC PERMIT MAINT.CF1 CLASS(VMMDISK) ACC(CONTROL) ID(VSMWORK1)
```

Example 5-17 Allow SMAPI worker servers to read the TCPMAINT 198 disk

```
RAC PERMIT TCPMAINT.198 CLASS(VMMDISK) ACC(READ) ID(VSMGUARD)
RAC PERMIT TCPMAINT.198 CLASS(VMMDISK) ACC(READ) ID(VSMWORK1)
RAC PERMIT TCPMAINT.198 CLASS(VMMDISK) ACC(READ) ID(VSMWORK2)
RAC PERMIT TCPMAINT.198 CLASS(VMMDISK) ACC(READ) ID(VSMWORK3)
```

Example 5-18 Enable reader access to DTCSMAPI for MAINT and TCPMAINT user IDs

```
RAC PERMIT MAINT CLASS(VMRDR) ID(DTCSMAPI) ACCESS(UPDATE)
RAC PERMIT TCPMAINT CLASS(VMRDR) ID(DTCSMAPI) ACCESS(UPDATE)
```

VMBATCH access

Permit the SMAPI servers CONTROL access to a generic VMBATCH, or to an existing discrete VMBATCH profile to use the SMAPI services, as shown in Example 5-19 and Example 5-20.

Example 5-19 Give CONTROL access if you have an existing generic VMBATCH profile

```
RAC PERMIT ** CLASS(VMBATCH) ID(VSMWORK1) ACCESS(CONTROL)
RAC PERMIT ** CLASS(VMBATCH) ID(VSMWORK2) ACCESS(CONTROL)
RAC PERMIT ** CLASS(VMBATCH) ID(VSMWORK3) ACCESS(CONTROL)
RAC PERMIT ** CLASS(VMBATCH) ID(DTCSMAPI) ACCESS(CONTROL)
```

Example 5-20 Give CONTROL access if you have an existing generic VMBATCH profile:

```
RAC PERMIT CLASS(VMBATCH) ID(VSMWORK1) ACCESS(CONTROL)
RAC PERMIT CLASS(VMBATCH) ID(VSMWORK2) ACCESS(CONTROL)
RAC PERMIT CLASS(VMBATCH) ID(VSMWORK3) ACCESS(CONTROL)
RAC PERMIT CLASS(VMBATCH) ID(DTCSMAPI) ACCESS(CONTROL)
```

Although all the items that are described here are important, they are not enough without validating them. Auditing SMAPI requests ensures that the security policies that are applied are being followed and are correctly assigned.

5.4 IBM Cloud Infrastructure Center

The z/VM Cloud Management Appliance (CMA) no longer exists. Instead, the IBM Cloud Infrastructure Center (ICIC) is used to manage z/VM-hosted clouds. It delivers the following capabilities:

- ▶ Simplified provisioning of virtual machine instances into an on-premises cloud via a self-service portal.
- ▶ Infrastructure provisioning that can be confined by workflow-driven policies.
- ▶ Automated configuration of I/O and network resources.
- ▶ Image management that includes virtual machine image capture, catalog, and deployment.
- ▶ Easy integration into higher-level cloud automation and orchestration tools.
- ▶ Federation of an on-premises cloud with OpenStack clouds via OpenStack compatible APIs establishing a multi-region cloud.
- ▶ Management of existing virtual machines that aren't created by compute node with onboarding feature (z/VM only).

For more information on the IBM Cloud Infrastructure Center, see section 2.2 in [Hybrid cloud with on-premises cloud on IBM Z or LinuxONE, SG24-8530](#).

5.4.1 Architectural overview on z/VM

As seen in Figure 5-2, in the case of a single cloud, only one management node is needed. It manages all the compute nodes. One compute node is required for each z/VM which is to be managed.

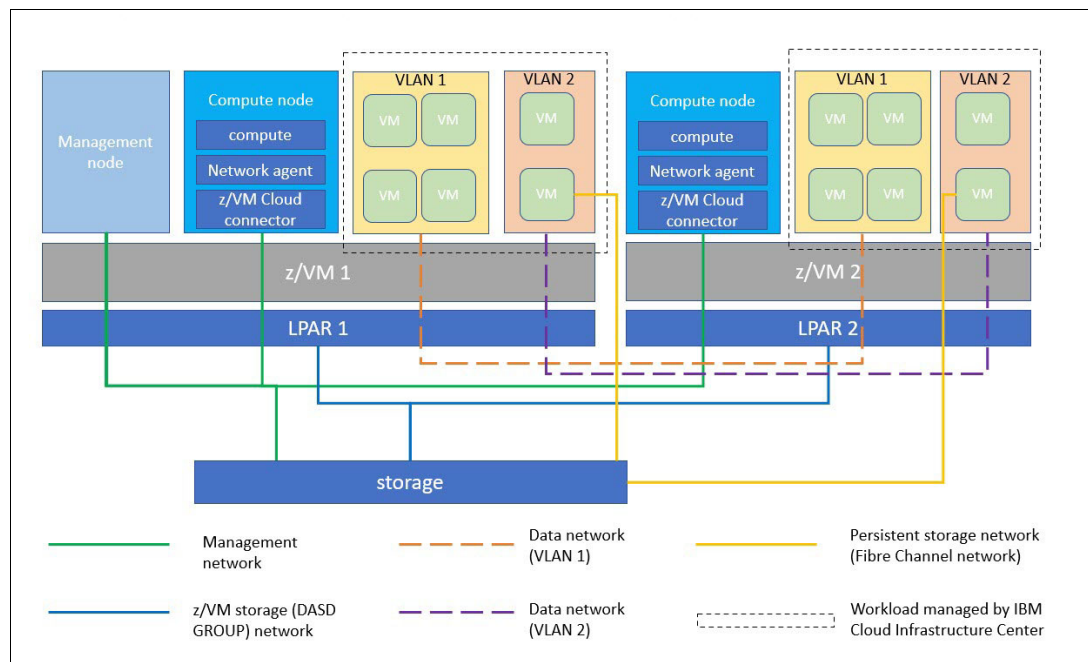


Figure 5-2 Overall architecture of IBM Cloud Infrastructure Center on z/VM

5.4.2 Basic requirements and configuration options

The following information provides a consolidated view of the hardware and software requirements for your IBM Cloud Infrastructure Center environment for z/VM system.

- ▶ z/VM version 7.1, 7.2 or 7.3

Note: The information provided above assumes DIRMAINT and RACF are used. For tools other than DIRMAINT and RACF, refer to your vendor to find corresponding required configurations.

- ▶ It is recommended to update z/VM to the latest level with APARs installed as listed on the [z/VM service information page](#).
- ▶ All the z/VM SMAPI and z/VM DIRMAINT APARs must be installed for the corresponding z/VM version.
- ▶ APAR 66344 must be installed in cases of running ICIC on a 2nd level z/VM system if using z/VM 7.1.
- ▶ If ICIC is running on z/VM 7.2 with mixed CP and IFL configured on the LPAR, then z/VM APAR VM66568 must be installed.

5.4.3 Management node

The management node is a Linux machine running a set of services performing management work. One management node can manage multiple compute nodes (1:n relationship).

The main difference between the z/VM architecture and KVM is the management node. For KVM, the management node is required to be in a different LPAR from the KVM hosts. This is because the management node should not be virtualized inside one of the KVM host hypervisor layers. The rest of the architecture is equivalent, as well as deployments and management which are similar to the web portal, however installation and configuration differs.

Below are the hardware and software requirements.

Minimum sever requirements:

- ▶ Memory: 16 GB
- ▶ IFL: 0.5
- ▶ Disk: 40 GB

Supported operating systems:

- ▶ Red Hat Enterprise Linux 8.6
- ▶ Red Hat Enterprise Linux 8.8

For more information on requirements for the management node, see the following website:

<https://www.ibm.com/docs/en/cic/1.2.0?topic=planning-compute-nodes-hypervisors>

Note: Image and backup data files are stored on the management server therefore it is recommended to plan for extra disc space in the cases of multiple images and backup operation.

Also Note: For the standalone IBM Cloud Infrastructure Center, it's recommended to consider using some external storage such as nfs or other shared storage to mount to the following folder in order to increase the disk size easier when needed:

The default folder to contain imported or created images can be very large if there are multiple images in the IBM Cloud Infrastructure Center. Set the owner of `/var/lib/glance/images` to be `glance:glance` if a shared remote mounted directory is used.

Important: If on the management node, the root disk runs out of space, IBM Cloud Infrastructure Center services may run into unexpected behavior, services may be unavailable, and may cause database inconsistency or loss of data. Also management node's hostname can't be changed once IBM Cloud Infrastructure Center installation is complete, otherwise service may be unavailable or operation may time out.

5.4.4 Compute node

A compute node is a Linux machine running a set of agents that interfaces with the management node (Rakesh). One compute node must be created for each z/VM managed through the management node. Below are the hardware and software requirements.

Minimum sever requirements:

- ▶ Memory: 8 GB
- ▶ IFL: 0.2
- ▶ Disk: 80 GB

Supported operating system:

- ▶ Red Hat Enterprise Linux 8.6
- ▶ Red Hat Enterprise Linux 8.8

For more information on requirements for the compute node, see the following website:

<https://www.ibm.com/docs/en/cic/1.2.0?topic=planning-compute-nodes-hypervisors>

5.4.5 Setting up the environment

There are some configurations and resources that need to be prepared before installing IBM Cloud Infrastructure Center on z/VM.

User IDs need to be authorized in order to be used as compute nodes. Some statements also must be included in the user's definition:

- ▶ Authorize compute user IDs for z/VM SMAPI call by updating `VSMWORK1 AUTHLIST`. Refer to [z/VM Systems Management Application Programming](#) for more information about how to do the authorization.
- ▶ The compute user ID must have the `OPTION LNKNOPAS` statement in its User Directory to link the disk during provisioning.

- ▶ The compute user ID must have the IUCV ANY statement in its User Directory to communicate with the managed virtual machines through the IUCV channel.
- ▶ The compute user ID must have EMSG ON set up

Suggested SMAPI tuning options can be found in the following z/VM library:
<https://www.vm.ibm.com/library/index.html>

There, you can search for the specific version of z/VM and perform the configuration. If you have external security management, ensure you also configure it by referring to [Using SMAPI with an External Security Manager](#).

A VM directory management tool (such as DIRMAINT) must be installed and enabled on each z/VM before it can be used as a compute node in the IBM Cloud Infrastructure Center. Optionally, a ECKD or FBA DASD GROUP is required for the root and the ephemeral disks of the provisioned virtual machines if Boot From Volume is not used.

Note: The z/VM DASD GROUP must be either ECKD or FBA. Mixed disk types are not supported.

A Layer2 VSWITCH is used by the IBM Cloud Infrastructure Center to provide connectivity for provisioned virtual machines and should be created on the to-be-managed z/VM hosts before you install IBM Cloud Infrastructure Center.

5.4.6 Installing IBM Cloud Infrastructure Center

It is important to ensure that the hardware and software pre-requisites are met, as well as having the z/VM environment correctly set up. These steps will ensure that the management node is correctly prepared.

Note: The default umask of the management node's root user must be 022.

The installation steps are as follows:

1. Configure the DNF repositories for the installation

To configure the DNF repository, select and add BaseOS and AppStream repositories. All other repositories must be disabled or removed to avoid conflict. Verify that the BaseOS and AppStream repositories have both been correctly added by DNF repolist. Example:

```
[root@mgmtnode ~]# dnf repolist
repo id                repo name
a-rhel86-s390x-appstream  RHEL86-s390x-appstream
a-rhel86-s390x-base      RHEL86-s390x-base
```

2. Configure the firewall

IBM Cloud Infrastructure Center requires access to certain ports for inbound and outbound traffic, as well as local ports which are used on the management node. Connectivity issues often are caused by incorrect firewall rules.

Firewall configuration can be very specific and complex depending on the environment. It is recommended to manually configure it by using the information shown in Table 5-1.

Table 5-1 Firewall configuration

Traffic direction	Port	Usage	Protocol
-------------------	------	-------	----------

Inbound	80	Apache HTTPD Web Server	TCP (HTTP)
Inbound	443	Apache HTTPD Web Server	TCP (HTTPS)
Inbound	5000	keystone	TCP (HTTPS)
Inbound	5470	bumblebee	TCP (HTTPS)
Inbound	5671	rabbitmq	TCP (AMQPS)
Inbound	8080	swift	TCP (HTTPS)
Inbound	8428	validator	TCP (HTTPS)
Inbound	8774	nova	TCP (HTTPS)
Inbound	8770	placement	TCP (HTTPS)
Inbound	8998	clerk	TCP (HTTPS)
Inbound	9000	cinder	TCP (HTTPS)
Inbound	9292	glance	TCP (HTTPS)
Inbound	9696	neutron	TCP (HTTPS)
Inbound	35357	keystone	TCP (HTTPS)
Inbound	8041	gnocchi	TCP (HTTPS)
Inbound	8778	panko	TCP (HTTPS)
Outbound	Allow ICMP	ping	ICMP
Outbound	22	compute hosts	TCP (SSH)
Outbound	User specified – typically 25 or 587	Email notification	SMTP

Ports that are used by the management node can be found in Table 5-2. They are only used internally (no inbound or outbound traffic).

Table 5-2 Management node ports

Port	Usage
6200	swift-object-service
6201	swift-container-service
6202	swift-account-service
6641	ovn north connection
6642	ovn south connection
11211	memcached
25672	rabbitmq-dist
50110	mysqlDB

Note: For IBM Cloud Infrastructure Center to successfully register a host, the host's firewall must allow inbound traffic for port 22.

Table 5-3 lists the ports used by the compute node. They are also only used internally.

Table 5-3 Compute node ports

Traffic direction	Port	Usage	Protocol
Inbound	Allow ICMP	ping	ICMP
Inbound	22	Secure Shell	TCP (SSH)
Inbound (z/VM only)	8080	httpd	TCP
Outbound	8080	swift	TCP
Outbound	80	httpd	TCP
Outbound	8770	placement	TCP (HTTPS)
Outbound	8774	nova	TCP (HTTPS)
Outbound	9000	cinder	TCP (HTTPS)
Outbound	9292	glance	TCP (HTTPS)

Outbound	9696	neutron	TCP (HTTPS)
----------	------	---------	-------------

The option exists to have the installer automatically configure firewall settings on the management node. Alternatively, the `-c` option can be added which will configure default firewall default settings. `-c—firewall-type` can also be passed to specify `firewalld` or `iptables` as required. Note that this option cannot configure firewalls which are external to the management node.

3. Configure web proxy settings

If a web proxy configuration is required on the management node, then this needs to be considered before installing IBM Cloud Infrastructure Center. Failing to configure this properly might lead to redirecting requests to the proxy instead.

Before installation, ensure that the configuration has an exception for traffic that is mean for IBM Cloud Infrastructure Center, for example:

```
export no_proxy="localhost,127.0.0.1,.example.com"
```

Note: The hostname and IP address of the management node cannot be reconfigured after installation as this will break IBM Cloud Infrastructure Center.

4. Set up the configuration file

A directory named `icic` in `/etc` must be made before installation. A file named `config.properties` must also be created within it. Its content should contain configurations that are customized to the environments where IBM Cloud Infrastructure Center will be deployed, as shown in Example 5-21.

Example 5-21 Configuration file

```
[icic configs]
physical_network=vlannet1
compute_instance_template=ins%05x
compute_user_profile=profile_name
default_admin_userid=admin_userid
```

5. Unpack the installer components

Before unpacking, ensure the installer matches your licensing model of Version 1.2.0.0 of IBM Cloud Infrastructure Center (either Per Server Virtual or Per Engine licensing).

Depending on the source of the installer, the process can vary.

a. **Via DVD**

If installed from a DVD, the ISO must be mounted by using the following commands.

```
mkdir -p /media/iso
mount -t iso9660 -o ro /dev/sr0 /media/iso
```

In the above command, `/dev/sr0` stands for the disk driver device and `/media/iso` is the folder where the DVD is mounted, however this may vary by system.

The installation files will be inside the directory that the ISO has been mounted to.

b. **Via tar file**

If the installation will be using the CD828023.tar, then the installation files must be extracted from it by using the following commands.

For Per Virtual Machine licensing, enter the below:

```
tar -xzvf CD828023.tar
```

For Per Engine licensing, the following applies:

```
tar -xzvf CD8281501.tar
```

Upon mounting the ISO or extracting the installation package, there will be the following four files:

```
icic-opsmgr-s390x-rhel-1.2.9.9.tgz
Icic-opsmgr-1.2.0.0.tgz.sig
Icicpublickey
readme.txt
```

6. Extract icic-opsmgr-s390x-rhel-1.2.0.0.tgz, which is in the folder icic-opsmgr-1.2.0.0/images/ by using the following command.

```
tar -xzvf icic-install-s390x-rhel-1.2.0.0.tgz
```

7. Change the working directory to extract_location/icic-1.2.0.0/.

If doing a silent installation with multiple network interfaces, a dedicated network interface must be specified before running the installer. The variable HOST_INTERFACE may be set to a valid interface before running the script. If only a single interface exists on the system, then the variable is set automatically by the installer.

IBM Cloud Infrastructure Center requires the en_US.UTF-8 locale. Ensure that the locale command can be executed without any warning messages and that the locale environment variables are set to en_US.UTF-8, as follows:

```
# locale
LANG=en_US.UTF-8
LC_CTYPE="en_US.UTF-8"
LC_NUMERIC="en_US.UTF-8"
LC_TIME="en_US.UTF-8"
LC_COLLATE="en_US.UTF-8"
LC_MONETARY="en_US.UTF-8"
LC_MESSAGES="en_US.UTF-8"
LC_PAPER="en_US.UTF-8"
LC_NAME="en_US.UTF-8"
LC_ADDRESS="en_US.UTF-8"
LC_TELEPHONE="en_US.UTF-8"
LC_MEASUREMENT="en_US.UTF-8"
LC_IDENTIFICATION="en_US.UTF-8"
LC_ALL=
```

Note: Default values of **LC_CTYPE=en_US.UTF-8** and **LANG=en_US.UTF-8** will be used if these variables are not set prior to installation.

If IBM Cloud Infrastructure Center is installed to a management node via SSH with limited resources or a slow network connection, a time out can occur. If using a macOS or Linux client, you can add ServerAliveInterval INTERVAL to ~/.ssh/config to keep the connection alive.

8. As a root user, you can start the installation by using the following methods (versions 1.1.6.0 or later installs are hybrid hypervisor therefore you no longer need to specify the specific hypervisor you are using):

To start the installation:

```
./install
```

To start a silent installation

```
./install -s
```

To start an installation and skip selinux checks:

```
./install -i
```

Note: If selinux is not set to enforcing and -l is not given the installer will fail with the following message:

```
SELINUX is not enforced! Enable and enforce SELINUX, then try to install again.
The installation has exited with error code 266.
```

To start the installation with an automatically configured firewall:

```
./install -c
```

To start the installation with automatic configuration of iptables:

```
./install -c --firewall-type iptables
```

Note: If you are not using an External Security Manager (ESM), then the default_admin_userid is required.

Once the above steps are complete, run the following command to verify the status of the services:

```
/opt/ibm/icic/bin/icic-services status
```

Next, the methods of installing the IBM Cloud Infrastructure Center feature of Infrastructure Suite for z/VM and Linux will be explored.

The installation packages can be ordered from the IBM Infrastructure Suite for z/VM and Linux (IISz) in ShopZ. They are:

```
IISz_IBM_Cloud_Infrastructure_Center_x.x.x.y
IISz_IBM_Cloud_Infrastructure_Center_x.x.x_installer.y
```

Where x is the release number and y is the package ending format (iso or tar.gz). Before installation, the two packages must be combined.

The steps for doing so for tar.gz standalone install are:

1. Create two directories, such as /iiszcore and /iiszinstaller
2. Copy IISz_IBM_Cloud_Infrastructure_Center_x.x.x.y to the /iiszcore and copy IISz_IBM_Cloud_Infrastructure_Center_x.x.x_installer.y to /iiszinstaller directories.
3. Extract the two packages by using tar -xvzf
4. Verify the signatures (refer to instruction in the readme.txt file)
5. Unpack iisz_icic-core-s390x-x.x.x.x.tgz in the /iiszcore directory and unpack iisz_icic-install-s390x-x.x.x.x.tgz in the /iiszinstaller directory.

6. Unpack/iiszcore/icic-opsmgr-x.x.x.x/images/icic-install-s390x-rhel- x.x.x.x.tgz This is the main standalone package which will produce icic-x.x.x.x directory.
7. Combine the installer file with the core package files by running `cp /iiszinstaller/icic-x.x.x.x/install /iiszcore/icic-opsmgr-x.x.x.x/images/icic-x.x.x.x/`
8. Refer to the general installation process to continue with the installation.

The steps to combine packages for tar.gz multimode (HA) install are:

1. Create two directories such as /iiszcore and /iiszinstaller
2. Copy the package IISz_IBM_Cloud_Infrastructure_Center_x.x.x.y to /iiszcore directory and copy the package IISz_IBM_Cloud_Infrastructure_Center_x.x.x_installer.y to /iiszinstaller directory.
3. Extract each package using `tar -xvzf`
4. Verify the signature following the steps outlined in readme.txt for each package.
5. Unpack iisz_icic-core-s390x-x.x.x.x.tgz in the /iiszcore directory and unpack iisz_icic-install-s390x-x.x.x.x.tgz in the /iiszinstaller directory.
6. Combine the setup_opsmgr.sh file with the core package files by running `cp /iiszinstaller/icic-x.x.x.x/setup_opsmgr.sh /iiszcore/icic-opsmgr-x.x.x.x`
7. Refer to the general install process document in IBM Cloud Infrastructure Center Operation Manager (OpsMgr) document to continue with the installation.

The steps needed to combine packages for iso standalone install are:

1. Create two directories such as /iiszcore and /installer to copy the content of the iso to.
2. Create two more directories for mounting the ISO's such as /coreiso and /installiso
3. Mount the core package IISz_IBM_Cloud_Infrastructure_Center_x.x.x.y to /coreiso using `mount -o loop IISz_IBM_Cloud_Infrastructure_Center_x.x.x.y /coreiso`
4. Copy all the content of the /coreiso to /iiszcore and unmount /coreiso
5. Mount the install package IISz_IBM_Cloud_Infrastructure_Center_x.x.x_installer.y to ?/installiso using `mount -o loop IISz_IBM_Cloud_Infrastructure_Center_x.x.x_installer.y /installiso`
6. Copy all the content of the /installiso to /iiszinstaller and unmount /installiso ?
7. Verify the signature following the steps outlined in readme.txt for each package.
8. Unpack iisz_icic-core-s390x-x.x.x.x.tgz in the iiszcore directory and unpack iisz_icic-install-s390x-x.x.x.x.tgz in the /iiszinstaller directory.
9. Unpack/iiszcore/icic-opsmgr-x.x.x.x/images/icic-install-s390x-rhel- x.x.x.x.tgz This is the main standalone package which will produce icic-x.x.x.x directory.
10. Combine the installer file with the core package files by running `cp /iiszinstaller/icic-x.x.x.x/install /iiszcore/icic-opsmgr-x.x.x.x/images/icic-x.x.x.x/`
11. Refer to the general installation steps to continue with the installation. You would have already checked the signatures of the packages so you can now skip this step.

The steps to combine packages for iso multimode (HA) install:

1. Create two directories such as /iiszcore and /installer to copy the content of the iso to.
2. Create two more directories for mounting the ISO's such as /coreiso and /installiso
3. Mount the core package IISz_IBM_Cloud_Infrastructure_Center_x.x.x.y to /coreiso using `mount -o loop IISz_IBM_Cloud_Infrastructure_Center_x.x.x.y /coreiso`
4. Copy all the content of the /coreiso to /iiszcore and unmount /coreiso

5. Mount the install package IISz_IBM_Cloud_Infrastructure_Center_x.x.x_installer.y to ?/installiso using mount -o loop IISz_IBM_Cloud_Infrastructure_Center_x.x.x_installer.y /installiso ?
6. Copy all the content of the /installiso to /iiszinstaller and unmount /installiso
7. Verify the signature following the steps outlined in readme.txt for each package.
8. Unpack iisz_icic-core-s390x-x.x.x.x.tgz in the iiszcore directory and unpack ?iisz_icic-install-s390x-x.x.x.x.tgz in the /iiszinstaller directory. ?
9. Combine the setup_opsmgr.sh file with the core package files by running `cp ? /iiszinstaller/icic-x.x.x.x/setup_opsmgr.sh /iiszcore/icic-opsmgr-x.x.x.x`
10. Refer to the general install process document in IBM Cloud Infrastructure

For more information on how to install, uninstall, and upgrade IBM Cloud Infrastructure Center on your server, see the following website:

<https://www.ibm.com/docs/en/cic/1.2.0?topic=installing-uninstalling-upgrading>

5.5 Securing your cloud components

A Cloud on z/VM environment might use several components. It is important to protect each of the components.

The cloud components on z/VM can be protected with most of what is described in Chapter 2, “IBM z/VM hypervisor” on page 7, but that does not remove the need for an External Security Manager (ESM). When implementing your cloud by using RACF, give the VMs appropriate accesses to do their jobs. As described in section 4.1.1, “Least privilege principle” on page 84, do not let the VMs exceed the scope of their responsibility.

It is important to have your company’s security policy job roles relate to the cloud, such as a cloud administrator and a cloud auditor. Make sure the job roles that are related to the cloud also have their accesses described in the security policy, and that those accesses are implemented across the cloud environment.

Integrating the identity management across the cloud environment makes it easy to manage. With APAR VM65676 for z/VM 6.3, OpenStack Keystone is supported for installation-wide authentication and authorization to OpenStack Services. Using the identity integration brings some important capabilities to the cloud environment and z/VM. One is being able to authenticate user and password requests against multiple back ends, such as SQL or LDAP, as described in section 6.2, “LDAP” on page 165. Other key service capabilities that are available are Token, which makes it possible to validate and manage tokens for user authentication, Catalog, which allows for endpoint registry of available services, Policy, which authorizes API requests, and others, such as domain, project, and user models with role-based access control (RBAC) for access compute, storage, networking, and so on.

Table 5-4 summarizes the security mechanisms for a Cloud on z/VM environment.

Table 5-4 Summarize the security mechanisms in a private Cloud on z/VM environment

IBM Z cloud layer	Security mechanism	Risks addressed
OpenStack (Compute Node)	<ul style="list-style-type: none"> ▶ Tenancy ▶ HTTPS (encryption) 	<ul style="list-style-type: none"> ▶ Insecure APIs ▶ Denial of service
SMAPI	<ul style="list-style-type: none"> ▶ RBAC by API ▶ TLS (encryption) 	<ul style="list-style-type: none"> ▶ Insecure APIs ▶ Malicious insiders

IBM Z cloud layer	Security mechanism	Risks addressed
DirMaint for z/VM	<ul style="list-style-type: none"> ▶ Resource access control ▶ Auditing 	<ul style="list-style-type: none"> ▶ Data loss ▶ Insufficient due diligence
z/VM (CP with RACFVM)	<ul style="list-style-type: none"> ▶ Guest isolation ▶ Privilege classes ▶ RBAC ▶ Security zones ▶ Auditing (SMF) 	<ul style="list-style-type: none"> ▶ Data breaches ▶ Account hijacking ▶ Abuse and nefarious use ▶ Insufficient due diligence ▶ Shared technology issues

5.5.1 Security considerations inherent in a cloud environment

Security considerations in a cloud environment are critical to ensure the confidentiality, integrity, and availability of data and services. It is important to remember that basics, such as access control and incident response strategies still apply in the cloud environments. Some best practises are listed below for reference.

- ▶ Data Encryption

Data at rest and in transit should be encrypted in order to be protected from unauthorized access. It is recommended to use strong encryption algorithms and secure key management practices.

- ▶ Identity and Access Management (IAM)

Implement robust IAM policies and controls to manage and monitor user access, roles, and permissions. Ensure least privilege access and regularly review access levels.

- ▶ Authentication and Authorization

Employ multi-factor authentication (MFA) for added security during user login.

- ▶ Architecture Security

Understand the underlying technologies that the cloud computing uses to provision services, including the implications that the technical controls involved have on the security and privacy of the system, over the full system lifecycle, and across all system components. (Rakesh)

- ▶ Logging and Monitoring

Logging and monitoring mechanisms should be implemented to detect suspicious activity and aid with audit preparation.

- ▶ Incident Response and Disaster Recovery

Develop and regularly test incident response and disaster recovery plans to mitigate the impact of security incidents. Make sure your data is backed up securely, ensuring minimal downtime and data loss.

- ▶ Compliance and Legal Requirements:

Understand and adhere to relevant legal, regulatory, and compliance requirements specific to your industry and region.

- ▶ Security Training and Awareness:

Provide regular security training to employees to increase awareness of security risks and best practices.

By incorporating these security considerations into your cloud environment, you can significantly enhance the overall security posture and protect your organization's assets and data.



IBM z/VM and enterprise security

This chapter provides information about IBM Security zSecure Manager for RACF/VM, briefly discusses the use of LDAP servers and utilities on z/VM and covers multi-factor authentication.

Additionally, this chapter describes Linux on IBM Z security from the perspective of the following items:

- ▶ Access control
- ▶ Audit issues
- ▶ Cryptographic functions available
- ▶ User Management.

6.1 z/Secure

zSecure is an optional product that can help simplify administrative security tasks.

It supports administrators in enabling more efficient and effective ways of setting up profiles and group structures in your RACF databases. Recurring administrative tasks can be automated by using zSecure. It helps minimize complexity and improve quality of service. Reports can be produced regularly or even on an automated basis, so changes to the RACF database can be visualized by comparing the reports.

Audit functions are included in the product, which provides material to auditors and meets auditors demands for reports.

zSecure supports these issues:

- ▶ Adding or deleting user IDs and groups
- ▶ Granting access to user IDs and groups
- ▶ Setting and resetting user IDs and passwords
- ▶ Running daily, weekly, and monthly reports

The audit functions of zSecure help identify potential security concerns and prioritize them by ranking the concerns that are identified. Inconsistencies in the security definitions or missing definitions can be addressed quickly. Vulnerabilities can be detected before they raise a serious security issue.

IBM zSecure for z/VM can execute queries in seconds and implement mass changes with less administrative overhead. It can identify RACF problems on the z/VM operating system, such as missing or inconsistent definitions, enabling you to fix or prevent mistakes before they become a threat to security and compliance. It can monitor privileged users to help ensure that old accounts are properly deleted and that products have been well integrated, helping to avoid vulnerabilities that can be exploited by other users.

With the CARLa Auditing and Reporting Language (CARLa), you can create your own reports. These reports can be run under IBM Interactive System Productivity Facility (ISPF) or in batch by using data from any RACF database, or live or extracted RACF System Management Facility (SMF) data.

IBM Security zSecure Manager for RACF z/VM represents a paradigm shift forward in RACF administration. This product combines both Administration and Auditing. The simple way to sum up this product is a RACF administrator in a box. Think® of zSecure Manager as a front end to RACF security administration and auditing. It is not a replacement for an experienced RACF administrator. However, in the hands of an experienced RACF administrator it makes their job much easier, more efficient, and quicker. Finally, for the RACF novice, it enables them to administer and audit RACF without any RACF command syntax knowledge while they learn RACF commands and their correct syntax along the way.

zSecure Manager for RACF z/VM 2.5.1, announced June 2022 provides improved integration with IBM QRADAR and Splunk. It delivers the following enhancements:

- ▶ Near real-time feeds of RACF SMF events to IBM QRadar® SIEM and Splunk
- ▶ Cache server that can enable the following:
 - Get last 24 hours of RACF SMF event data
 - See all events from all RACF machines in a single system image (SSI) cluster in one query

- Query the cache server from the ISPF Events (EV) menu
- ▶ RACF Security Server for z/VM and IBM Z Multi-Factor Authentication support
- ▶ User interface enhancements:
 - Selection capabilities on audit and global audit settings in the RA.D and RA.R (RACF data sets and resources) menu options.
 - RA.R search on * string * to find all profiles, across all resource classes, where the string occurs in profile key.
- ▶ CARLa enhancements: providing more granular control when generating reports.
- ▶ Support for RACF databases on SCSI devices
- ▶ Support to read OpenEdition BFS files

This new release of IBM zSecure requires an IBM Z server that is capable of supporting IBM z/VM 7.1, or later.

Note: The SMF cache server and real-time SMF to QRadar and Splunk support require z/VM 7.2 with APAR VM66459.

For more information about zSecure, see the product documentation, which can be found at the following website:

<http://www.ibm.com/support/knowledgecenter/SS2RWS>

6.2 LDAP

Lightweight Directory Access Protocol (LDAP) is a commonly used system for storing directory-style information, such as (user records) in a centralized database. Most directory and authentication systems use LDAP in some way to make directory information available for services such as network-based authentication.

Note: Microsoft Active Directory is based on Kerberos, a system for cryptographically secured access control in a distributed network, and LDAP. Other identity management systems, such as the open-source *FreeIPA*, are also based on LDAP and Kerberos.

z/VM supports a version of IBM Security Directory Server, ported from z/OS. This allows a z/VM system administrator to run both an LDAP server (for storing and maintenance of directory schemas) and LDAP client utilities (search, bind, and similar) under the CMS operating system. Additionally, the z/VM port of ISDS supports the SDBM schema, which allows the LDAP administrator to use the z/VM RACF database as a back-end for identity protection.

For more information on configuring z/VM LDAP, see the IBM Redbooks publication, [Security for Linux on System z, SG24-7728](#).

The thought that an enterprise directory must be stored on a single monolithic server and managed by a single application is not true. A good directory structure supports the ability for portions of the directory tree to be held in different servers according to geographic, organizational, or technical reasons. Likewise, a directory based on LDAP can be distributed across any number of LDAP implementations. This concept is a fundamental part of LDAP: The directory information tree (DIT) refers to the entire structure of an enterprise directory, encompassing parts of the directory that may be widely distributed across the enterprise.

It is not likely that z/VM LDAP would be used as the core directory store for an enterprise. However, for applications on Linux guests under z/VM, it makes an excellent choice due to its lightweight proximity to the Linux systems, and password security.

For installations which do already have multiple directory servers, however, the functionality provided by the z/VM LDAP server may be less useful. The [IBM Z Multi-factor Authentication](#) product supports *ldap-bind* as part of an identity management policy. This means that enterprise LDAP configured on another platform (such as on z/OS, or in Microsoft Active Directory, or via openLDAP on Linux on IBM Z) can be used as a z/VM logon authentication factor in place of passwords managed under CMS. This allows for a simplification of password policy across the enterprise, and integrates z/VM into broader enterprise identity management policies.

6.3 Multi-Factor Authentication (MFA) for z/VM

[IBM Z Multi-Factor Authentication \(MFA\) for z/VM](#) and Linux provides alternative authentication methods for systems. It can be used with a variety of applications.

Passwords are the most common methods used to authenticate users to applications. However, they pose a target to attacks and exploitations. Often times, users pick simple or common passwords, write them down on a physical medium or unintentionally install malware that logs them. Nowadays raw computing power needed for a dedicated brute-force machine is easily obtainable and not as costly. This is where MFA brings the benefit of providing an extra step in the authentication process, thus raising the security assurance level.

IBM Z MFA provides the following features:

- ▶ The MFA server runs on Linux on IBM Z
- ▶ MFA uses TLS encryption
- ▶ z/VM systems communicate with the MFA server via a TCP/IP based protocol
- ▶ Multiple z/VM systems with the same security context and identity management policies can connect to one MFA instance
- ▶ Specified users are allowed to log on without MFA for emergencies and disaster recovery

6.3.1 Multi-factor authentication methods in z/VM

In essence, multi-factor authentication is a type of access control which requires the user to successfully provide more than one authentication factor. They are typically grouped in the following categories:

- ▶ something the user knows – for example a password.
- ▶ Something the user has – for example, a physical key card.
- ▶ Something the user is – for example, iris scanning.

IBM MFA offers six types of authentication factors.

- ▶ MFA for RSA SecurID

The validity of the user's credentials is determined by the RSA Authentication Manager. After the check, the operating system resumes control and completes the authentication and authorization process. The required credentials are hardware or software RSA SecurID token, as well as an RSA SecurID PIN®.

- ▶ PIV/CAC or X.509 Certificate

This method utilises Personal Identification Verification (PIV) and Common Access Card (CAC) cards. The user is authenticated via client identity certificates. The required credentials are a PIN number known to the user and an approved certificate.

- ▶ MFA for RADIUS

IBM MFA includes support for "generic" RADIUS, SafeNet RADIUS, and RSA SecurID RADIUS. Generic RADIUS refers to the RADIUS server of your choice that returns a simple allowed or denied response. In all cases, the RADIUS server determines whether the user's credentials are valid. If so, then the operating system completes the authentication and authorization process.

- ▶ MFA for timed one-time password (TOTP)

Generating a TOTP can be done as a generic TOTP or through IBM TouchToken for iOS.

If the user's account is configured for generic TOTP, they can log in by using common Quick Response (QR) codes on both Android and Apple devices. A QR code application needs to be installed on the user's mobile device, such as IBM Verify, Duo Mobile or Google Authenticator. A timed one-time password is generated for the user with their username to log in. TOTP requires a fingerprint and a device with the provisioned QR code application on Android or Apple, or the IBM TouchToken application for iOS.

- ▶ Yubico one-time password

OTP passwords are created upon triggering the Yubikey token. They must match with the OTP passwords generated by the Yubico OTP component on the MFA server. This method requires the use of the hardware Yubikey token and another authentication method (something the user knows).

- ▶ IBM Security Verify Access

Security Verify Access requires the IBM Security Verify Access verification one-time password (if configured), as well as the IBM Security Verify Access user ID and password.

6.3.2 Out-of-Band authentication

Out-of-band authentication is a type of two-factor authentication (2FA) which requires users to verify their identities through two different communications channels. IBM MFA Out-of-Band authentication requires you to authenticate "out-of-band" with one or more factors to retrieve a cache token credential, which you then use as your password.

The following features of Out-of-Band authentication are available to IBM z/VM:

- ▶ Compound Out-of-Band authentication, which allows the specification of more than one authentication factor in the authentication process.
- ▶ Enhanced security in the Out-of-Band pre-authentication web dialogs by requiring the user to provide their policy name prior to entering their user name and credentials for the specified policy. As an aid for ease-of-use, the address of the web server and policy name can be bookmarked by the user's web browser

A security administrator must specifically configure user accounts for IBM MFA Out-of-Band. A user-specific IBM MFA Out-of-Band login page prompts the user for all of the authentication factors that must be provided.

For more information on Multi-Factor Authentication (MFA) on z/VM and how it is provided in an out-of-band (OOB) way, see the following website:

<https://www.ibm.com/docs/en/zvm/7.3?topic=users-multi-factor-authorization>

6.3.3 RSA Authentication Manager

As mentioned in section 6.3.1, “Multi-factor authentication methods in z/VM”, RSA Authentication Manager can be used to determine the validity of a user’s credentials. It includes the following components:

- ▶ SecurID token code: A continuously regenerated OTP used to authenticate the user. It’s a pseudo-random 6-8 digit number, based on the current time. It is displayed on the RSA SecurID token device, assuming that only authorized users can access the token device.
- ▶ SecurID PIN: A 4-8 digit number known only to the user. It can be of their choosing or system generated by the Authentication Manager depending on the RSA token policy. The PIN can be cleared or reset by the security administrator. In doing so, the current PIN becomes invalid.
- ▶ SecurID passcode: A combination of a PIN and a token code which form an OTP, valid only while being displayed. It can only be used once.

For hardware tokens without a PIN pad, the passcode consists of the user’s PIN followed by the token code. Both must be entered.

For SecurID PIN pad hardware tokens and software token applications, the user enters the PIN on the PINpad and the token generates a hash-encrypted passcode from the PIN and the generated token. The token generates a new passcode at regular intervals, typically every 60 seconds. The user then uses the generated passcode to log in.



Linux on IBM Z security

Running the enterprise cloud with Linux on IBM Z servers provides some advantage over a physically distributed server farm when unique technologies within the platform are used to harden the overall security. Securing Linux on IBM Z is crucial, especially when these systems handle sensitive and critical workloads. Security is an ongoing process, and it's essential to stay informed about the latest security threats and best practices for Linux on IBM Z. Regularly review and update your security policies and procedures to adapt to changing threats and technologies.

While Linux on an IBM z15 supports a basic form of validating that the code you IPL'd is, in fact, the code you meant to IPL (secure IPL), IBM z16 now supports this on Linux and z/OS. z/VM supports “guest secure IPL,” which is validation of the code you're booting inside a virtual machine, ensuring no one has tampered with it, changed it, or corrupted it. It does not prevent modification after IPL. You still need your usual security controls for that. The following are an overview of the security controls for Linux on IBM Z that are discussed in this chapter:

- ▶ Authentication
- ▶ Access control
- ▶ User management
- ▶ Data
- ▶ Audit
- ▶ Cryptographic hardware

7.1 Authentication

Authentication in Linux on IBM Z, like on any other Linux-based system, is a crucial aspect of security. It ensures that only authorized users and processes can access the system and its resources. Authentication is the process of determining whether someone really is who they claim to be.

The users attempting to access a system or a resource must first give sufficient proof of their identity. A server authentication is done by using two of the following three categories, or factors, for providing identity:

- ▶ Something that you know: A password or PIN
- ▶ Something that you have: A token, a user ID, a badge, or a certificate
- ▶ Something that you are: Biometrics characteristics

The traditional way to authenticate on a Linux server is having a user ID on the system and knowing a password for it. Implementation of more than two of the factors is available for a Linux system, making it possible to request a user ID, a password, and a PIN that is generated by some electronic device, such as a token or an application on a cell phone, when authenticating. Use of more factors for authentication brings a high level of security to what is being accessed.

7.1.1 User Authentication

Utilize strong and secure password policies, including complexity requirements (for example, minimum length, character types). Encourage users to use passphrase-based authentication for stronger passwords. Consider implementing Multi-Factor Authentication (MFA) or Two-Factor Authentication (2FA) to add an extra layer of security. . Other considerations include the following:

- ▶ Password Storage

Store user passwords securely using strong cryptographic hashing algorithms (e.g., SHA-512). Avoid using weak or outdated password storage methods like DES.

- ▶ Public Key Authentication

Promote the use of SSH keys for authentication, particularly for administrative access. Securely manage and store SSH private keys using tools like SSH agents or hardware security modules (HSMs).

- ▶ Utilize Pluggable Authentication Modules (PAM) for flexible authentication configuration

Pluggable Authentication Modules (PAMs) can be used to reinforce compliance with the organization information security policy by increasing the number of factors that are used to authenticate and allowing access only to users meeting the specific characteristics that are defined with PAM. Applications that are enabled to use PAM can be plugged into new technologies (including IBM Z MFA) without the need to modify the existing applications. This flexibility provides administrators with these advantages:

- Use any available authentication service for an application.
- Use multiple authentication mechanisms for a service.
- Add authentication service modules without needing to modify the application.
- Use a single password for authentication on multiple modules.

Another factor that improves the security level is the use of PKI, such as an SSH key pair. The

users must have a public and private key pair that ensures the user's ID. Although it is possible to use an SSH key pair without setting a password to it, a password should be set to the key pair. This prevents an attacker who has access to the private key but does not know the password for the user ID from being authenticated at the server.

7.2 Access control

Defining each job role in Linux is complicated because everything converges to the root user ID. However, doing so is a preferred practice that defines the access and provides strong control over who can access a superuser account.

The discretionary access control (DAC) model, which is standard Linux security, does not provide protection from broken software or malware running as a normal user or root. Users can grant risky levels of access to files they own.

Use of mandatory access control (MAC) provides full control over all interactions of the software. Administratively defined policy closely controls users and process interactions within the system, and can protect the system from broken software or malware running as any user.

Security-Enhanced Linux (SELinux) on Red Hat Enterprise Linux (RHEL) is an implementation of MAC that uses Linux Security Models that is based on the principle of least privilege. When enabled in permissive mode, every access to a system resource by a user or process such as an I/O device must be controlled by SELinux. This can sometimes cause extra processing cycles on the system.

Note: SELinux is also available on SUSE Linux Enterprise Server (SLES)

AppArmor is another Linux application security framework that is included with Ubuntu as well as SLES and is an open source project. It takes a different approach from SELinux and provides an easy-to-use way for security applications in Linux. The following are some features that can be found in AppArmor:

- ▶ Yet another Setup Tool (YaST), which is an administration tool for configuration, maintenance, and automated development of a per-program security policy
- ▶ Predefined security policies for standard Linux programs and services
- ▶ Robust reporting and alerting capabilities to facilitate regulatory compliance
- ▶ Common Interface Model (CIM), which is a schema for clients that integrate with industry standard management consoles
- ▶ ZENworks Linux Management integration for profile distribution and report aggregation
- ▶ Path-name-based system that does not require labeling or relabeling of file systems

For more information about how to set up SELinux or AppArmor at Linux on IBM Z, see [Security for Linux on System z, SG24-7728](#).

7.3 User management

User management in Linux is a fundamental aspect of system administration, as it involves creating, configuring, and managing user accounts, which are essential for controlling access to the system. On a cloud environment, with the flexibility to increase and decrease its size,

the number of user IDs and the complexity of managing the user IDs increase. It is important to have a way to manage user IDs, mainly from a security point of view.

Centralizing the repository of user IDs helps in the management activities, reducing the administration effort compared to distributed user IDs management. It is considered a preferred practice for the maintenance of the information security policies that are applied to user management.

The centralization of user ID management involves adding, deleting, changing account information, and resetting passwords. Doing that from a single and centralized point, such as an LDAP server, can help keep the security requirements and policies consistent throughout the cloud environment. This configuration avoids the need to spread sensitive information from users, such as passwords, to all servers.

When using a centralized user ID management server, all servers must connect to it by using an encrypted connection. Not all of the information flowing between the LDAP server and the servers on the cloud is sensitive, but enabling this protection is simpler to implement than using a mix of encrypted and non-encrypted connections.

7.3.1 Update management

Keeping the operating system updated helps prevent its exposure. An established update process under the servers tracks system updates and manages them in an acceptable time frame. Using a minimal system installation also helps keep control of security and system update. There are fewer potential points of security exposure when fewer packages are installed and managed.

The use of a centralized patch management tool can decrease the complexity and time spent to apply server patches when the number of servers being managed increases. It also helps to track patches that are applied and patches that are needed to all servers managed, avoiding the possibility to leaving a server without the updates.

Effective update management is crucial for maintaining the security and stability of a Linux system. Here are key practices and considerations for managing updates in Linux:

- ▶ **Update Repositories**

Use official and trusted repositories provided by your Linux distribution. Avoid adding third-party repositories unless necessary.

- ▶ **Regular Updates**

Schedule and perform regular updates to keep your system and software packages up to date with security patches and bug fixes.

- ▶ **Automated Updates**

Consider enabling automatic updates for critical security packages or applying updates during non-business hours to minimize disruption.

- ▶ **Package Managers**

Familiarize yourself with the package manager used by your Linux distribution (e.g., apt for Debian/Ubuntu, yum or dnf for Red Hat/CentOS, zypper for openSUSE).

Use the package manager to search for updates and apply them. For example, to update packages on Debian-based systems, you can use `sudo apt update` and `sudo apt upgrade`.

- ▶ **Kernel Updates**

Keep the Linux kernel updated, as it is a critical component of system security and stability. Be prepared to reboot the system after kernel updates.

Keeping the operating system updated helps prevent its exposure. An established update process under the servers tracks system updates and manages them in an acceptable time frame. Using a minimal system installation also helps keep control of security and system update. There are fewer potential points of security exposure when fewer packages are installed and managed.

The use of a centralized patch management tool can decrease the complexity and time spent to apply server patches when the number of servers being managed increases. It also helps to track patches that are applied and patches that are needed to all servers managed, avoiding the possibility to leaving a server without the updates.

7.4 Data

Protecting the access to the disks is important, but another way to improve data security is encrypting it. Because encryption depends on a key, correct handling and implementation of a key management policy is important. Failing on encryption key management can result in an encryption deadlock and permanent loss of all encrypted data.

Data management on Linux involves various tasks related to the storage, organization, security, and backup of data on a Linux-based system. The following are key considerations for managing data on Linux.

► **Filesystem and Partitions**

Choose an appropriate filesystem (e.g., ext4, XFS) for your data storage needs. Partition your storage devices effectively to separate system and data partitions.

► **File and Directory Structure**

Maintain a well-organized directory structure for your data. Use meaningful directory names to categorize data. Keep critical data separate from system files to ease backup and recovery.

► **File Permissions**

Use proper file and directory permissions to control access to data. The `chmod`, `chown`, and `chgrp` commands can help manage permissions. Implement the principle of least privilege, ensuring that only authorized users can access sensitive data.

► **Encryption**

Consider encrypting sensitive data at rest using tools like LUKS for disk encryption or eCryptfs for directory-level encryption. Implement encryption for data in transit using protocols like SSL/TLS for network communication. For more information on LUKS and dm-crypt, see the following website:

<https://www.ibm.com/docs/en/linux-on-systems?topic=2020-infrastructure-concepts>

► **Backup and Recovery**

Regularly back up critical data to external or remote storage. Use backup solutions like `rsync`, `tar`, or dedicated backup software. Implement automated backup schedules.

Test backups periodically to ensure data integrity and the ability to recover.

► **RAID and Redundancy**

Use RAID (Redundant Array of Independent Disks) to provide data redundancy and fault tolerance for critical data. RAID levels like RAID 1 (mirroring) and RAID 5 (striping with parity) offer various trade-offs between redundancy and performance.

The use of encryption on IBM Z has advantages because it uses cryptographic hardware and cryptographic functions that are built in the central processor, such as the Central Processor Assist for Cryptographic Function (CPACF). It handles the cryptographic cipher calculations, leaving the central processor available for other uses and reducing the central processor cycles compared to the same cipher calculations done by using software emulation.

Using tools to encrypt the Linux on IBM Z data can increase the data security. The dm-crypt subsystem in Linux is implemented as a device mapper that can be stacked on the top of other devices that are managed through the device mapper framework. Therefore, you can encrypt from entire disks to software RAID volumes and LVM logical volumes, adding flexibility to the encryption strategy. In a dm-crypt environment, the data appears in the clear only when it is already in the program.

For more information and steps on how to encrypt data on disks by using dm-crypt, see the following: *Security for Linux on System z*, SG24-7728.

Data on backup media must be encrypted. It is a security breach if a backup media with sensitive information leaves the data center and others outside the organization have access to that media. Protecting the data center and all devices within it is important, but allowing information to leave the data center without being protected is the same as ignoring all protection implemented in the organization data center.

7.5 Audit

A defined information security policy is worthless if there is no way to assess whether the policies are effective, meaning that it was adhered to by all employees and they are playing the roles that they are expected to.

Tracking changes, and authorized and unauthorized accesses, is a way to make sure that the information security policy is followed. But, with the increase in servers that are managed on the enterprise cloud, the amount of audit data that is generated makes it impossible for a human to analyze all of it, find a threat, and act on it while the intrusion is still happening. For that reason, define, during the planning stage of the enterprise cloud and the IT infrastructure, which actions must be logged for audits.

The complexity in auditing is reduced when defined roles are available in the information security policy. Users under one role should not have access to override the MACs and should not be able to manipulate the controls that are under the jurisdiction of another job role. With the separation of duties, the functions of the systems and integrity of audit logs are not compromised.

To create a separation of duties under Linux, use SELinux or AppArmor. If those tools are not used or enabled, the task to control and determine user privileges become more complicated. A preferred practice is to use sudo to control access to privileged commands. Use of sudo ensures better protection by limiting the privileged commands that a user can run and protecting the root password from being shared with system administrators. Use of sudo also ensures audit of accountability for users who run privileged commands.

7.6 Cryptographic hardware

Linux on IBM Z can benefit from the use of IBM Z cryptographic hardware. It supports the use of CP Assist for Cryptographic Functions (CPACF) and Crypto-Express8S (the latest available

at the time of this writing) by using in-kernel crypto-APIs and the libica cryptographic functions library. Use of these features provides the following benefits:

- ▶ File system encryption
- ▶ Communication encryption (to the applications such as IBM HTTP Server)
- ▶ System security by providing advanced cryptographic functions

CPACF is available on all CPs, including zIIPs, IFLs, and General Purpose CPUs. It provides a set of symmetric cryptographic functions that enhance the encryption and decryption performance of clear-key operations for SSL, virtual private network (VPN), and data storing applications that do not require a high level of security.

z16 is enhanced with processor activity instrumentation to count cryptographic operations. Consequently, z/OS has been enhanced to capture crypto usage data for z/OS workloads in SMF 0, 30 and 1154 records.

CPACF offers the following data encryption and decryption algorithms for data privacy and confidentiality:

- ▶ Data Encryption Standard (DES)
 - Single-length key DES
 - Double-length key DES
 - Triple-length key DES (TDES)
- ▶ Advanced Encryption Standard (AES) for 128-bit, 192-bit, and 256-bit keys

CPACF offers the following hashing algorithms for data integrity:

- ▶ SHA-1: 160 bit
- ▶ SHA-2: 224, 256, 384, and 512 bit
- ▶ SHA-3: 224, 256, 384, and 512 bit

For MAC, CPACF offers these options:

- ▶ Single-length key MAC
- ▶ Double-length key MAC

For cryptographic key generation, CPACF offers True Random Number Generation (TRNG) algorithms.

The Crypto Express 8S (CEX8S) co-processor is built from the 4770 Hardware Security Module (HSM) which provides a Quantum-Safe Root of Trust, and APIs that are used to modernize existing applications as well as build new ones, leveraging quantum safe cryptographic algorithms.

CEX8s has a number of new functions and features. The following are orderable features:

- ▶ The Crypto Express8S (2 HSMs) feature contains two PCIe adapters that can each be configured as a coprocessor supporting secure key transactions or as an accelerator for Secure Sockets Layer (SSL) operations.
- ▶ The Crypto Express8S (1 HSM) feature contains one PCIe adapter that can be configured as a coprocessor supporting secure key transactions or as an accelerator for Secure Sockets Layer (SSL) operations.

The Crypto Express 8S can be configured in one of three way: as an accelerator, as a Common Cryptographic Architecture (CCA) coprocessor or as an IBM Enterprise PKCS #11 (EP11) coprocessor. EP11 mode enhancements include quantum-safe algorithms in hybrid

cryptography for secure channel negotiations between the Crypto Express 8S and the CPACF and TKE.

Note: You gain security from using CPACF and CEX8S through in-kernel cryptography APIs and, for Linux on IBM Z, the libica cryptographic functions library.

For more information about CPACF and Crypto-Express5S, see the *IBM z16 (3931) Technical Guide*, SG24-8951. For more information about how to use those features at Linux on IBM Z, see *Crypto Express for Cloud Workloads*, SG24-8547.

7.6.1 Firewall

The use of a firewall is defined by the IT Infrastructure and by the information security policy of an organization. Using the guest isolation feature under z/VM and IBM Z architecture makes such a solution as secure as having a firewall running on every Linux on IBM Z server. However, if the information security policy enforces the use of a firewall on any back-end server, including those running on a IBM Z environment, that should be implemented.

There are several sophisticated firewall features solutions that are available for Linux that can filter and manipulate packets based on complex rules that are defined by the system administrator. A preferred practice is to use a restrictive firewall policy instead of a permissive policy. This ensures that packets that are explicitly not allowed to flow to the network are dropped instead of rejected.

Some tools help to automate firewall policy creation. SUSE Enterprise Linux offers a firewall configuration tool that uses YaST that can be used both in graphical mode or text mode. Red Hat Enterprise Linux offers a firewall configuration tool that is called system-config-firewall that can also be used in graphical or text mode. Another option is a tool that is called Firewall Builder. It is an open source tool and can be found at the following website:

<http://www.fwbuilder.org>

Firewall Builder can be downloaded and built for SUSE Enterprise Linux Server or Red Hat Enterprise Linux.

Related publications

The publications that are listed in this section are considered suitable for a more detailed description of the topics that are covered in this book.

Other publications

These publications are also relevant as further information sources:

- ▶ *Directory Maintenance Facility Tailoring and Administration Guide for z/VM 6.3*, SC24-6190
- ▶ *RACF Security Server Security Administrator's Guide*, SC24-6218
- ▶ *RSCS Networking Planning and Configuration for z/VM 6.3*, SC24-6227
- ▶ *Secure Configuration Guide for z/VM 6.3*, SC24-6230
- ▶ *Systems Management Application Programming*, SC24-6234

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