Introduction to z/OS System Integrity in z/OS for ISVs

Karl Schmitz
z/OS System Integrity Competency Center
kdsch@us.ibm.com

Trademarks

The following are trademarks of the International Business Machines Corporation in the United States and/or other countries.

IBM*
IBM Logo*
z/OS*
RACF*

* Registered trademarks of IBM Corporation

The following are trademarks or registered trademarks of other companies.

Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.
IT Infrastructure Library is a registered trademark of the Central Computer and Telecommunications Agency which is now part of the Office of Government Commerce.
Intel, Intel logo, Intel Inside, Intel Inside logo, Intel Centrino, Intel Centrino logo, Celeron, Intel Xeon, Intel SpeedStep, Itanium, and Pentium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.
Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.
Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.
ITIL is a registered trademark, and a registered community trademark of the Office of Government Commerce, and is registered in the U.S. Patent and Trademark Office.
UNIX is a registered trademark of The Open Group in the United States and other countries.
Java and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates.
Cell Broadband Engine is a trademark of Sony Computer Entertainment, Inc. in the United States, other countries, or both and is used under license therefrom.
Linear Tape-Open, LTO, the LTO Logo, Ultrium, and the Ultrium logo are trademarks of HP, IBM Corp. and Quantum in the U.S. and other countries.

* All other products may be trademarks or registered trademarks of their respective companies.

Notes:
Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.
IBM hardware products are manufactured from new parts, or new and serviceable used parts. Regardless, our warranty terms apply.
All customer examples cited or described in this presentation are presented as illustrations of the manner in which some customers have used IBM products and the results they may have achieved. Actual environmental costs and performance characteristics will vary depending on individual customer configurations and conditions.
This publication was produced in the United States. IBM may not offer the products, services or features discussed in this document in other countries, and the information may be subject to change without notice. Consult your local IBM business contact for information on the product or services available in your area.
All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.
Information about non-IBM products is obtained from the manufacturers of those products or their published announcements. IBM has not tested those products and cannot confirm the performance, compatibility, or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.
Prices subject to change without notice. Contact your IBM representative or Business Partner for the most current pricing in your geography.

Coding for System Integrity in z/OS

- ***Definition***
- ***Guidelines***
- ***Examples***

System Integrity Definition

- *Announced with MVS in 1973*
- *Property of a system that prevents users from circumventing security mechanisms*
- *In z/OS, there is no way for an unauthorized problem program to:*
  - *Bypass store or fetch protection*
  - *Bypass password/RACF protection*
  - *Obtain control in an authorized state*

Types of Authorization

- ***PSW Key 0-7***
- ***PKM 0-7***
- ***Supervisor State***
- ***APF Authorization***

Ways of becoming authorized

- *SVC routines*
- *PC routines*
- *APF authorized programs*
- *Program Properties Table*
- *Exit routines*

z/OS System Integrity Guidelines

- *Creating predictable interfaces*
- *Dealing with user supplied storage*
- *Dealing with user supplied control blocks*
- *Dealing with user supplied values*
- *Protecting data*
- *Authorization requirements*
- *Serializing Resources*

Predictable Interfaces

- *Interfaces between unauthorized and authorized programs must behave predictably*
  - *Applies to intended and unintended interfaces*
  - *Security checking must be performed in authorized code*
  - *Only load modules intended to run as authorized jobsteps or commands should be linked AC(1)*

User Supplied Storage

- *Access caller supplied storage in the key of the caller*
- *For example, use MVCSK or MVCDK*
- *SVC and PC routines do not use standard linkage conventions. Untrusted callers provide:*
  - *Registers 0, 1, 13, 15 for SVCs*
  - *All registers except register 4 for stacking PC routines*

User Supplied Control Blocks

- ***Verify system control blocks through trusted pointers in system key storage***
- ***Serialize as appropriate***

User Supplied Values

- *Verify that values are legitimate*
- *For example, lengths and offsets*
- *Beware of values that might change after verification*
- *Consider all sources of input*
  - *Parameters*
  - *Files*
  - *Sockets*
  - *Environment Variables*
  - *Terminals*
  - *Other*

Protecting Data

- ***Authorized programs must protect data from unauthorized tampering***
- ***Do not use key 8 common storage***

Authorization Requirements

- ***Services that bypass security checks must be restricted to authorized callers***
- ***Callers allowed to bypass security checks must provide equivalent controls***
- ***Do not provide services that make unauthorized callers authorized***

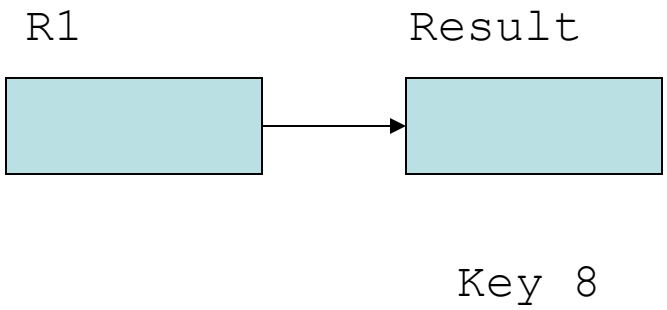
Serializing Resources

- ***Serialize to control multiple access to resources***
- ***Serialization technique must be one restricted to authorized programs***

System Integrity Exposures Examples

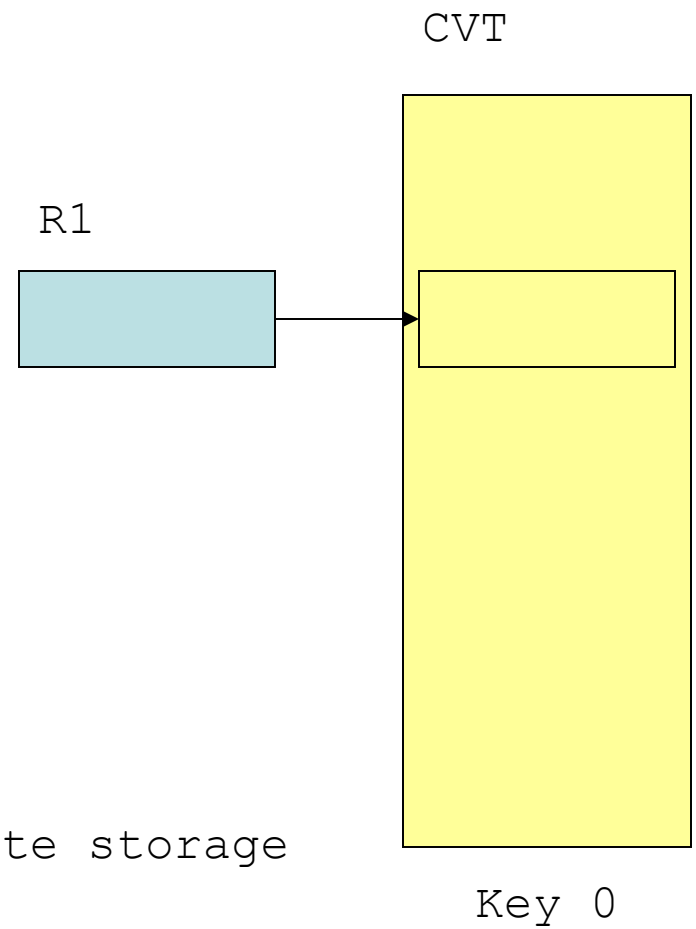
Example 1: SVC (Key 0, Supervisor State)

```
.
.
MODESET EXTKEY=TCB . .
OC          0(4,R1),0(R1)
MODESET EXTKEY=ZERO . .
.
.
ST          R5,0(R1)
.
.
```



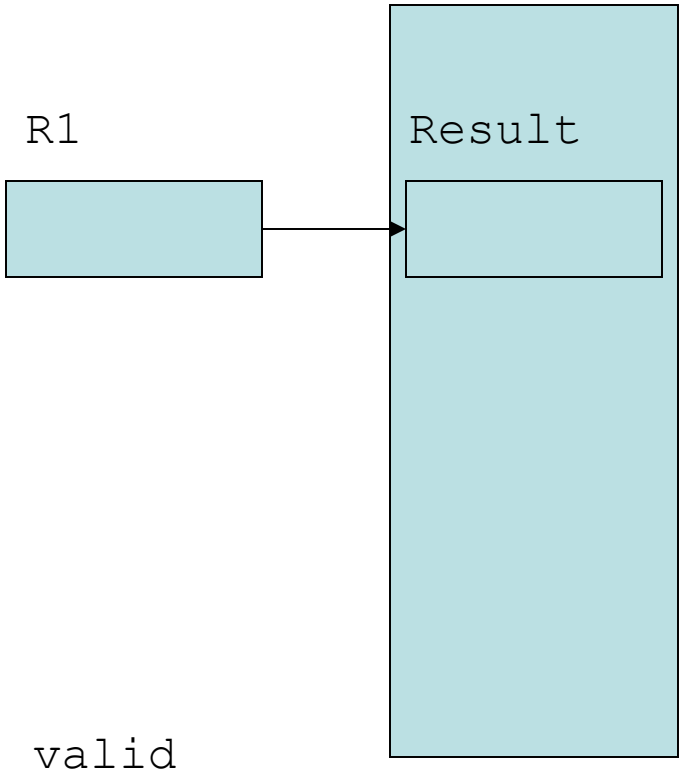
Example 1

```
.
.
MODESET EXTKEY=TCB . .
OC          0(4,R1),0(R1)
MODESET EXTKEY=ZERO . .
.
.
ST          R5,0(R1)
.
.
```

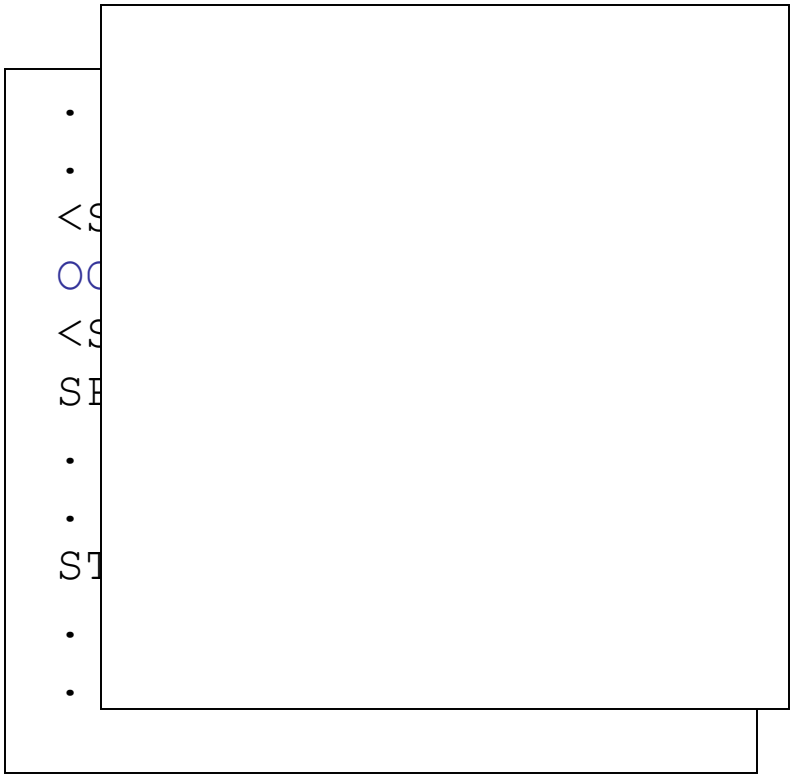


Example 1

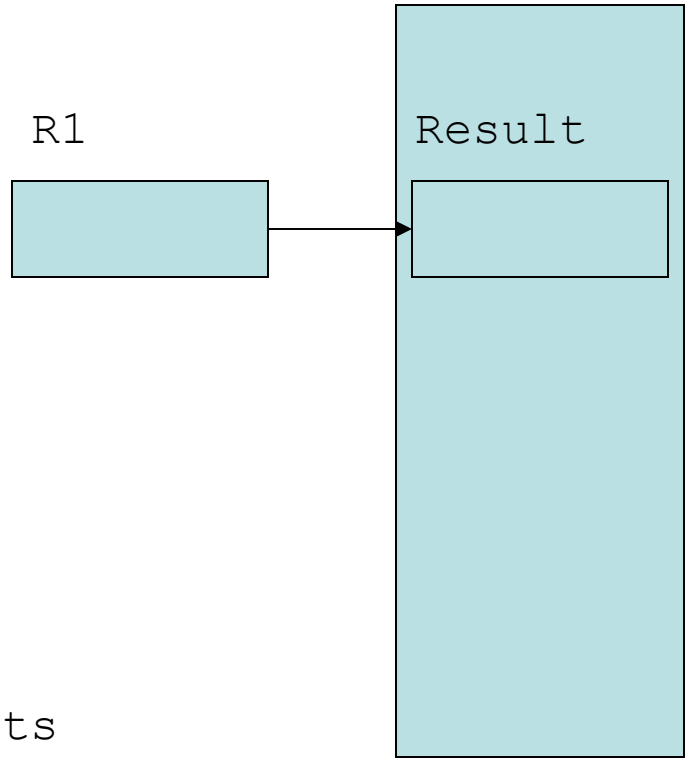
```
.
.
MODESET EXTKEY=TCB . .
OC          0(4,R1),0(R1)
MODESET EXTKEY=ZERO . .
.
.
ST          R5,0(R1)
.
.
```



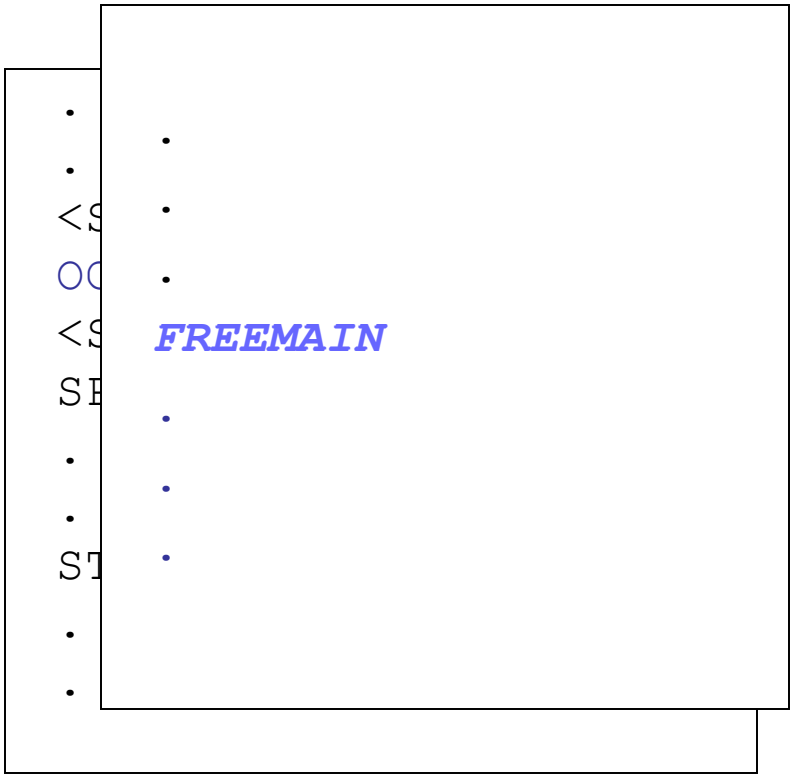
Example 1

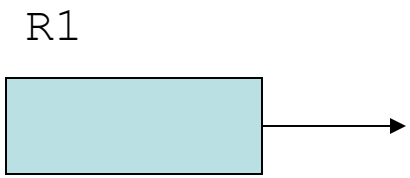


STIMER routine gets control



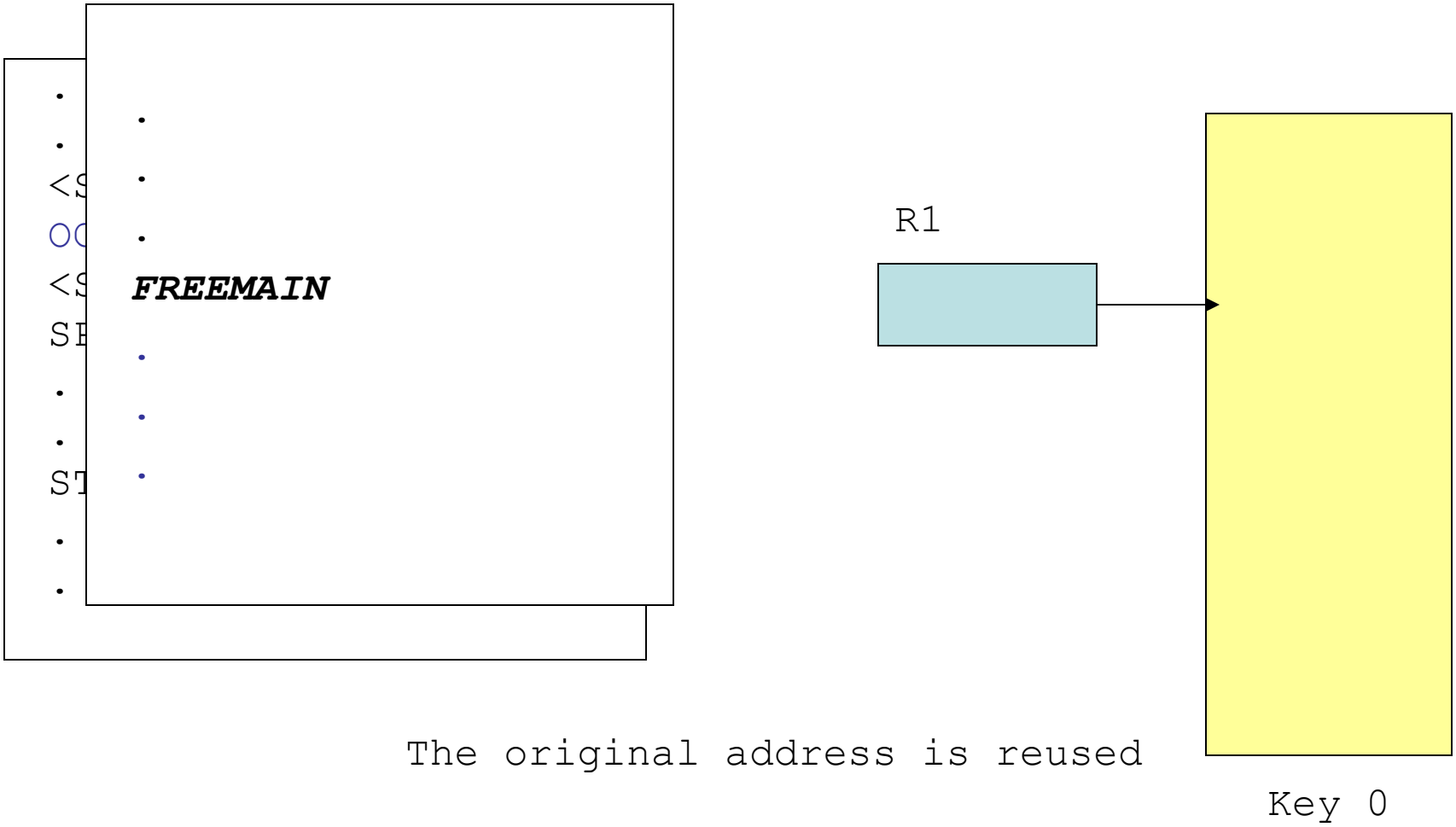
Example 1





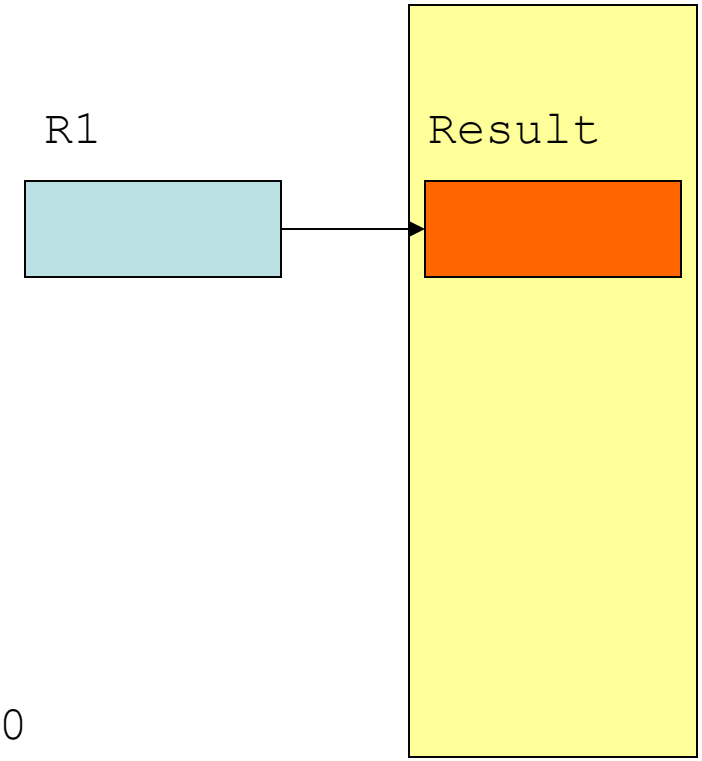
The key 8 storage is freed

Example 1



Example 1

```
.
.
MODESET EXTKEY=TCB . .
OC          0(4,R1),0(R1)
MODESET EXTKEY=ZERO . .
.
.
ST          R5,0(R1)
.
.
```



Overwrites key 0 storage

Example 1

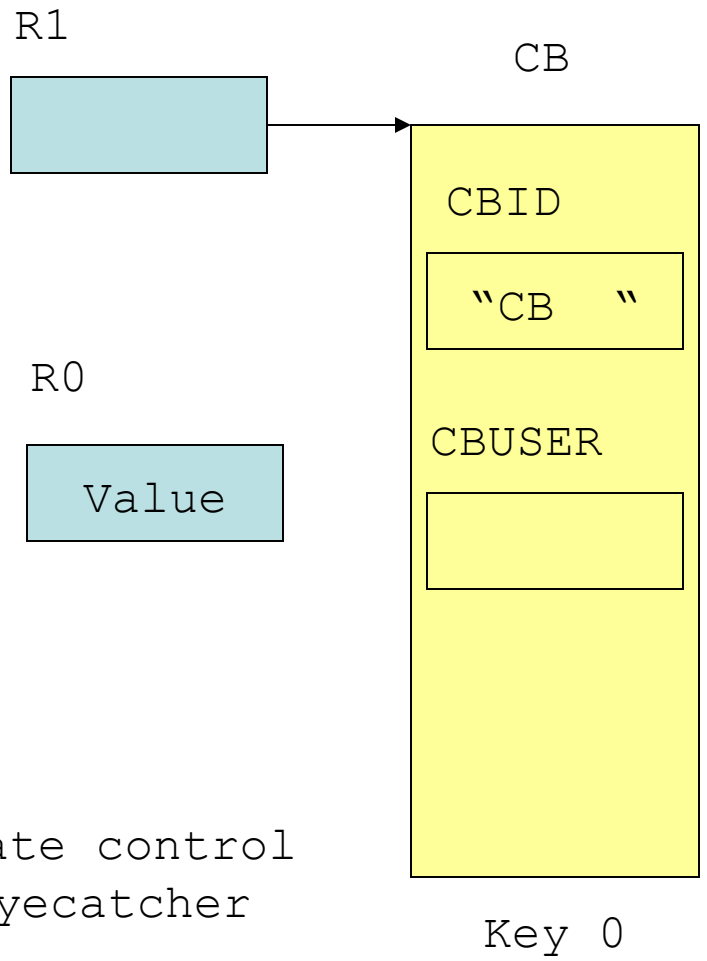
- *Violates guidelines for dealing with user supplied storage:*
  - *Access caller supplied storage in the key of the caller*
  - *For example, use MVCSK or MVCDK*

Example 2: SVC (Key 0, Supervisor State)

- *Imaginary set of services*
  - *CBINIT – creates control block and returns address*
  - *CBSET – accepts control block address*
  - *CBTERM – accepts control block address and frees control block*

Example 2

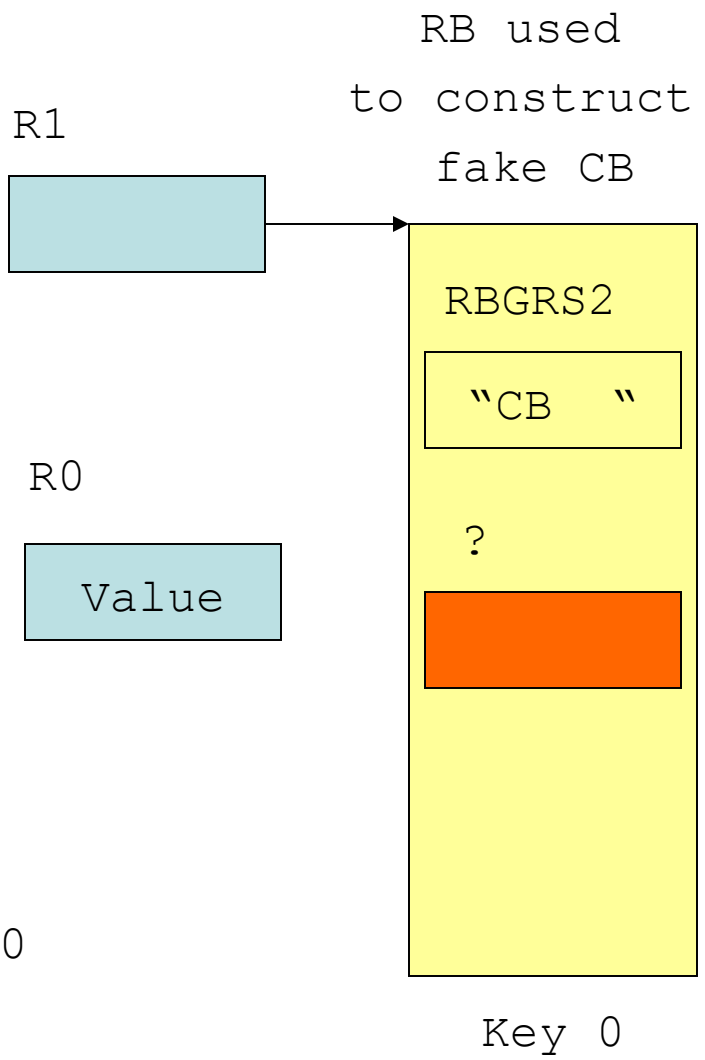
```
.
USING   CB,R1
SR      R5,R5
IVSK    R5,R1
LTR     R5,R5
BNZ     ERROR
CLC     =C'CB  ',CBID
BNE     ERROR
ST      R0,CBUSER
.
```



Attempts to validate control blocks's key and eyecatcher

Example 2

```
.
USING   CB,R1
SR      R5,R5
IVSK    R5,R1
LTR     R5,R5
BNZ     ERROR
CLC     =C'CB  ',CBID
BNE     ERROR
ST      R0,CBUSER
.
```



Overwrites key 0 storage

Example 2

- ***Violates guideline for dealing with user supplied control blocks:***
  - ***Verify system control blocks through trusted pointers in system key storage***
  - ***Treat unverified control blocks as user supplied storage***

Example 3: SVC (Key 0, Supervisor State)

```
IGC00ATH    CSECT                    Bad Auth SVC
            BALR      12,0
            USING     *,12
            L         2,28(5)          Caller's RB
* Resume address < Beginning of PLPA
            CLC       21(3,2),361(3) Is caller in LPA?
            BL        RETURN
            L         2,180(4)         JSCB
* R0 != 1 request auth off
            BCT       0,AUTHOFF
AUTHON      OI     236(2),X'01'    Set JSCBAUTH
            B         RETURN
AUTHOFF     NI        236(2),X'FE'    Clear AUTH
RETURN      BR        14
            END       IGC00ATH
```

Example 3

- *Many ways to misuse this SVC*
- *Violates guidelines for dealing with authorization requirements:*
  - *Services that bypass security checks must be restricted to authorized callers*
  - *Callers allowed to bypass security checks must provide equivalent controls*
  - *Do not provide services that make unauthorized callers authorized*

Example 4: APF authorized Unix program (Key 8, Problem State, APF authorized)

```
main(int argc, char * argv[])

char   valueBuffer[100];
strcpy(valueBuffer, argv[1]);
```

Example 4

- *Classic buffer overflow vulnerability since length of input can be greater than 100*
- *Violates guidelines for dealing with user supplied values:*
  - *Verify that values are legitimate (in this case, length of argument string.*

Conclusion

- ***The security of z/OS requires attention to detail***
- ***Developers of authorized programs should follow the guidelines described in this presentation***