Introduction to Multilevel Security (MLS) on z/OS®

RACF-2008
Session RTB11

June 2008

Mark Nelson, CISSP®
z/OS Security Server (RACF®) Design and Development
IBM® Poughkeepsie
markan@us.ibm.com

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Agenda

- **What is Multilevel Security?**
- **The Road to Multilevel Security**
- **Levels and Categories**
- **SECLABELs**
- **Dominance and Equivalence**
- **Discretionary vs. Mandatory Access Controls**
- **Controlling Multilevel Security using SETROPTS**
- **Usage Scenarios**
  - TCP/IP
  - JES
  - DB2
- **Considerations**

What is Multilevel Security?

- **Multilevel security is:**
  - The ability to mix different categories and classes of information within the same computing environment in a controlled manner without compromise
  - A combination of hardware, software, and operational procedures
  - Valuable anytime there is a need to isolate data, such as:
    - In a service bureaus environment
    - When there is truly sensitive data
    - As a way of complying with evolving regulatory environment

The Road to Multilevel Security

- **RACF's support for multilevel security has evolved since the mid-80s:**
  - 1985: RACF 1.7 - Assignment of levels and categories to users and data objects
  - 1990: RACF 1.9 - Multilevel ("B1") support
    - SECLABELs
    - Console logon
    - NJE, RJE, JES controls
    - No support for TCP/IP, DB2
  - 2004: z/OS R5 – Multilevel support
    - Extends existing multilevel controls to TCP/IP, UNIX System Services, and DB2

The Road to Multilevel Security…

- **1985/RACF 1.7: Levels and Categories:**
  - **Security level (SECLEVEL), a hierarchical classification ('PUBLIC', 'INTERNAL USE', 'CONFIDENTIAL', 'TOP SECRET')**
  - **Security category, a non-hierarchical classification ('HR', 'RESEARCH', 'FINANCIAL', 'ICE NINE')**
  - **Levels and categories are assigned to users and data objects**
    - When a user access a resource which has a SECLEVEL or security category, the user must have a higher SECLEVEL and all of the categories that are associated with the resource.
  - **SECLEVELs and categories are defined in the SECDATA general resource class**

```
RALTER SECDATA SECLEVEL ADDMEM('UNCLASSIFIED'/10,
  'CONFIDENTIAL'/20,'SECRET'/30, 'ULTRA'/100)

RALTER SECDATA CATEGORY ADDMEM(FINANCIAL HR RESEARCH)
```

Why Multilevel Security

- **Traditional access control mechanisms allow the resource owner to control who has access to data**
  - The data owner has the discretion to grant access, hence the term 'discretionary access' mechanism.
- **Data classifications, if present are assigned by the data owner**
  - Data owners could misclassify data by opening a data set at one level and then writing it to another level
- **Multilevel security formalizes the classification of data and enforces a data access policy that is set by the security administrator, not the data owner**

RACF and Multilevel Security: The SECLABEL

- **MVS 3.1.3 and RACF 1.9 (1990) introduced the concept of the security label or SECLABEL**
- **A security label or SECLABEL consists of two parts:**
  - A security level (SECLEVEL)
  - Zero or more security categories
- **SECLABELs are defined in the SECLABEL class**

```
RDEFINE SECLABEL PUBINFO  SECLEVEL(UNCLASSIFIED) ADDCATEGORY(FINANCIAL HR RESEARCH)
RDEFINE SECLABEL HRCONF   SECLEVEL(CONFIDENTIAL) ADDCATEGORY(HR)
RDEFINE SECLABEL EXECUTIV SECLEVEL(ULTRA)        ADDCATEGORY(FINANCIAL RESEARCH HR)
```

RACF and Multilevel Security: The SECLABEL…

- **In a fully-operational multilevel security environment, all users and data objects must have SECLABELS**
- **SECLABELs can be assigned to users (including started task and batch users), data resources, and to other security-related objects (such as terminals) using RACF commands:**

```
ALTDSD 'PERSONEL.EMPLOYEE.DATA' SECLABEL(HRCONF)
ALTUSER MARKN SECLABEL(EXECUTIV)
```


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RACF and Multilevel Security: The SECLABEL…

- **RACF provides several system-defined SECLABELs:**
  - **SYSHIGH**: The highest defined SECLEVEL and all defined categories
    - Should be restricted to special system-level address spaces (such as the consoles address space), and systems programmers, system operators, and system administrators
  - **SYSLOW**: The lowest defined SECLEVEL and no defined categories
    - Assigned to resources which have no classified data content
  - **SYSNONE**: Equivalent to any SECLABEL to which it is compared
    - Restricted to resources which do not contain data, such as catalogs where a resource manager mediates the access
    - Not to be assigned to users or address spaces
  - **SYSMULTI**: Equivalent to any SECLABEL to which it is compared
    - Restricted to server or daemon address spaces which are designed to and documented as supporting MLS
- **The SECLABEL class must be RACLISTed**

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RACF and Multilevel Security: The SECLABEL…

- **Assigning a SECLABEL to a user does not give the user access to the SECLABEL; The user must be PERMITted to the SECLABEL:**

```
PERMIT EXECUTIV CLASS(SECLABEL) ID(MARKN) ACCESS(READ)
```


Dominance and Equivalence

- **When SECLABELs are compared in an access check, RACF examines the dominance relationship between the SECLABELs.**
  - For SECLABEL **A** to dominate SECLABEL **B**
    - The Security Level of **A** is equal to or greater then the Security Level of **B**
    - **A** has at least all the Categories that define **B**
    - Avoid the temptation to say that SECLABEL **A** is “greater” then SECLABEL **B**
- **SECLABELs A and B are equivalent if the A dominates B and B dominates A**
  - Same SECLEVEL
  - Same set of categories
  - Equivalence is a ‘subset’ of dominance
- **Disjoint SECLABELs are SECLABELs where there is at least one category in SECLABEL A that is not is SECLABEL B and one category in SECLABEL B that is not is SECLABEL A**

Discretionary vs. Mandatory Access

- **Discretionary Access Control**
  - "A means of restricting access to objects based upon the identity of subjects and.or groups to which they belong. The controls are discretionary in the sense that a subject with certain access permission is capable of passing that permission (perhaps indirectly) on to any other subject"
- **Mandatory Access Control**
  - "A means of restricting access to objects based on the sensitivity (as represented by a label) of the information contained in the objects and the formal authorization (i.e. clearance) of subjects to access information of such sensitivity,"

Discretionary and Mandatory Access Check

- **Discretionary Access Checks (DAC) and Mandatory Access Checks (MAC) work together:**
  - Mandatory checks are performed first
  - If the mandatory check passes, then the discretionary access checks are performed
    - Access list
    - UACC
    - Etc.

SECLABEL Relationship for Processing Data

- **In a fully operational MLS environment:**
  - Reading data requires that the subject's SECLABEL must dominate the object's SECLABEL
  - Writing data requires that the object's (data) SECLABEL must dominate the subject's (user's) SECLABEL
  - Reading and writing data requires that the object's SECLABEL must be equivalent to the subject's SECLABEL
- **SETROPTS options control exactly how robust you want your MLS environment to be**

Reverse Mandatory Access Checking

- **For some types of objects the required dominance relationship is 'opposite' of a normal dominance relationship**
  - Reading data requires that the objects's SECLABEL dominates the subject's SECLABEL
  - Reading and writing data requires that the object's SECLABEL is equivalent to the subject's SECLABEL
  - These types of objects have RVRSMAC=YES in the RACF Class Descriptor Table (CDT)
    - WRITER
    - CONSOLE
    - APPCPORT

SECLABEL-related SETROPTS Controls

- **The SETROPTS command is used to control the enabling of multilevel security controls through the use of these SETROPTS options:**
  - SETROPTS CLASSACT(SECLABEL)
  - SETROPTS MLACTIVE
  - SETROPTS MLSTABLE
  - SETROPTS MLQUIET
  - SETROPTS SECLABELCONTROL
  - SETROPTS COMPATMODE

Activating SECLABEL Processing

- **Activating and RACLISTing the SECLABEL class activates SECLABEL processing**
  - **`SETR CLASSACT(SECLABEL) RACLIST(SECLABEL)`**
- **This alters the access check path:**
  - If the both the user and the object have a SECLABEL then the user's SECLABEL is compared to the resource
  - If the resource has a SECLABEL and the user does not, then the access check fails.
  - If the user has a SECLABEL and but the resource does not, then the access check continues with the discretionary access check.

SETROPTS MLACTIVE

- **With MLACTIVE, RACF requires that all resources for classes with SECLABEL=REQUIRED in the CDT have SECLABELs**
- **This option is activated by issuing the command:**
  - **`SETR MLACTIVE`**
- **There are WARNING and FAILURE modes for this option**

SETROPTS MLS

- **With SETR MLS in effect, RACF enforces the write-down property**
  - Subjects are prevented from writing down to a “lower” SECLABEL
  - Sometimes called the “*-property”
- **Prevents improper declassification of data**
  - Reading data requires that the subject(user) must dominate the object’s SECLABEL
  - Writing data requires that the object’s SECLABEL must dominate the subject SECLABEL
  - Reading and writing data requires that the SECLABEL of the subject and the SECLABEL of the object are equivalent

SETROPTS MLS…

- **This option is activated by issuing the command:**
  - **`SETR MLS`**
- **There are WARNING and FAILURE modes for this option**
- **When SETR NOMLS (MLS is off) is in effect:**
  - Reading or reading and writing data requires that the subject(user) dominates the object's
  - Writing data requires that the subject's SECLABEL dominates the user's SECLABEL or the object's SECLABEL dominates the user
    - SECLEVELs may be different, but the categories must match!

SETROPTS MLS/MLACTIVE WARNING Mode

- **If either MLS and/or MLACTIVE are in warning mode, RACF will pass a MAC test and generate warning message (ICH408I) if:**
  - The request would have passed if the option was off
  - The request will fail with the option on
- **This can be done by placing WARING after the SETROPTS MLS or MLACTIVE:**
  - **`SETR MLS(WARNING)`**
  - **`SETR MLACTIVE(WARNING)`**
- **This may be something useful when first enabling MLS or MLACTIVE to ensure all the correct profiles have been created with the correct SECLABELs**

SETROPTS MLSTABLE

- **Ensures that SECLABELs won't change while someone is in the process of using them by:**
  - Preventing changes of SECLABELs definitions
  - Preventing changes of SECLABELs assigned to a RACF profile
- **Must set MLQUIET to allow such changes to occur while MLSTABLE is active**

SETROPTS MLQUIET

- **Allows changing of SECLABEL definitions and SECLABELs within a RACF profile**
- **Overrides (and only needed if) MLSTABLE is active**
- **Only SPECIAL, TRUSTED, or console operator can logon or access resources protected by RACF profiles.**

SETROPTS SECLABELCONTROL

- **Prevents non-SPECIAL users from setting or changing a resource SECLABEL**
- **Without SECLABELCONTROL, a user who can create or modify a RACF profile, can also modify the SECLABEL assigned to the profile**

SETROPTS COMPATMODE

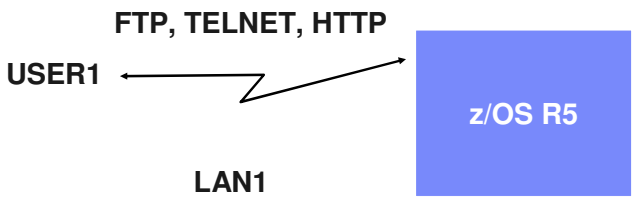
- **A migration mode that allows users running WITHOUT a SECLABEL to access resources protected by RACF profiles that HAVE a SECLABEL if the user could use that SECLABEL**
- **Applies only to applications that issue RACROUTE REQUEST=VERIFY to create the user ACEE without specifying any RACF 1.9.0 or later keywords**

SECLABELs for TCP/IP

- **Administrator can define "security zones" representing IP subnetworks via TCP/IP configuration data**
  - Specifies hostname, or address, or subnet range
  - Any granularity desired, down to individual IP address if needed
  - Specifies a "zone" name. Example: INTERNAL, EXTERNAL, PARTNER1
- **TCP/IP maps zone names to RACF SERVAUTH resource EZB.NETACCESS.sysname.stackname.zonename**
  - Installation is responsible for network topology and protection of network links
    - IPSEC (VPN) can also be used to help this
- **TCP/IP stack ensures that application on host can only send/receive packets if application and IP address have appropriate SECLABELs**
  - Support for servers or daemons that understand MLS (FTP, TELNET, INET) or even HTTP for some usage
    - Assign SYSMULTI SECLABEL to server/daemon
    - Can then communicate with any of the subnetworks

SECLABELs for TCP/IP…

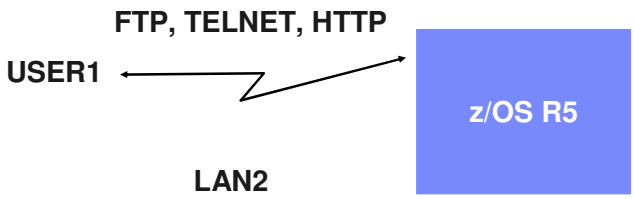
- **Consider USER1 with access to**:
  - SECLABELs A and B
  - Workstations on three LANs
    - LAN1 defined with SECLABEL A
    - LAN2 defined with SECLABEL B
    - LAN3 defined with SECLABEL C



The user's session will run with SECLABEL A

SECLABELs for TCP/IP…

- **Consider USER1 with access to**:
  - SECLABELs A and B
  - Workstations on three LANs
    - LAN1 defined with SECLABEL A
    - LAN2 defined with SECLABEL B
    - LAN3 defined with SECLABEL C



The user's session will run with SECLABEL B

SECLABELs for TCP/IP…

- **Consider USER1 with access to**:
  - SECLABELs A and B
  - Workstations on three LANs
    - LAN1 defined with SECLABEL A
    - LAN2 defined with SECLABEL B
    - LAN3 defined with SECLABEL C

The user's session will fail,
since the user cannot use SECLABEL C

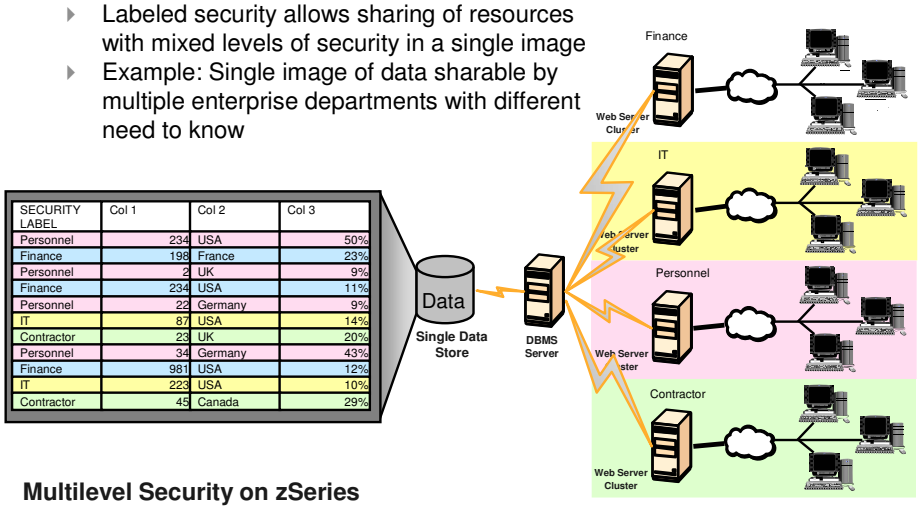
Multilevel Security and JES

- **Consider a Service Bureau with multiple customers:**
  - Customer A does not want their output printed on Customer B's printers
- **How to do it?**
  - Create disjoint SECLABELs A and B
  - Create WRITER profiles for customer A printers; assign SECLABEL A
  - Create WRITER profiles for customer B printers; assign SECLABEL B
  - Customer A users (with SECLABEL A) cannot print to wrong printers
  - Customer B users (with SECLABEL B) cannot print to wrong printers
  - System operators cannot misdirect the output, either

Multilevel Security with DB2 V8

- **Multilevel Security with DB2 V8**
  - Labeled security allows sharing of resources with mixed levels of security in a single image
  - Example: Single image of data sharable by multiple enterprise departments with different need to know

SECURITY LABEL	Col 1	Col 2	Col 3
Personnel	234	USA	50%
Finance	198	France	23%
Personnel	2	UK	9%
Finance	234	USA	11%
Personnel	22	Germany	9%
IT	87	USA	14%
Contractor	23	UK	20%
Personnel	34	Germany	43%
Finance	981	USA	12%
IT	223	USA	10%
Contractor	45	Canada	29%



Multilevel Security on zSeries

Multilevel Security and DB2 V8

- **Multilevel Security with Row Level Granularity**
  - Use RACF for MAC
    - Use SECLABELs
    - Key advantage is consistent, integrated security
  - Table has a column defined as a security label
    - Each row value has a specific security label
    - Get user security label from RACF
    - Save in rows for INSERT, UPDATE, LOAD, ...
  - Compare SECLABEL in row to SECLABEL for the DB2 users
    - If access is allowed, then normal access
    - If access is not allowed, data not returned
  - Runtime user to data checking
  - SECLABEL values are cached to minimize processing time

Considerations

- **Do not attempt to enable a multilevel security environment unless you have an accepted and well-defined data classification policy**
- **All authorization checks are bypassed for objects which match entries in the RACF global access table (GAC) that are defined with the requested access authority.**
- **If MLS and MLACTIVE are <u>both</u> in FAIL mode, then any user that has the SPECIAL attribute <u>and</u> is logged on with SYSHIGH is treated as though they are in WARNING mode**
  - Useful to know if you get into trouble

References

- **Planning for Multilevel Security and the Common Criteria, (GA22-7509-05)**
  - **… available on the web from the "Library" section of the RACF web page (www.ibm.com/eserver/zseries/zos/ racf)**