

Intro to z/OS: Part 1

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Session AF





Introduction

- This **class will cover** (at the 50,000 foot level) many **different areas** (but not all) of **z/OS**



Introduction

- This **class will cover** (at the 50,000 foot level) many **different areas** (but not all) of **z/OS**
- Don't be overwhelmed. There is a ton of material here. The purpose of this session is to acquaint you with some of the major concepts of **z/OS**

Agenda



Part 1:

Why Z Matters

Hardware/LPAR

z/OS Components

Software Stack

App Dev, App Exec and Mgmt Envs

DASD

Data Sets / Allocation

TSO/E

ISPF

z/OS UNIX/ISHELL/OMVS/Remote

Address Spaces & Modes

Storage & DAT

Part 2 – Next

Batch Processing/JES/JCL

SDSF

Job Flow

System Log

VTOC & Catalogs

PDS & PDSE

SMS

IPL

Sysplex/GDPS

Serialization

Managing Workloads

Why Z Matters?



Why Z Matters

Utilities The Utilities icon shows a water tap, a gear, and a lightbulb inside a circular frame.

Retail The Retail icon is a shopping cart with a mouse cursor pointing at it.

Government The Government icon is a white building with a dome, set against a blue sky and green ground.

Financial The Financial icon is a bar chart with an upward-pointing arrow and a dollar sign.

Travel The Travel icon is a globe with an airplane flying over it.

Healthcare The Healthcare icon is a blue Star of Life with a white caduceus in the center.

Telecoms The Telecoms icon is a blue radio tower with signal waves.

Automotive The Automotive icon is a dark blue circle containing a white car and a wrench.

Weather The Weather icon is a sun partially obscured by a grey cloud with rain falling from it.

Why Z Matters

92 of the top 100
worldwide banks
run on **Z**



Why Z Matters

10 out of 10 of the world's largest **insurers**



Why Z Matters

>90% of the US's
largest **retailers**



Why Z Matters

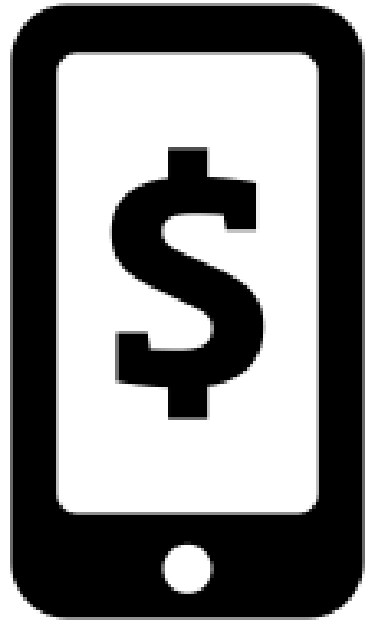
>90% of the US's
largest **airlines**



Why Z Matters

1.3 million

CICS transactions every
second of every day



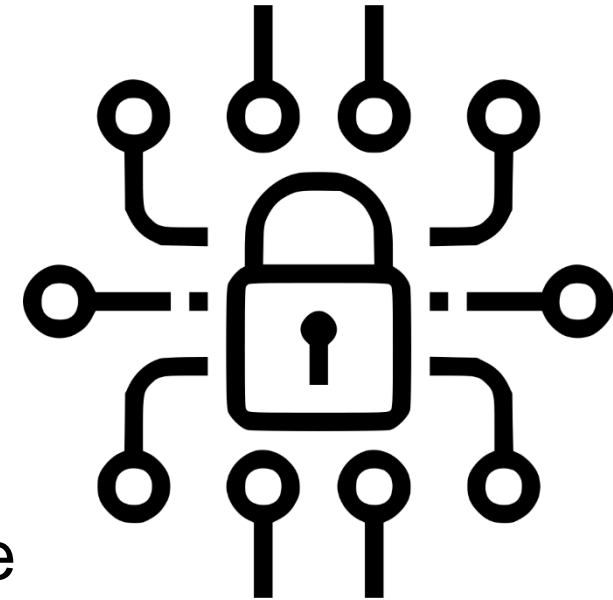
In comparison, there
are **68,542** Google
searches **every**
second globally

Why Z Matters

The average cost of a security breach in the US is estimated at **\$11 million**

IBM Z has the **highest** server security rating in the industry

Security is built into every level of the mainframe's structure, including the processor, operating system, communications, storage and applications



Why Z Matters

Mainframes process **30 billion**
business transactions per day

Mainframes process **1.3 million**
CICS transactions. Every second. Every day.



Mainframes enable **\$6 trillion**
in card payments annually

80 percent of the world's corporate
data originates on mainframes

91 percent of CIOs said new customer-
facing apps are accessing the mainframe

Naming of OS



z/OS Lineage

- At the beginning there was:
 - OS/360 (1966)
 - Configuration options PCP, MFT and MVT
 - OS/VS2 R1 (~1972)
 - Retroactively renamed to SVS
 - OS/VS2 R2 (~1974)
 - Also called **MVS**
 - MVS/370 (~1977)
 - MVS/SP V1
 - Optionally DFDS and DFEF
 - MVS/XA (1983)
 - MVS/SP V2 or V3 and MVS/DFP
 - MVS/ESA (~1990)
 - MVS/SP V4 or V5
 - Either MVS/DFP or DFSMS/MVS
 - OS/390 (1996)
 - **z/OS** (2001)

Since **2001** the **name**
has **remained z/OS**

This is the **longest**
that it has **been called**
one name!

Check Your
knowledge



Check your Knowledge

- What do you think the “Z” stand for in z/OS ?



Check your Knowledge

- What do you think the “Z” stand for in z/OS ?
 - **Zero downtime**

Hardware Context of z/OS

IBM Z Server – the IBM z15

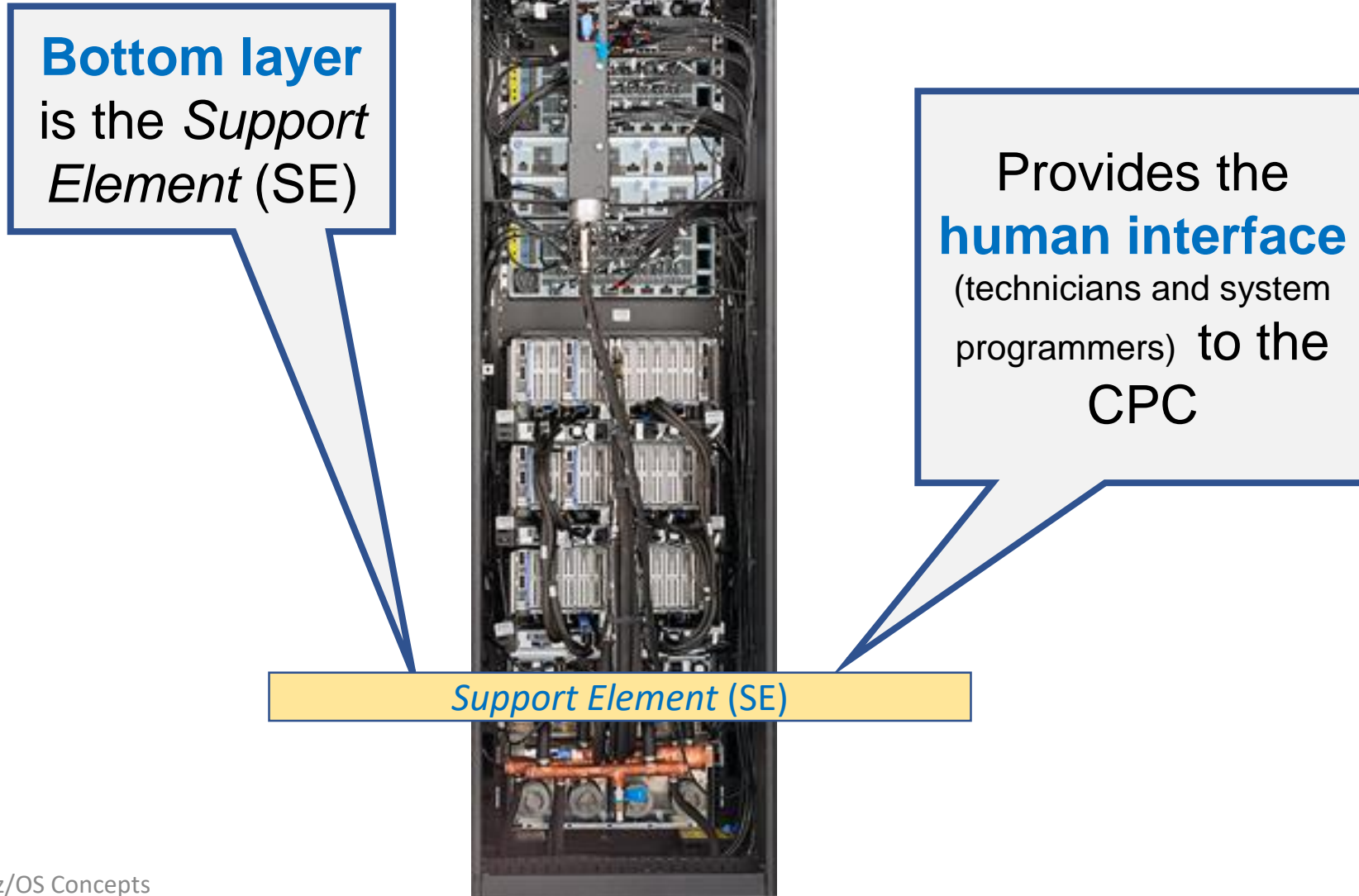


z/OS Concepts



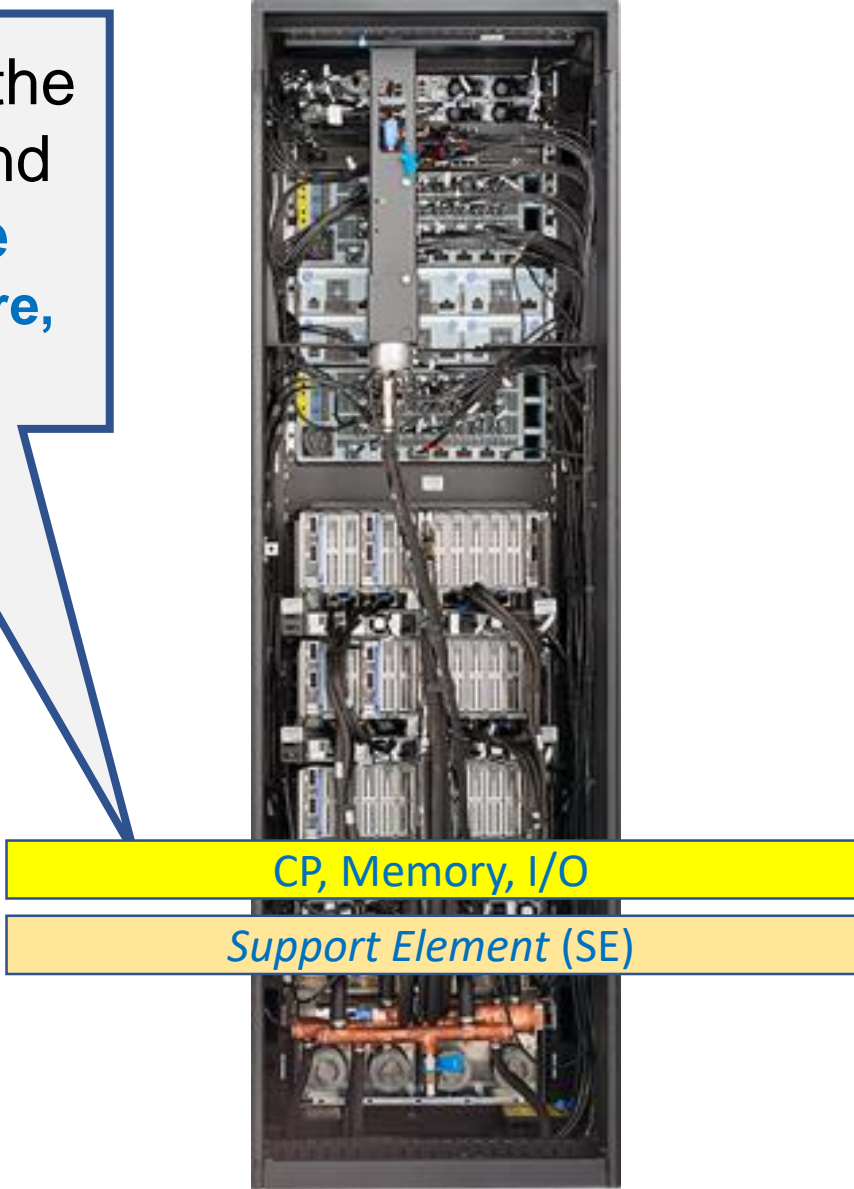
#CC

IBM Z Server – Support Element

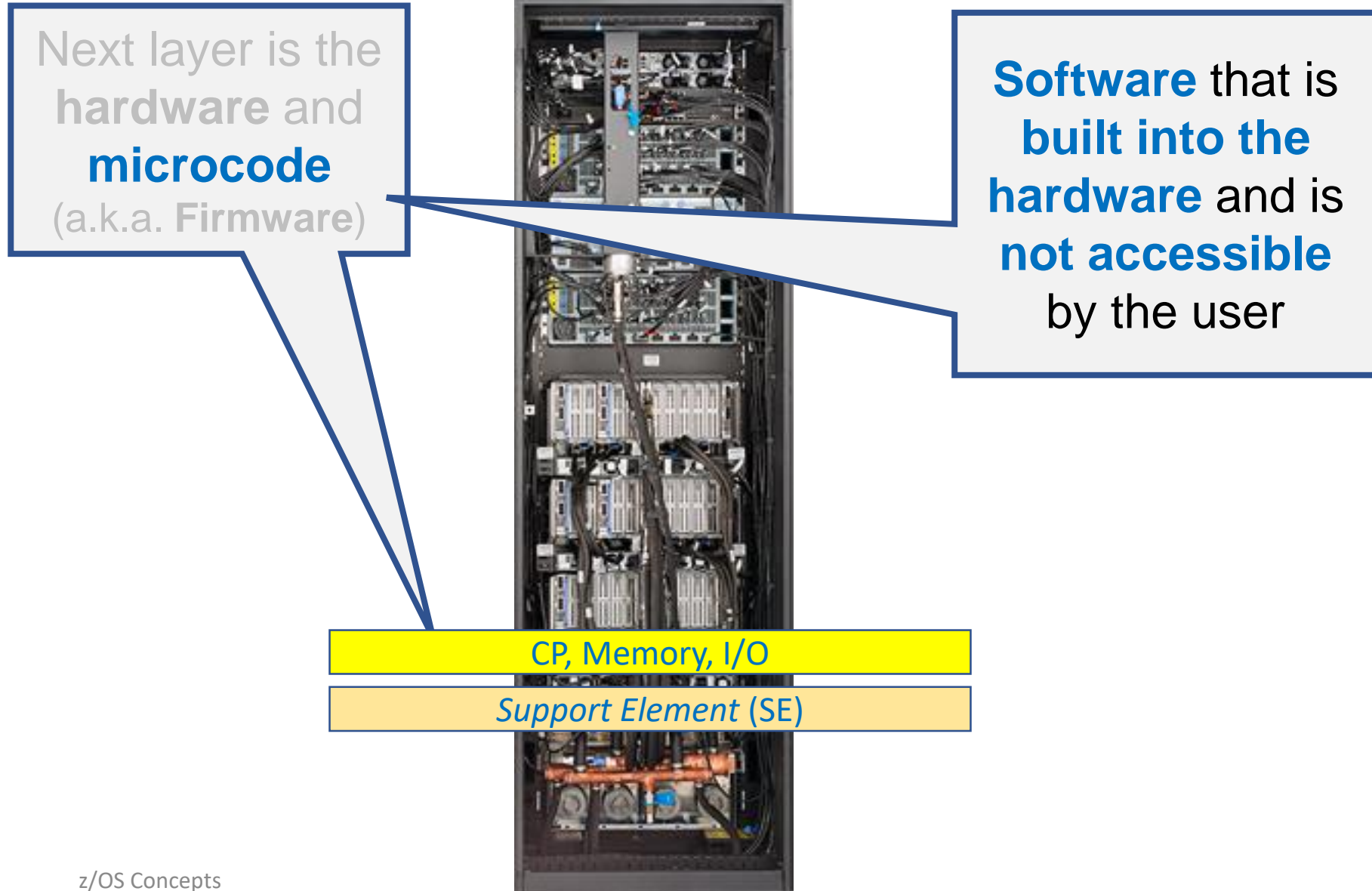


IBM Z Server – H/W, Microcode

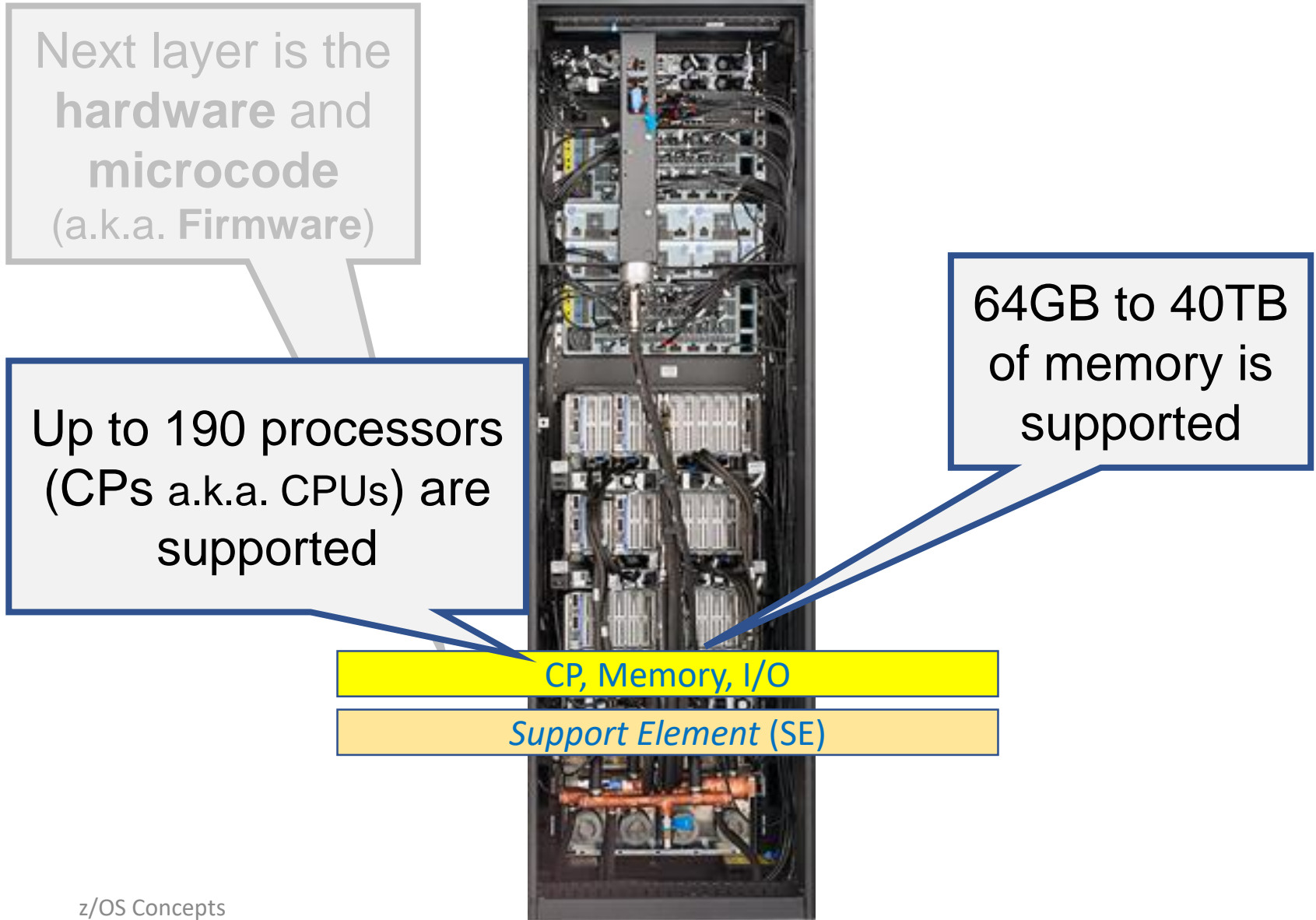
Next layer is the **hardware** and **microcode** (a.k.a. **Firmware, BIOS**)



IBM Z Server – H/W, Microcode



IBM Z Server – H/W, Microcode

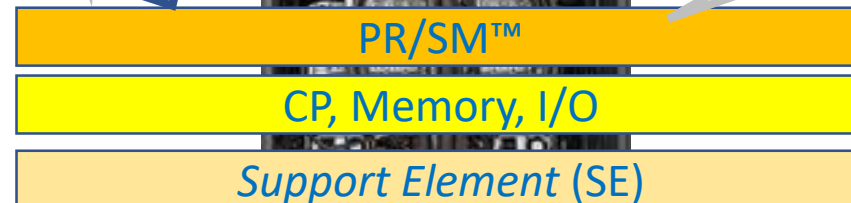


IBM Z Server – PR/SM™

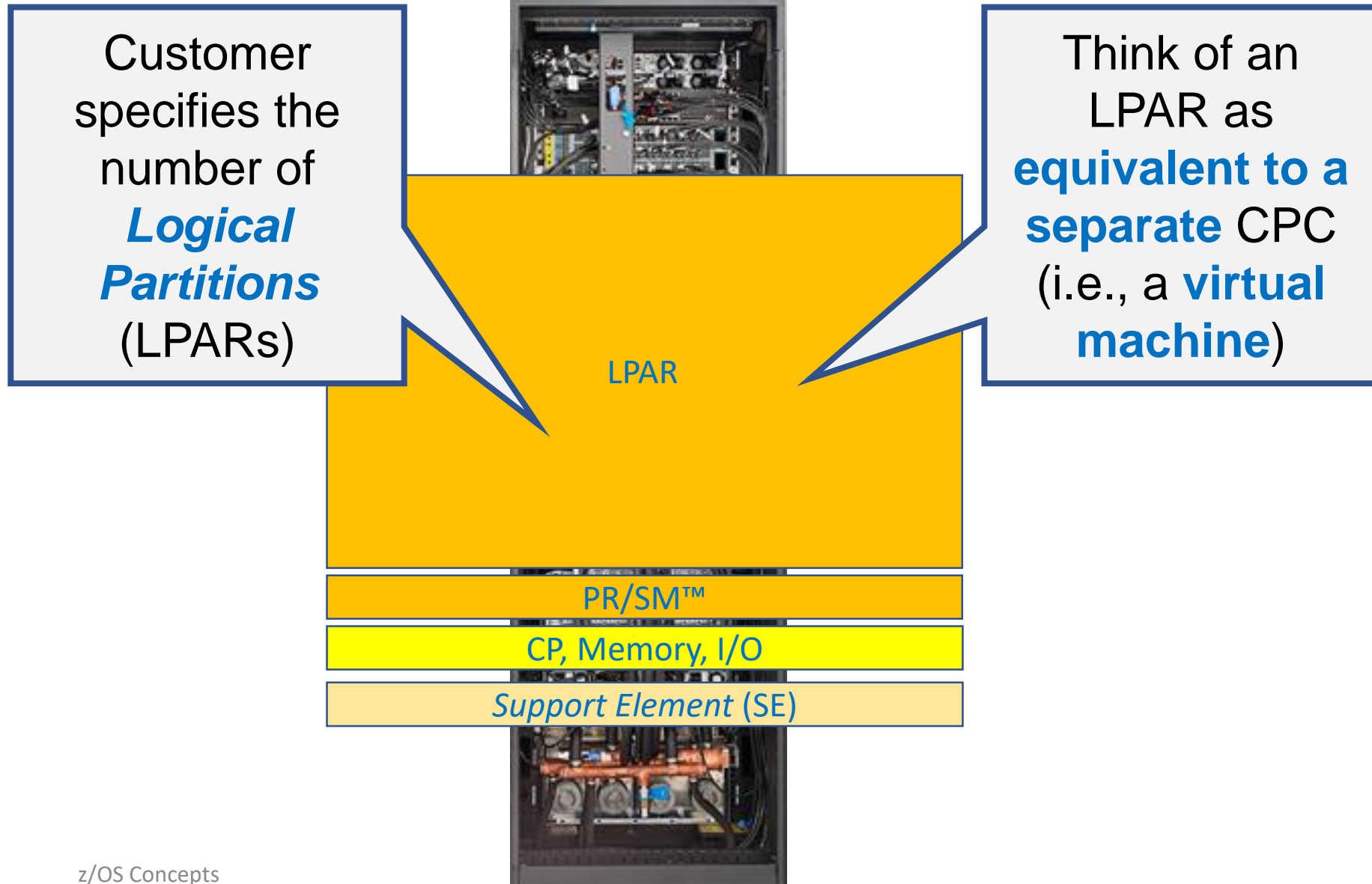
Next layer is *Processor Resource/Systems Manager (PR/SM)*

A **hypervisor** that manages virtual machines (enables the logical partitioning function (coming up next) of the CPC)

Exists in the **firmware** (software embedded in hardware and can be **updated**) of the CPC

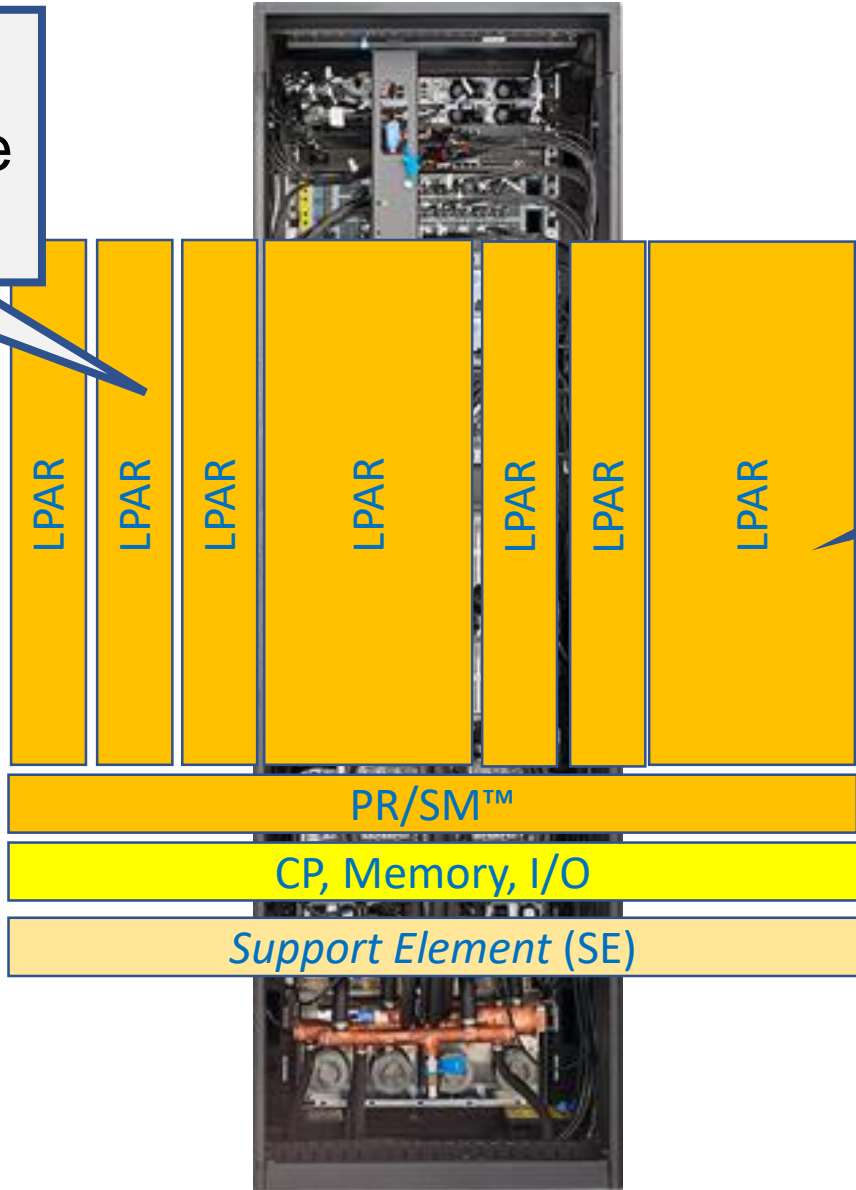


IBM Z Server – Single LPAR



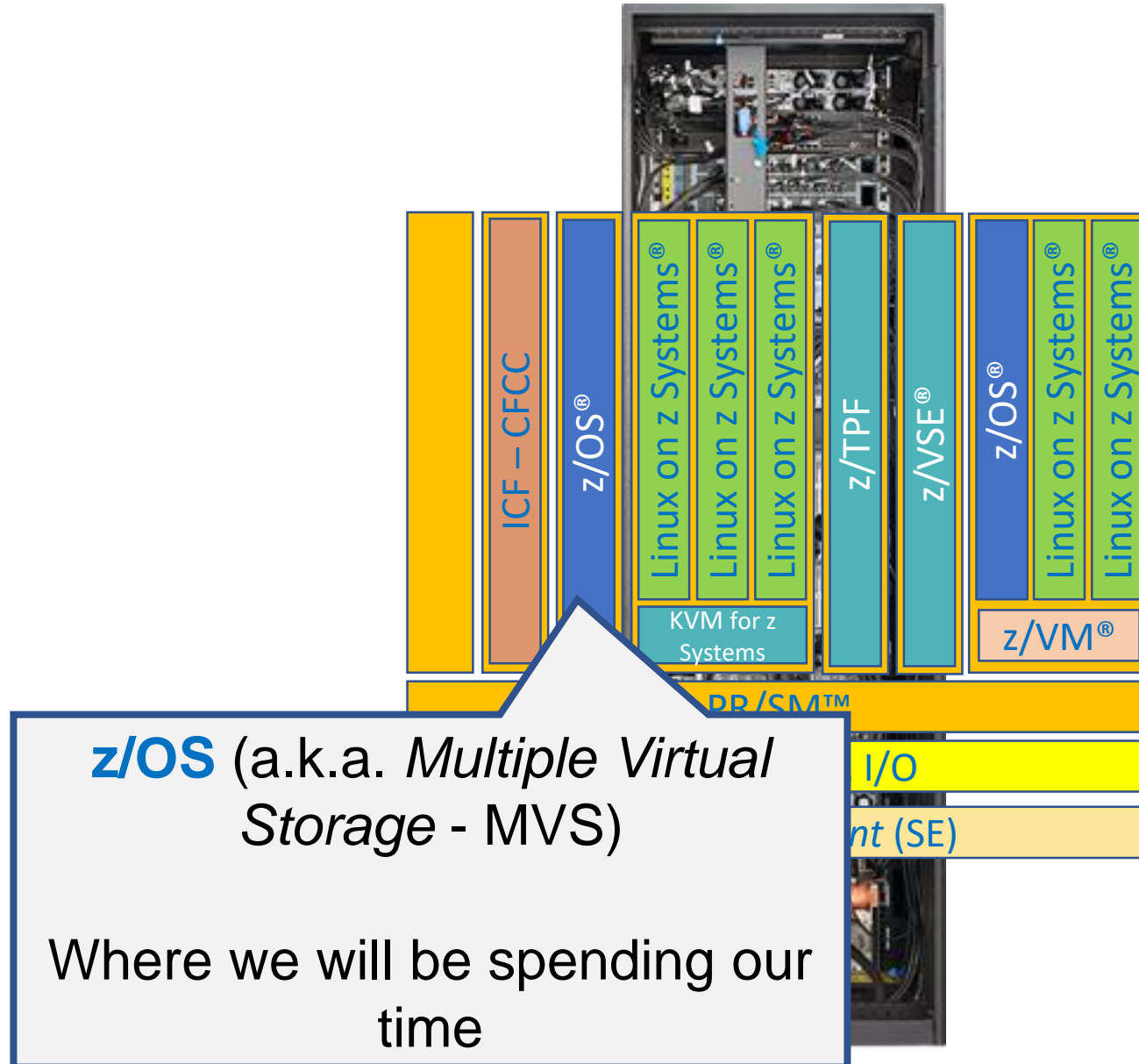
IBM Z Server – Multiple LPARs

Up to 85 LPARs can be defined



Each LPAR can be **allocated different amounts** of resources (up to 16TB memory)

IBM Z Hardware and z/OS



z/OS Elements, Features, and Components



z/OS Concepts – Elements, Features, Components

- z/OS is a **collection** of **elements**
 - Each element consists of a **collection of modules** (called **components**)

Examples:

IOS, RSM, GRS, Contents,
Allocation, Consoles, NIP,
Scheduler, SMF, BCPii, Logger



z/OS Concepts – Elements, Features, Components

- z/OS is a **collection of elements**
 - Each element consists of a **collection of modules** (called **components**)
 - **Base elements** are **always included** in z/OS
 - **BCP** (*Base Control Program*)
 - **DFSMSdfp** (*Data Facility Storage Management Subsystem*)
 - Deliver **essential** operating **system functions**

Other Base Elements:

Communication Server, z/OSMF,
HLASM, TSO, ISPF, JES2,
Metal C Runtime Library

z/OS Concepts – Elements, Features, Components



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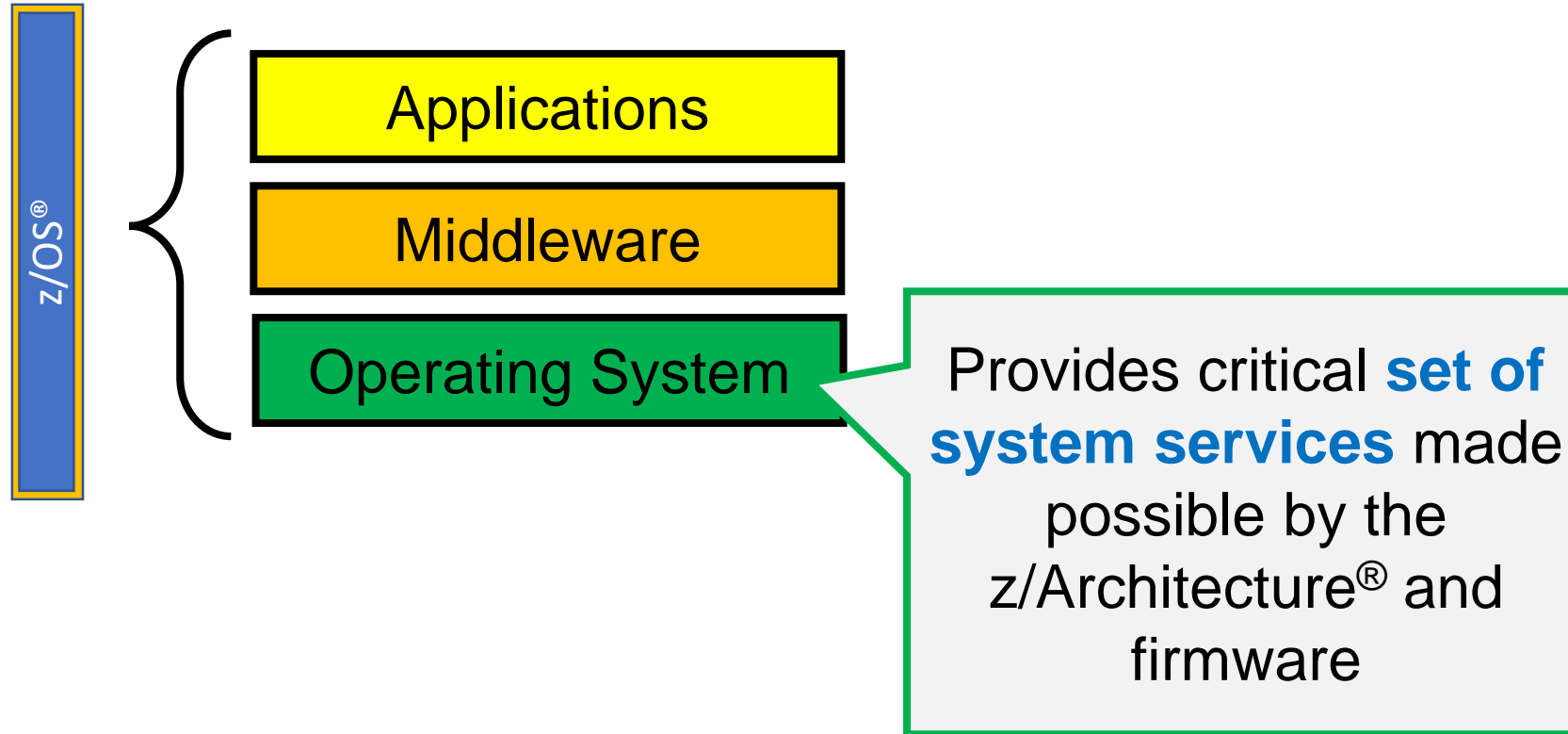
Optional Features
Examples:
Security Server, SDSF,
XL C/C++, RMF, JES3,
DFSMSHsm, DFSMSdss

- **Optional features** installed **in addition** to base elements
 - **Requested separately** from base elements
 - Can be **priced** or **free**

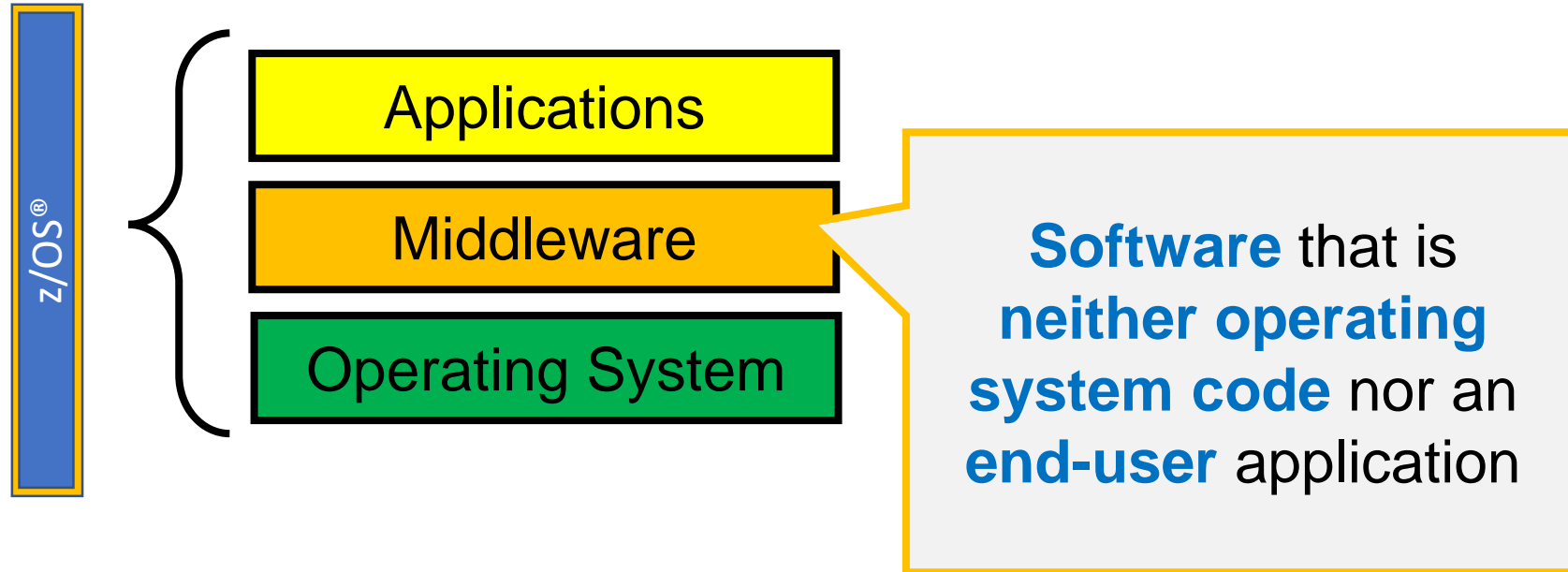
Software Stack



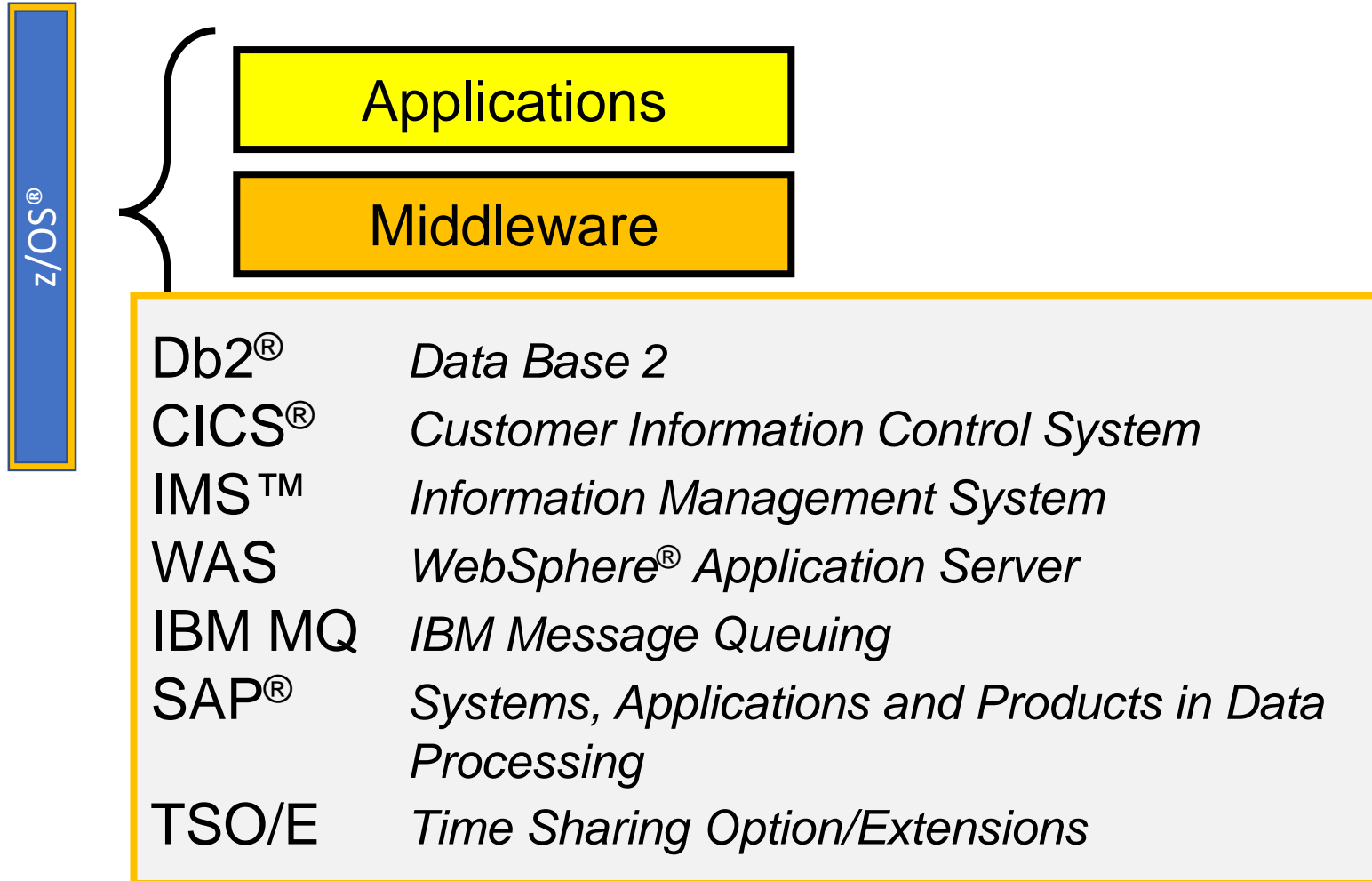
IBM z/OS Software Stack



IBM z/OS Software Stack



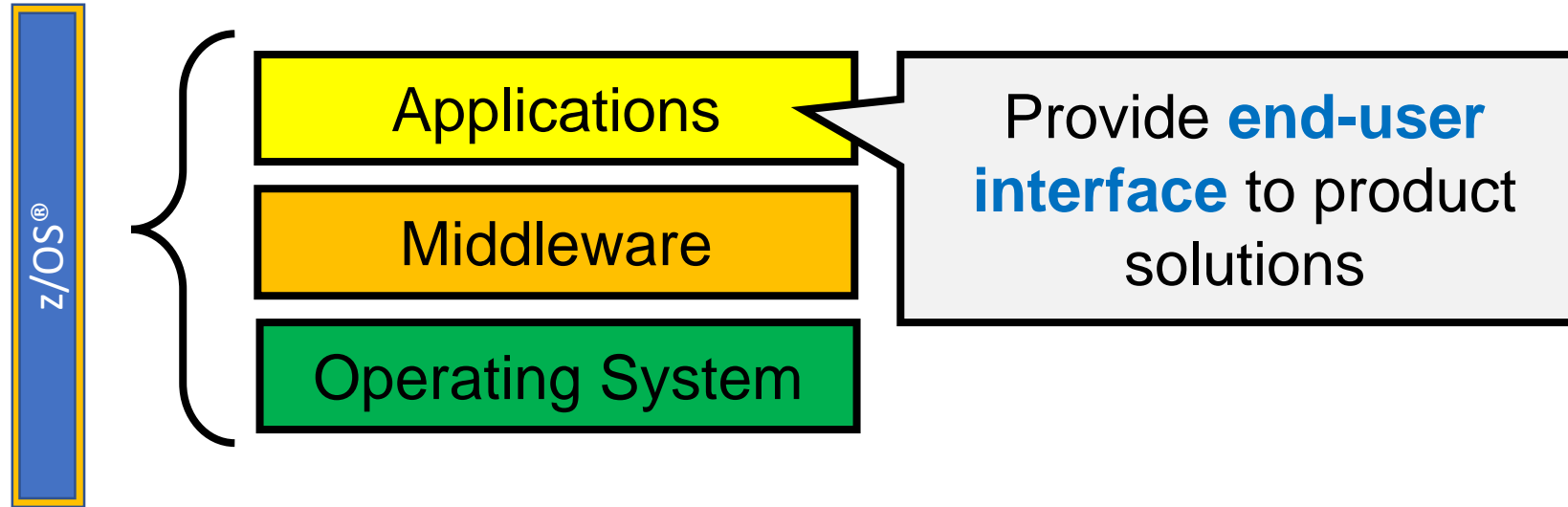
IBM z/OS Software Stack



SAP is the registered trademark of SAP SE in Germany and in several other countries.



IBM z/OS Software Stack



ISPF *Interactive System Productivity Facility*
SA z/OS *IBM Tivoli® System Automation for z/OS*

Application Development Environments, Application Execution Environments and z/OS Management Environments



Application Development Env

z/OS supports many **programming languages** as well as modern **IDEs** and **environments**



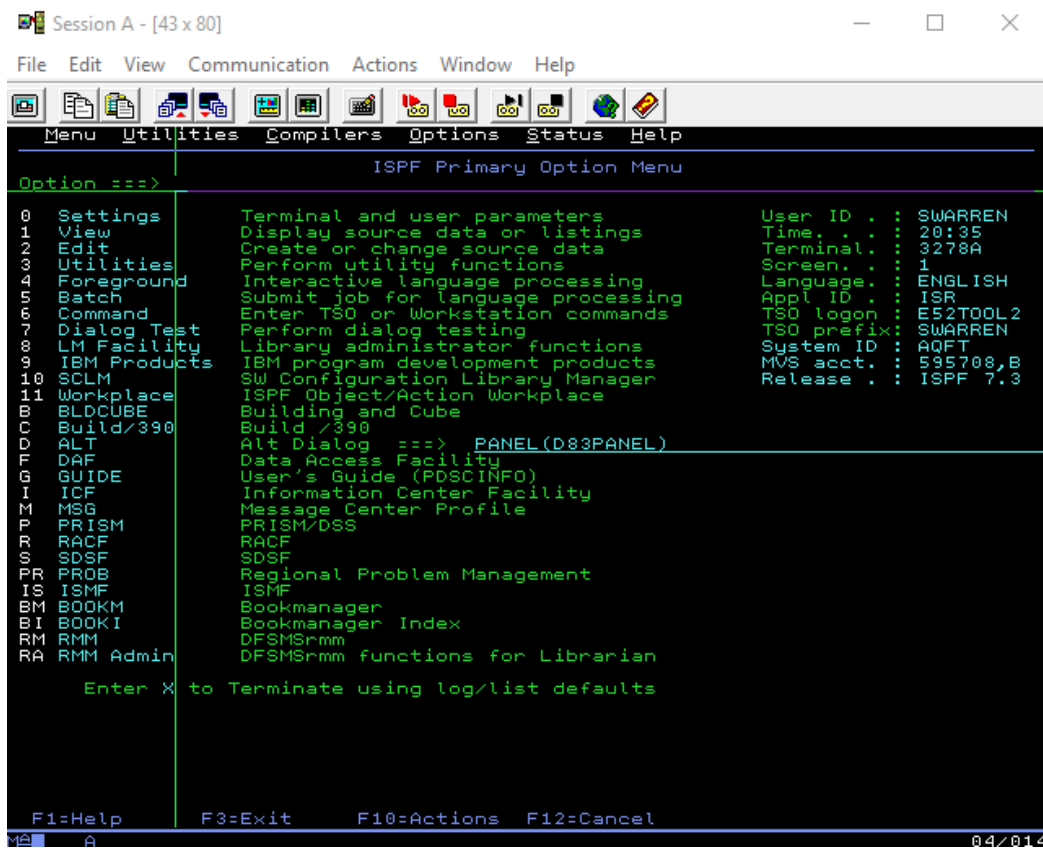
Application Development Env

z/OS supports many **programming languages** as well as modern **IDEs** and **environments**

- **Assembler**
- **COBOL**
- **C/C++**
- **PL/I**
- **Fortran**
- **REXX**
- **JAVA™**
- **Python**
- **Node.js**
- **Scala**

Application Development Env

Legacy interactive interface

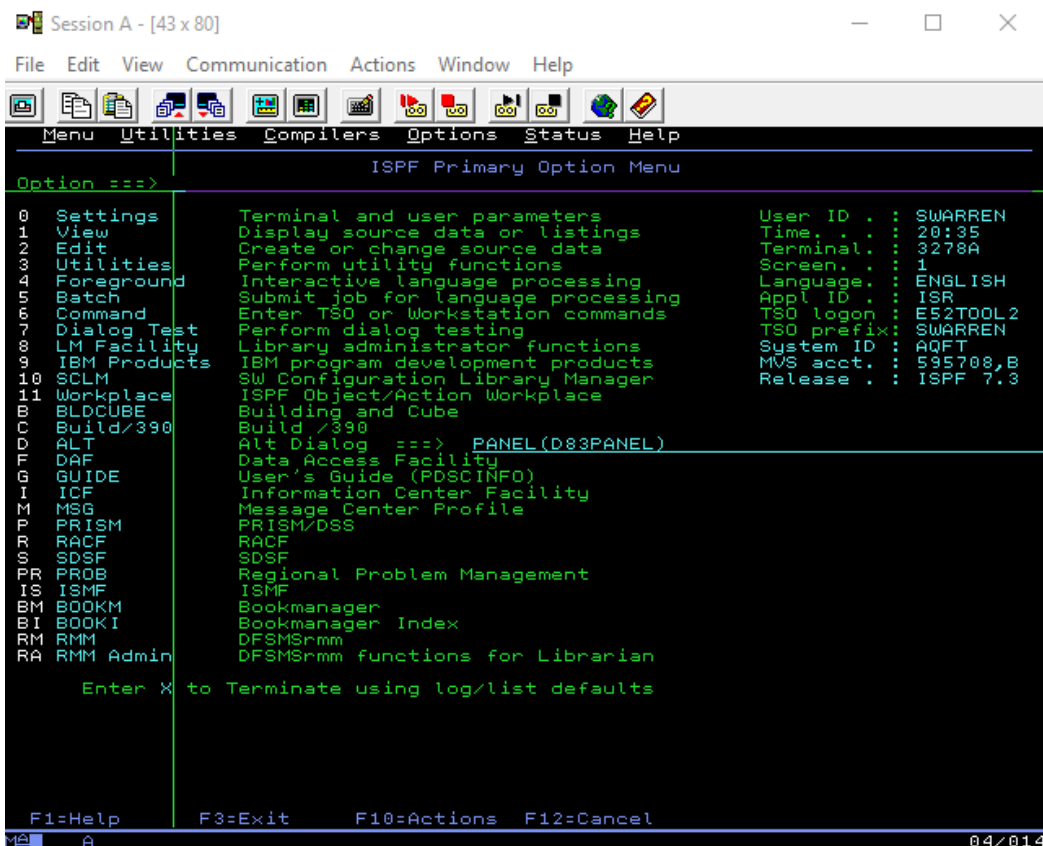


```
Session A - [43 x 80]
File Edit View Communication Actions Window Help
Menu Utilities Compilers Options Status Help
ISPF Primary Option Menu
Option ==>
0 Settings Terminal and user parameters User ID . : SWARREN
1 View Display source data or listings Time . . : 20:35
2 Edit Create or change source data Terminal . : 3278A
3 Utilities Perform utility functions Screen . : 1
4 Foreground Interactive language processing Language . : ENGLISH
5 Batch Submit job for language processing Appl ID . : ISA
6 Command Enter TSO or Workstation commands TSO logon : ES2TOOL2
7 Dialog Test Perform dialog testing TSO prefix: SWARREN
8 LM Facility Library administrator functions System ID : AQFT
9 IBM Products IBM program development products MVS acct. : 535708,B
10 SCLM SW Configuration Library Manager Release . : ISPF 7.3
11 Workplace ISPF Object/Action Workplace
BLDCUBE Building and Cube
Build/390 Build /390
ALT Alt Dialog ==> PANEL(D83PANEL)
DAF Data Access Facility
GUIDE User's Guide (PDSCINFO)
ICF Information Center Facility
MSG Message Center Profile
PRISM PRISM/DSS
RACF RACF
SDSF SDSF
PROB Regional Problem Management
ISMF ISMF
BOOKM Bookmanager
BOOKI Bookmanager Index
RMM DFSMSrmm
RMM Admin DFSMSrmm functions for Librarian
Enter X to Terminate using log/list defaults
F1=Help F3=Exit F10=Actions F12=Cancel
04/014
```

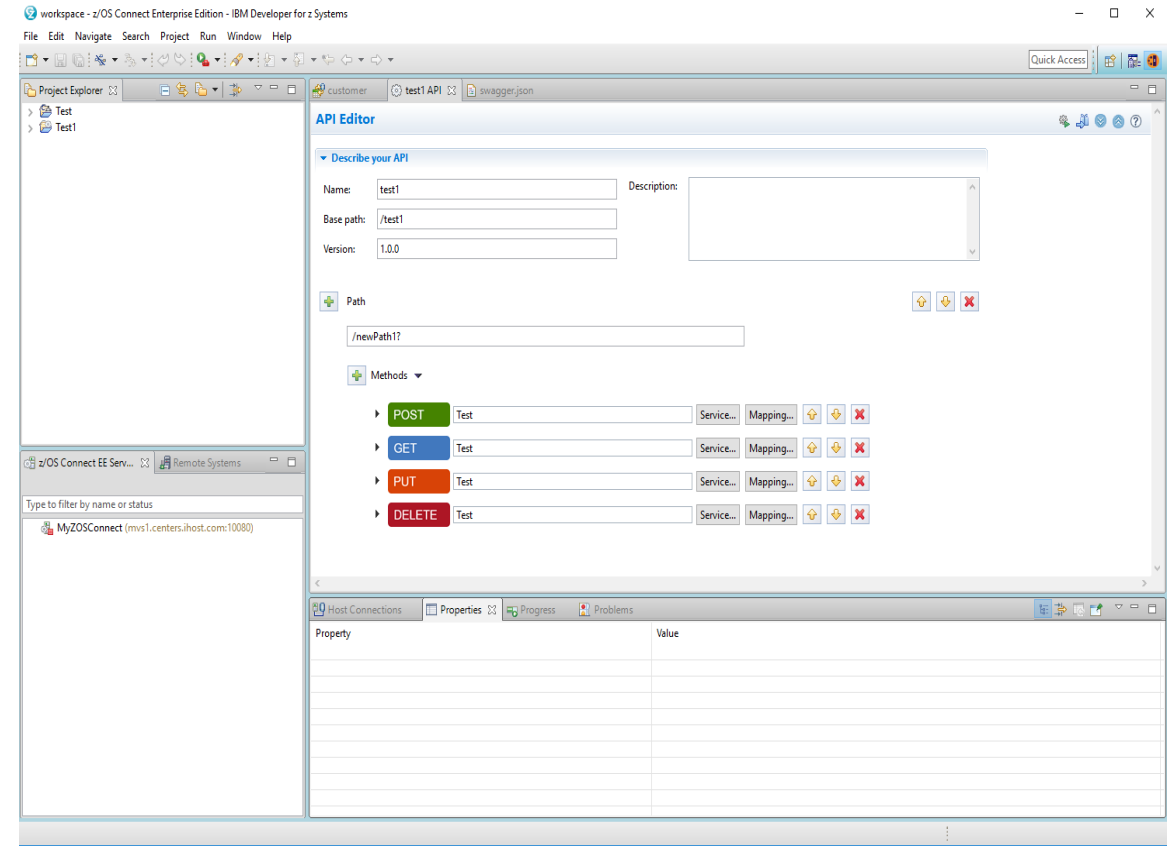


Application Development Env

Legacy interactive interface



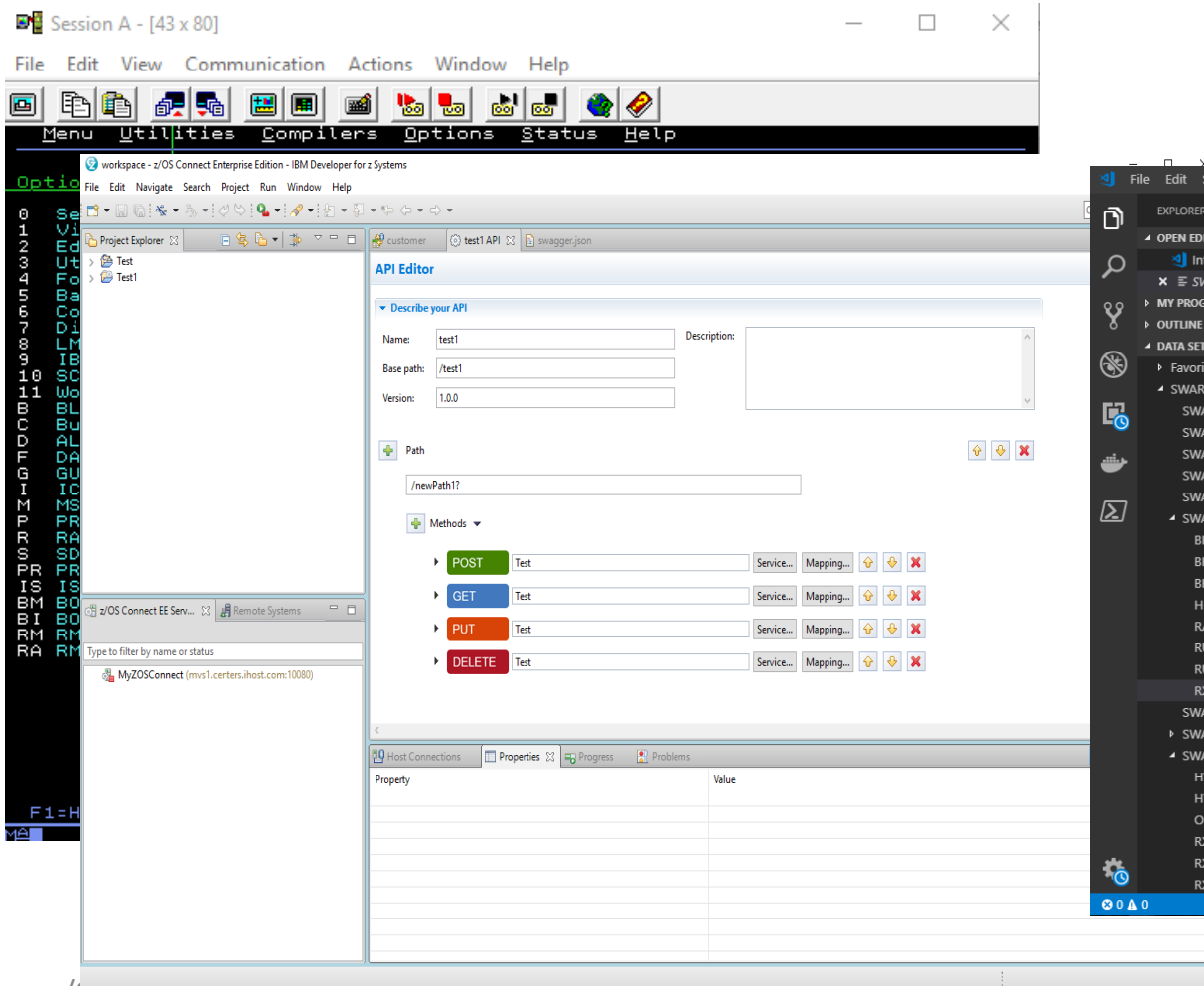
Integrated Development Environment (IDE)



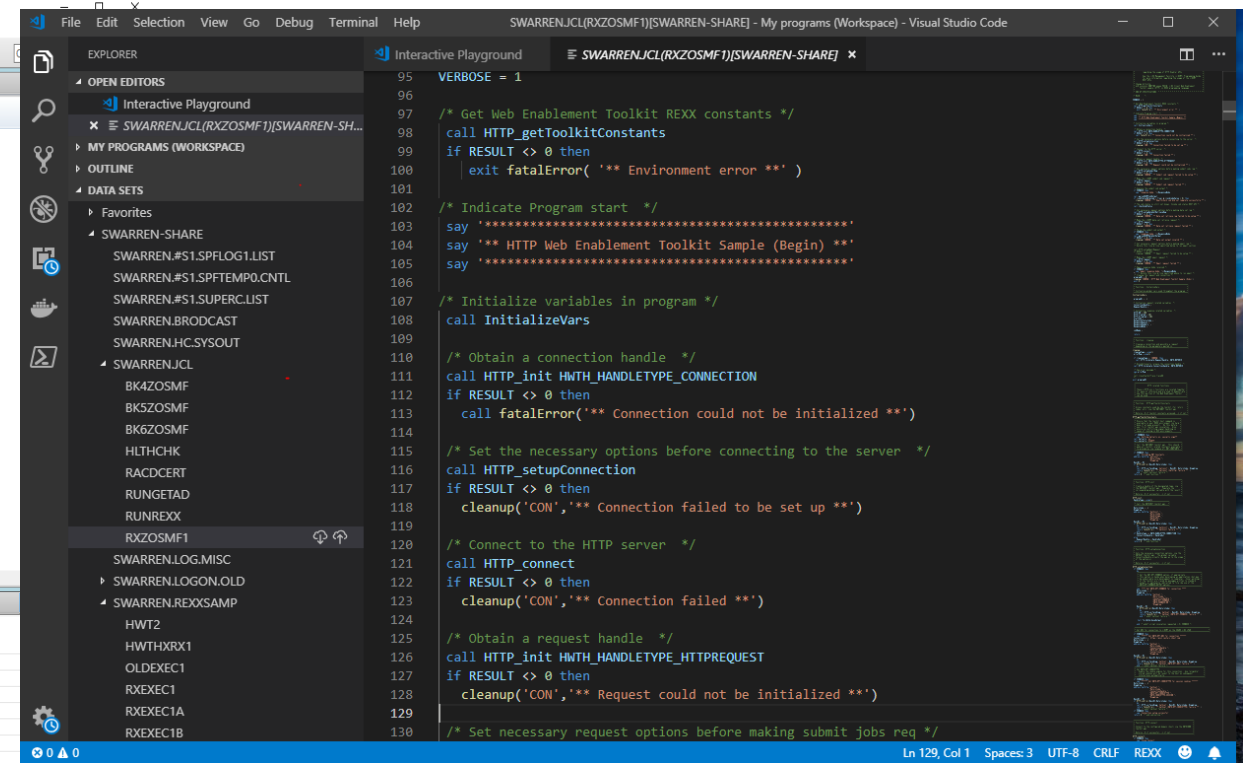


Application Development Env

Legacy interactive interface



Integrated Development Environment (IDE)



Other Modern Application Development Tools

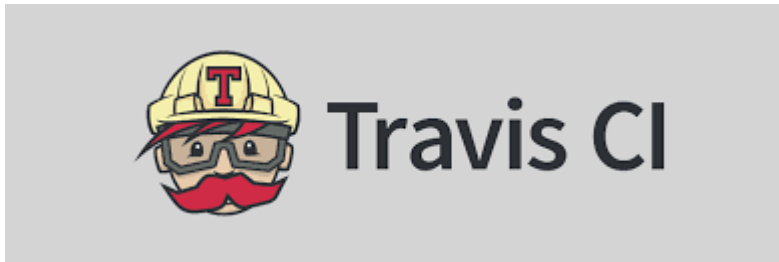
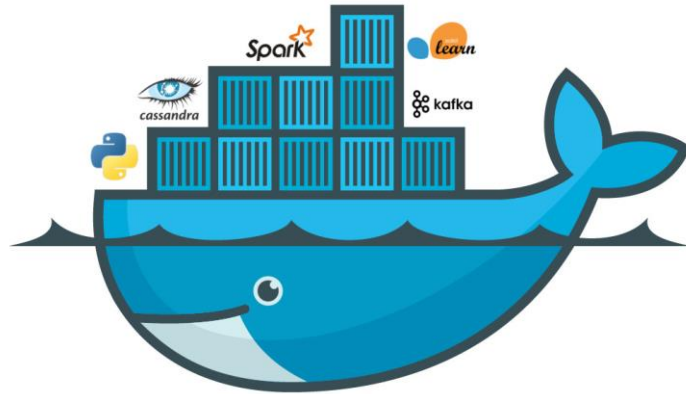
Application Development Env



Visual Studio Code



Jenkins



Application Execution Env



Traditional z/OS
application environments,
including middleware



Java Virtual Machine
application environment



z/OS UNIX application
environment

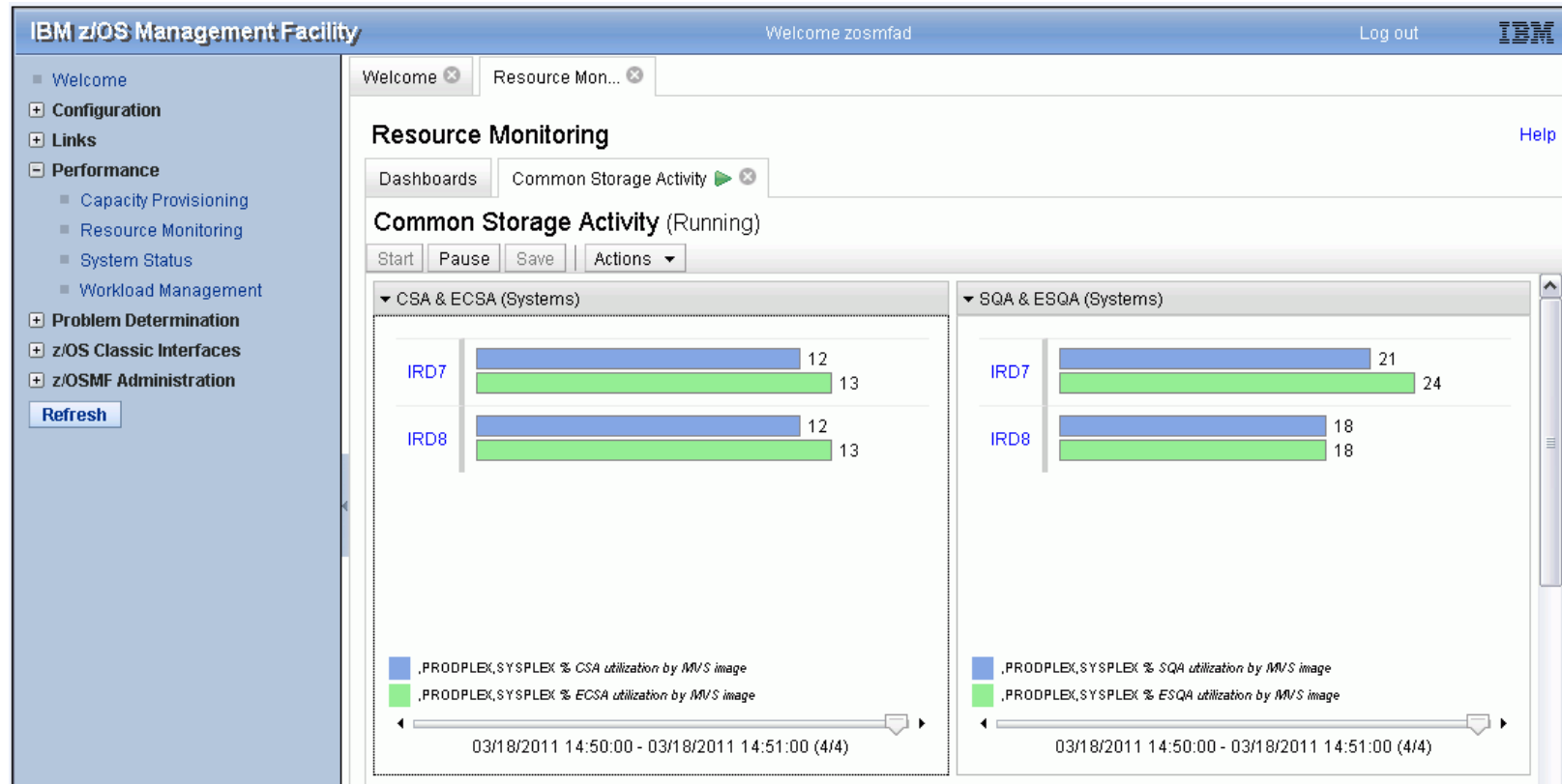


z/OS Container Extensions
application environment (new in z/OS
V2R4)



Management Environments

z/OS Management Facility (**z/OSMF**) provides modern interface to help manage your z/OS systems



DASD



IBM Speak – DASD

- **DASD** – *Direct Access Storage Device*
 - Think “**Hard Drive**”

IBM Speak – DASD

- **DASD** – *Direct Access Storage Device*
 - Think “**Hard Drive**”
 - a.k.a. DASD **Volume**
 - Volume needs **a label**
 - *Volume Serial Number* (**VOLSER**)
 - 1 to 6 characters

Data Sets

IBM Speak – Data Set

- **Data set**

- Think “**File**”
- Contains data in different structured formats
- **Need to choose the format of data set and reserve space (allocate dataset) prior to using for the first time**
- Resides on DASD, Tape
- z/OS has types of data sets
 - Legacy Data set
 - Unix file

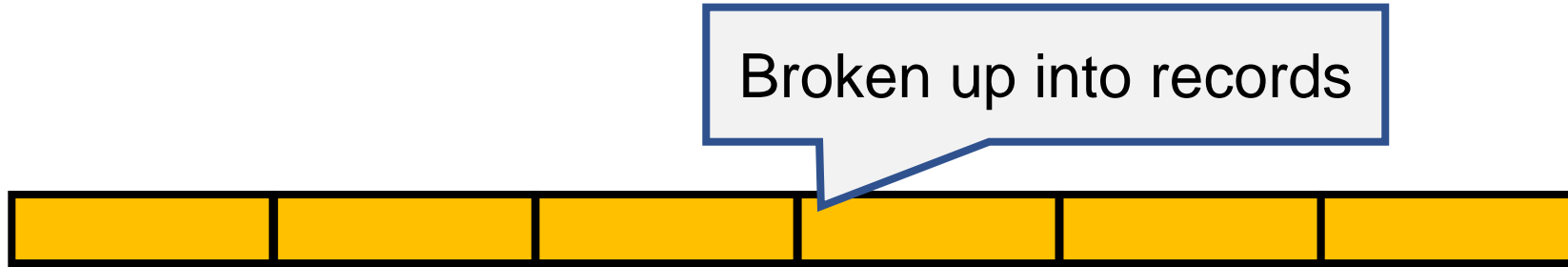
IBM prefers the spelling “data set” to “dataset”

IBM Speak – Data Set

A diagram illustrating a data set. It features a light gray speech bubble with a blue border containing the text "Data in a data set". Below the speech bubble is a long, horizontal yellow bar with a black outline, representing the data set itself.

Data in a data set

IBM Speak – Data Set

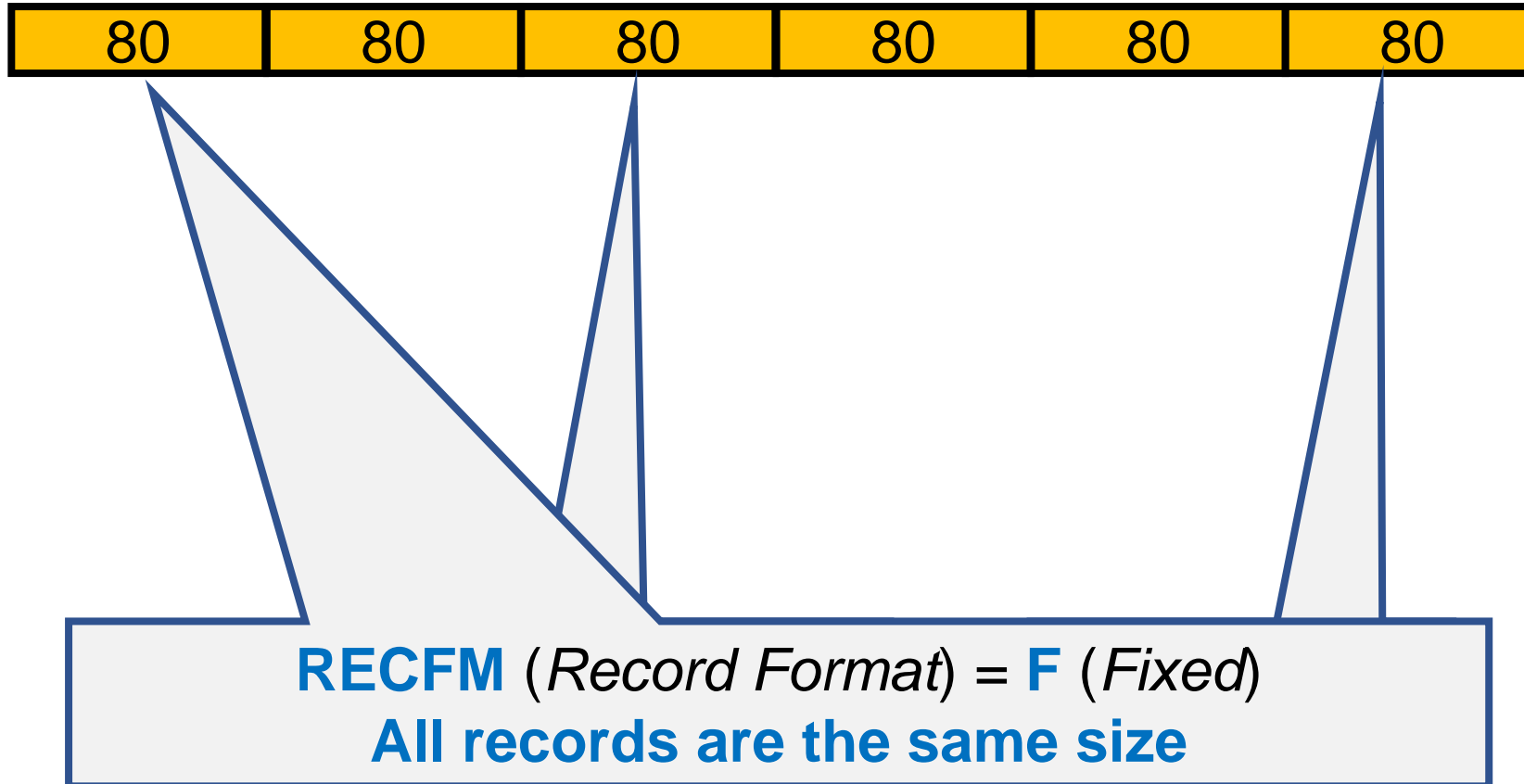


IBM Speak – Data Set

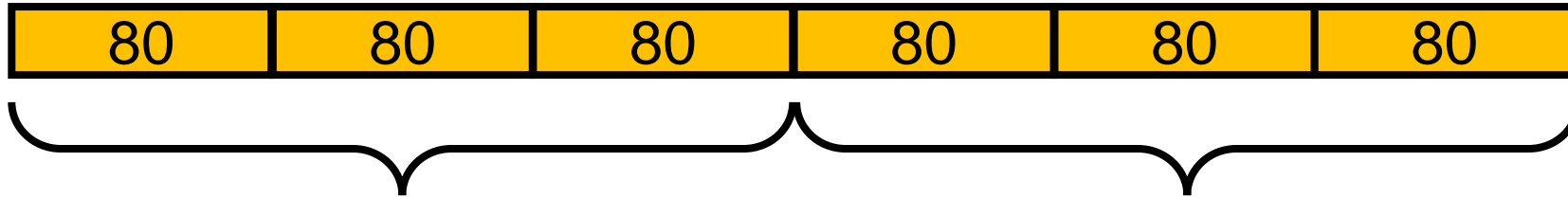


LRECL (*Logical Record Length*) = **80**
Number of **bytes in each record**

IBM Speak – Data Set



IBM Speak – Data Set



RECFM (*Record Format*) = **FB** (*Fixed Block*)
Records grouped into **blocks**

BLKSIZE (*Block Size*) = **240**

3 Records * **LRECL** = **BLKSIZE**

IBM Speak – Data Set

```
RECFM = FB BLKSIZE=240  
LRECL=80
```



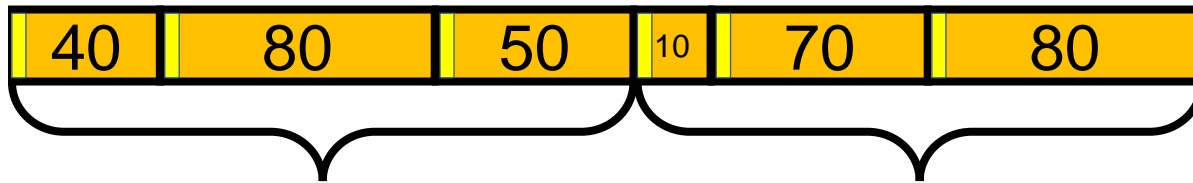
Broken up into variable sized records



LRECL (*Logical Record Length*) = **80**
Maximum number of **bytes** in a record

IBM Speak – Data Set

RECFM = FB BLKSIZE=240
LRECL=80



RECFM (*Record Format*) = **VB** (*Variable Block*)
Records grouped into **blocks**

BLKSIZE (*Block Size*) = **174**

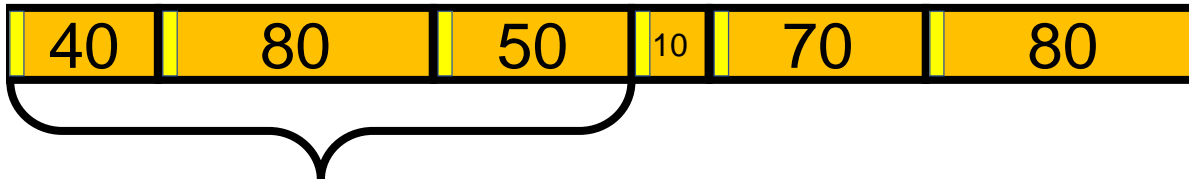
Find largest block: Total **LRECL** values + 4 byte
descriptor = **BLKSIZE**

IBM Speak – Data Set

Record Format (**RECFM**) = Fixed Block (FB); Block Size (**BLKSIZE**)=240; Logical Record Length (**LRECL**)=80



Record Format (**RECFM**) = Variable Block (VB); Block Size (**BLKSIZE**)=174; Logical Record Length (**LRECL**)=80



Block size = number of records to be read as a single I/O operation

Choose the appropriate settings for the type of data



IBM Speak – Data Set

One other data set attribute:
DSORG (*Data Set Organization*)

IBM Speak – Data Set

DSORG=**PS** (*Physically Sequential*)

Data

Editing the data set **gives you all the data** in the data set

IBM Speak – Data Set

DSORG=PS (*Physically Sequential*)

Data

DSORG=PO (*Partitioned*)

Directory

Member 1 Data

Member 2 Data

Member 3 Data

a.k.a. **PDS** (*Partitioned Data Set*)
or **PDSE** (*Partitioned Data Set
Extended*)

IBM Speak – Data Set

DSORG=PS (*Physically Sequential*)

Data

DSORG=**PO** (*Partitioned*)

Directory

Member 1 Data

Member 2 Data

Member 3 Data

The PDS contains a **directory** to **locate** the members

The Naming of Data Sets



IBM Speak – Data Set Name

- ***Data set name*** (DSN or DSName)
 - Think “**File Name**”



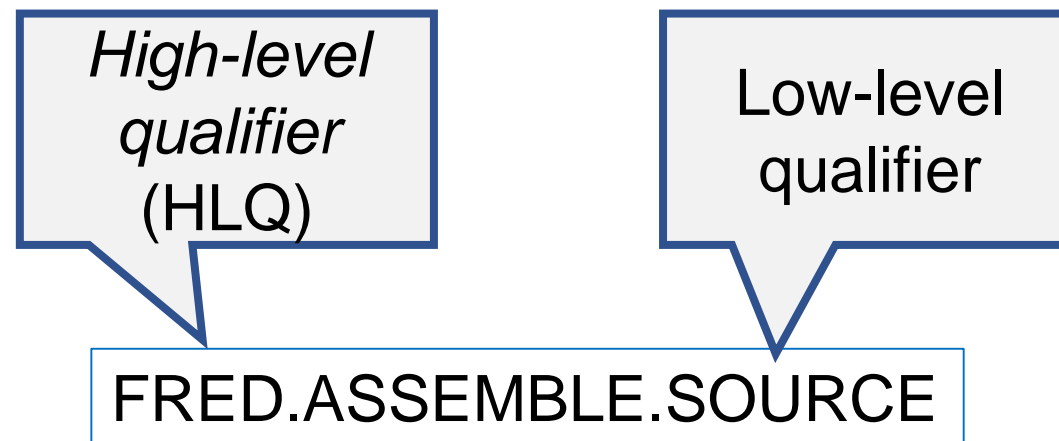
IBM Speak – Data Set Name

- *Data set name* (DSN or DSName)
 - Think “File Name”
 - 1 to 22 **segments**
 - segments **separated by a period**
 - each segment **limited to 8 characters**

FRED.ASSEMBLE.SOURCE

IBM Speak – Data Set Name

- *Data set name* (DSN or DSName)
 - Think “File Name”
 - 1 to 22 segments
 - segments separated by a period
 - each segment limited to 8 characters
 - Up to **44 characters** (includes periods)
 - **High-level qualifier** (HLQ) is typically your **userid**



Data Set Allocation



IBM Speak – Data Set Allocation

- **Data set allocation**
 - Think “**Create Space**” for a data set on disk

IBM Speak – Data Set Allocation

- **Data set allocation**

- Think “Create Space” for a data set on disk
- Need:
 - Data set **name**
 - **VOLSER** (i.e., the DASD volume) where the space should be allocated
 - Data set **attributes** (Size, RECFM, LRECL, BLKSZE, DSORG)

Check Your
knowledge



Check your knowledge

- What is a VOLSER?



Check your knowledge

- What is a VOLSER? -
 - **Volume Serial Number , name of your disk drive**



Check your knowledge

- What is a VOLSER? -
 - **Volume Serial Number , name of your disk drive**
- What is the maximum length of a z/OS data set name (including periods)?



Check your knowledge

- What is a VOLSER? -
 - **Volume Serial Number , name of your disk drive**
- What is the maximum length of a z/OS data set name (including periods)?
 - **44 Characters**

TSO/E



Interacting with z/OS – TSO

- **End users** (sometimes tens of thousands of them) use the system



Interacting with z/OS – TSO

- **End users** (sometimes tens of thousands of them) use the system
- TSO/E (*Time Sharing Option/Extensions*) allows **users to log on** and interactively **share resources**
 - Supports **limited set** of basic **commands**
 - Sometimes called using TSO in its “**native mode**”

Interacting with z/OS – TSO

```
----- TSO/E LOGON -----  
  
Enter LOGON parameters below:                                RACF LOGON parameters:  
  
Userid    ==> BIBOLET                                       New Password ==>  
  
Password  ==>                                               Group Ident  ==>  
  
Procedure ==> PROC01  
  
Acct Nbr  ==> 1234567  
  
Size      ==> 2096128  
  
Perform   ==>  
  
Command   ==> ex (rablog)  
  
Enter an 'S' before each option desired below:  
          -Nomail          -Nonotice          S -Reconnect          -OIDcard  
  
PF1/PF13 ==> Help      PF3/PF15 ==> Logoff      PA1 ==> Attention      PA2 ==> Reshow  
You may request specific help information by entering a '?' in any entry field
```

You provide your **userid** and **password**



Interacting with z/OS – TSO

```
ICH70001I BIBOLET LAST ACCESS AT 09:22:20 ON THURSDAY, FEBRUARY 23, 2017
ICH70002I YOUR PASSWORD WILL EXPIRE IN 88 DAYS.
IKJ56455I BIBOLET LOGON IN PROGRESS AT 09:25:09 ON FEBRUARY 23, 2017
*****
**          YOU ARE LOGGED ON TO PLPSC          **
*****
**          **
** IBM'S INTERNAL SYSTEMS MUST ONLY BE USED FOR CONDUCTING **
** IBM'S BUSINESS OR FOR PURPOSES AUTHORIZED BY IBM MANAGEMENT. **
** USE IS SUBJECT TO AUDIT AT ANY TIME BY IBM MANAGEMENT. THE **
** MAXIMUM CLASSIFICATION OF DATA ALLOWED ON THIS SYSTEM IS IBM **
** CONFIDENTIAL. **
**
*****
READY
```

READY indicates
TSO will **accept**
commands

ISPF



Interacting with z/OS – ISPF

```
ICH70001I BIBOLET  LAST ACCESS AT 09:22:20 ON THURSDAY, FEBRUARY 23, 2017
ICH70002I YOUR PASSWORD WILL EXPIRE IN  88 DAYS.
IKJ56455I BIBOLET LOGON IN PROGRESS AT 09:25:09 ON FEBRUARY 23, 2017
*****
**                YOU ARE LOGGED ON TO PLPSC                **
*****
**                **
** IBM'S INTERNAL SYSTEMS MUST ONLY BE USED FOR CONDUCTING **
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** MAXIMUM CLASSIFICATION OF DATA ALLOWED ON THIS SYSTEM IS IBM **
** CONFIDENTIAL.                **
**
*****
READY
ispf
```

Because TSO/E
native mode
supports **limited**
functions, most
users go right to **ISPF**



Interacting with z/OS – ISPF

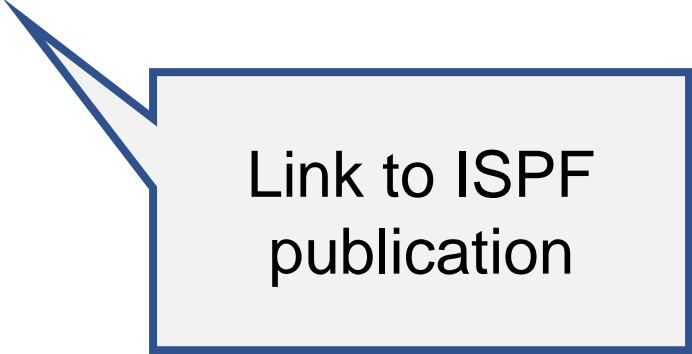
- **ISPF** (*Interactive System Productivity Facility*)
 - Full **panel application**
 - Panels are **hierarchical**

Interacting with z/OS – ISPF

- **ISPF** (*Interactive System Productivity Facility*)
 - Full **panel application**
 - Panels are **hierarchical**
 - **Navigated** via **keyboard**
 - **F7** and **F8 scroll up** (or backwards) and **down** (or forwards)
 - **Enter** (*not right-ctrl*) moves cursor to next input field
 - **Home** moves cursor to first input field
 - [ISPF use of Function Keys](#) – z/OS ISPF User's Guide Vol I

Table 1. Default Values

F1	HELP
F2	SPLIT
F3	END
F4	RETURN
F5	RFIND
F6	RCHANGE
F7	UP
F8	DOWN
F9	SWAP
F10	LEFT
F11	RIGHT
F12	RETRIEVE



Link to ISPF
publication



Interacting with z/OS – ISPF

- **ISPF** (*Interactive System Productivity Facility*)
 - Full **panel application**
 - Panels are **hierarchical**
 - **Navigated via keyboard**
 - **F7** and **F8** scroll **backward** and **forward**
 - **Enter** (*not right-ctrl*) moves cursor to next input field
 - **Home** moves cursor to first input field
 - [ISPF use of Function Keys](#) – z/OS ISPF User's Guide Vol I
 - Provides text **editor** and **browser**



Interacting with z/OS – ISPF

- **ISPF** (*Interactive System Productivity Facility*)
 - Full **panel application**
 - Panels are **hierarchical**
 - **Navigated via keyboard**
 - **F7** and **F8** scroll **backward** and **forward**
 - **Enter** (*not right-ctrl*) moves cursor to next input field
 - **Home** moves cursor to first input field
 - [ISPF use of Function Keys](#)
 - Provides text **editor** and **browser**
 - Data set **utilities**
 - Allocation
 - Deletion
 - Locating and Listing
 - etc.

Interacting with z/OS – ISPF

```
Menu RefList RefMode Utilities Help
                                     Data Set List Utility
Option ==>
                                     More: +
blank Display data set list          P Print data set list
  V Display VTOC information          PV Print VTOC information

Enter one or both of the parameters below:
Dsname Level . . . BIBOLET.*.SOURCE
Volume serial . . .

Data set list options
Initial View
1 1. Volume
  2. Space
  3. Attrib
  4. Total
Enter "/" to select
/ Confirm Data Set Delete
/ Confirm Member Delete
/ Include Additional Qualifiers
/ Display Catalog Name
/ Display Total Tracks
Prefix Dsname Level

When the data set list is displayed, enter either:
"/" on the data set list command field for the command prompt pop-up,
an ISPF line command, the name of a TSO command, CLIST, or REXX exec, or
```

=3.4 takes us to the **Data Set List Utility**

Interacting with z/OS – ISPF

```
Menu RefList RefMode Utilities Help
Data Set List Utility
Option ==>
blank Display data set list          P Print data set list
  V Display VTOC information          PV Print VTOC information
More: +
Enter one or both of the parameters below:
Dsname Level . . . BIBOLET.*.SOURCE
Volume serial . . .
Data set list options
Initial View
1 1. Volume
  2. Space
  3. Attrib
  4. Total
Enter "/" to select option
/ Confirm Data Set Delete
/ Confirm Member Delete
/ Include Attributes
/ Display Catalog
/ Display Total Space
Prefix Dsn
When the data set list is displayed, enter either
"/" on the data set list command field for
an ISPF line command, the name of a TSO command
```

Specify the data set name (or use wildcards) that you want to display and press Enter

Interacting with z/OS – ISPF

```
Menu Options View Utilities Compilers Help
-----
DSLIST - Data Sets Matching BIBOLET.*.SOURCE                               Row 1 of 577
Command ==>                                                                    Scroll ==> CSR

Command - Enter "/" to select action                                         Message                                         Volume
-----
BIBOLET.ADER.SOURCE                                                         MIGRAT2
BIBOLET.ANTK.SOURCE                                                         MIGRAT2
BIBOLET.ANTK.SOURCE.D020113                                                 MIGRAT2
BIBOLET.ANTK.SOURCE.D020413                                                 MIGRAT2
BIBOLET.ANTK.SOURCE.D020613                                                 MIGRAT2
BIBOLET.ANTK.SOURCE.D020713                                                 MIGRAT2
BIBOLET.ANTK.SOURCE.D021113                                                 MIGRAT2
BIBOLET.ANTK.SOURCE.D021413                                                 MIGRAT2
BIBOLET.APAR.SOURCE                                                         MIGRAT2
BIBOLET.ASMCLASS.SOURCE                                                     MIGRAT2
BIBOLET.ASSEMBLE.SOURCE                                                     SL2B0C
BIBOLET.AULT.SOURCE                                                         MIGRAT2
BIBOLET.AUTOACT.SOURCE                                                      MIGRAT2
BIBOLET.AUTOR.SOURCE                                                        MIGRAT2
BIBOLET.AUTOR.SOURCE.LOC                                                    MIGRAT2
BIBOLET.AUTOR.SOURCE.REVIEW1                                               MIGRAT2
BIBOLET.AUTOR.SOURCE.TOOSMALL                                              MIGRAT2
```

Data sets with **BIBOLET** as an **HLQ** and **SOURCE** as the **3rd qualifier** are displayed

Interacting with z/OS – ISPF

```
Menu Options View Utilities Compilers Help
-----
DSLIST - Data Sets Matching BIBOLET.*.SOURCE          Row 1 of 591
Command ==>                                          Scroll ==> CSR

Command - Enter "/" to select action

-----
BIBOLET.ADER.SOURCE                                2
BIBOLET.ANTK.SOURCE                                2
BIBOLET.ANTK.SOURCE.D020113                          2
BIBOLET.ANTK.SOURCE.D020413                          2
BIBOLET.ANTK.SOURCE.D020613                          2
BIBOLET.ANTK.SOURCE.D020713                          2
BIBOLET.ANTK.SOURCE.D020813                          2
BIBOLET.ANTK.SOURCE.D020913                          2
BIBOLET.ANTK.SOURCE.D021013                         MIGRAT2
BIBOLET.ANTK.SOURCE.D021113                         MIGRAT2
BIBOLET.ANTK.SOURCE.D021213                         MIGRAT2
/ BIBOLET.ASMCLASS.SOURCE                           SL732C
BIBOLET.ASSEMBLE.SOURCE                             MIGRAT2
BIBOLET.AULT.SOURCE                                 MIGRAT2
BIBOLET.AUTOACT.SOURCE                              MIGRAT2
BIBOLET.AUTOR.SOURCE                                MIGRAT2
BIBOLET.AUTOR.SOURCE.LOC                            MIGRAT2
BIBOLET.AUTOR.SOURCE.REVIEW1                        MIGRAT2
BIBOLET.AUTOR.SOURCE.TOOSMALL                       MIGRAT2
BIBOLET.AUTARC.D.SOURCE                             MIGRAT2
```

Side note:
To list the available
commands, enter a
slash “ / ”

Interacting with z/OS – ISPF

```
Menu Options View Utilities Compilers Help
-
D                               Data Set List Actions                               1
C
C                               Data Set: BIBOLET.ASSEMBLE.SOURCE                    e
C
-                               DSLIST Action                                     --
1.  Edit                       15. Reset                                         MIGRAT2
2.  View                       16. Move                                         MIGRAT2
3.  Browse                     17. Copy                                         MIGRAT2
4.  Member List                18. Refadd                                       MIGRAT2
5.  Delete                     19. Exclude                                       MIGRAT2
6.  Rename                    20. Unexclude 'NX'                               MIGRAT2
7.  Info                      21. Unexclude first 'NXF'                       MIGRAT2
8.  Short Info                22. Unexclude last 'NXL'                       MIGRAT2
9.  Print                     23. SuperC 'SC'                                  MIGRAT2
10. Catalog                   24. SuperCE 'SCE'                                MIGRAT2
/ 11. Uncatalog               25. Search-For 'SF'                              SL732C
12. Compress                  26. Search-ForE 'SFE'                            MIGRAT2
13. Free                      27. Allocate                                       MIGRAT2
14. Print Index                                             MIGRAT2
                                                                                     MIGRAT2
                                                                                     MIGRAT2
                                                                                     MIGRAT2
                                                                                     MIGRAT2
                                                                                     MIGRAT2
BIBOLET.AUTOR.SOURCE.TOOSMALL
BIBOLET.AUTOR.SOURCE
```

Enter the **number** of the function you desire



Interacting with z/OS – ISPF

```
File Edit Edit_Settings Menu Utilities Compilers Test Help
EDIT      BIBOLET.ASSEMBLE.SOURCE (HELOWRLD) - 01.00      Columns 00001 00072
Command ==>                                         Scroll ==> CSR
***** ***** Top of Data *****
000001      Title 'Hello World Program For The Assembler Class'
000002 HeloWrld AMODE 31      Addressing mode is 31-bit
000003 HeloWrld RMODE 31     Residency mode is 31-bit
000004 HeloWrld CSECT ,
000005      SAVE (14,12)     Save caller's registers
000006      BASR R12,0       Obtain addressability address
000007      USING *,R12     Establish addressability
000008
000009 *****
000010 *      Chain our savearea to the caller's savearea
000011 *****
000012
000013      LA R2,SaveArea      Get address of our savearea
000014      ST R2,8(,R13)      Make caller SA point to our SA
000015      ST R13,SaveArea+4  Make our SA point to our caller's SA X
000016
000017      LR R13,R2            Setup SA to be used by code that we call X
000018
000019
```

You **write** your program!

z/OS UNIX

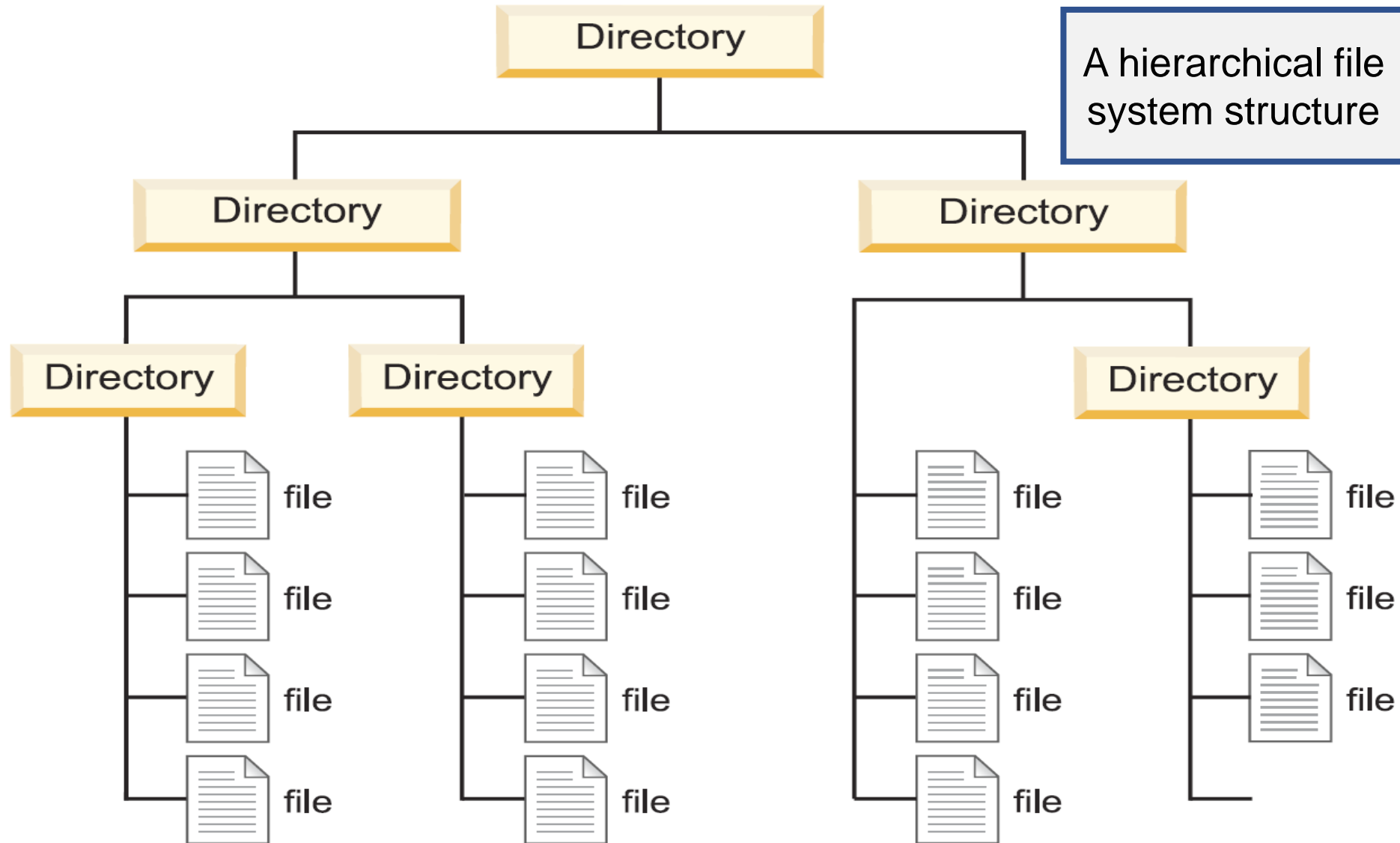


Interacting with z/OS – UNIX

- z/OS UNIX a certified UNIX operating system by the Open Software Foundation
- **z/OS UNIX[®]** provides **another interactive** way to access z/OS
- Before we examine some UNIX functions, we **need to understand** the z/OS UNIX file system
 - In particular, **the zFS** (*zSeries File System*)

UNIX is a registered trademark of The Open Group

Interacting with z/OS – UNIX zFS





Interacting with z/OS – UNIX zFS

- **Path name** identifies a file
 - **Consists** of **directory** names and a **file** name



Interacting with z/OS – UNIX zFS

- **Path name** identifies a file
 - Consists of **directory** names and a **file** name
- Up to **1023** characters



Interacting with z/OS – UNIX zFS

- **Path name** identifies a file
 - Consists of **directory** names and a **file** name
 - Up to **1023** characters
 - Directories and file name **separated by** a forward-slash (/)
`/dir1/dir2/dir3/MyFile`



Interacting with z/OS – UNIX zFS

- **Path name** identifies a file
 - Consists of **directory** names and a **file** name
 - Up to **1023** characters
 - Directories and file name **separated by** a forward-slash (/)
`/dir1/dir2/dir3/MyFile`
 - Names **are case sensitive**



Interacting with z/OS – UNIX zFS

- **Path name** identifies a file
 - Consists of **directory** names and a **file** name
 - Up to **1023** characters
 - Directories and file name **separated by** a forward-slash (/)
`/dir1/dir2/dir3/MyFile`
 - Names are case sensitive
 - All files are **sequential files**



Interacting with z/OS – UNIX

- z/OS UNIX provides **three main environments**
 - **ISHELL**
 - **ISPF panel interface** to z/OS UNIX System Services
 - Good for **users familiar with** TSO and ISPF



Interacting with z/OS – UNIX

- z/OS UNIX provides **three main environments**
 - **ISHELL**
 - ISPF panel interface to z/OS UNIX System Services
 - Good for **users familiar with TSO and ISPF**
 - **OMVS**
 - The z/OS UNIX **shell**
 - Users of **current UNIX systems** find the z/OS UNIX **shell environment familiar**



Interacting with z/OS – UNIX

- z/OS UNIX provides **three main environments**
 - **ISHELL**
 - ISPF panel interface to z/OS UNIX System Services
 - Good for **users familiar with TSO and ISPF**
 - **OMVS**
 - The z/OS UNIX shell
 - Users of **current UNIX systems** find the z/OS UNIX shell environment familiar
 - **Remote UNIX interfaces**
 - z/OS UNIX can be accessed thru standard UNIX interfaces remotely
 - **Telnet, SSH, NFS**

ISHELL

Interacting with z/OS – ISHELL

```
File Directory Special_file Tools File_systems Options Setup Help
-----
                UNIX System Services ISPF Shell

Enter a pathname and do one of these:

- Press Enter.
- Select an action bar choice.
- Specify an action code or command on the command line.

Return to this panel to work with a different pathname.
                                                    More:      +

/u/bibolet
-----
-----
-----

EUID=175

Command ==>
```

Entering **ISHELL** from the TSO **Ready prompt** (TSO native mode) displays this panel

Interacting with z/OS – ISHELL

```
File Directory Special_file Tools File_systems Options Setup Help
-----
          UNIX System Services ISPF Shell

Enter a pathname and do one of these:

- Press Enter.
- Select an action bar choice.
- Specify an action code or command on the command line.

Return to this panel to work with a different pathname.

                                     More:      +

/u/bibolet
-----
-----
-----

EUID=175

Command ==>
```

Press **Enter** to
get a list of files



Interacting with z/OS – ISHELL

```
File Directory Special_file Commands Help
Directory List

Select one or more files with / or action codes. If
action from the action bar otherwise your default ac
with S to use your default action. Cursor select ca
navigation. See help for details.
EUID=175 /u/bibolet/
Type Perm Changed-EST5EDT Owner -----Size Filename Row 1 of 47
_ Dir 555 2017-02-23 13:34 TCP 0 ..
_ File 600 2017-02-23 11:46 BIBOLET 2315 .sh_history
_ Dir 755 2017-02-23 11:46 BIBOLET 8192 .
_ Dir 755 2017-02-23 03:09 BIBOLET 8192 .jazz-scm
_ Dir 700 2017-01-23 10:40 BIBOLET 8192 .ezrtcwi.50397286
_ Dir 755 2017-01-23 10:36 BIBOLET 8192 HBB77B0
_ Dir 700 2017-01-04 12:39 BIBOLET 8192 .ezrtcwi.33620188
_ Dir 700 2016-10-26 11:43 BIBOLET 8192 .ezrtcwi.33620049
_ Dir 700 2016-09-23 10:04 BIBOLET 8192 .ezrtcwi.50397473
_ Dir 700 2016-09-22 13:41 BIBOLET 8192 .ezrtcwi.83952394
_ Dir 700 2016-08-23 15:53 BIBOLET 8192 .ezrtcwi.67175005
_ Dir 700 2016-08-10 15:23 BIBOLET 8192 .ezrtcwi.33620238
_ Dir 700 2016-08-10 13:33 BIBOLET 8192 .ezrtcwi.33620533
Command ==>
```

This panel is **tailorable** so your data may be displayed differently



Interacting with z/OS – ISHELL

```

File Edit Edit_Settings Menu Utilities Compilers Test Help
-----
EDIT      /u/bibolet/assemble/source/helowrld          Columns 00001 00072
Command ==>                                         Scroll ==> PAGE
***** Top of Data *****
==MSG> -Warning- The UNDO command is not available until you change
==MSG>                your edit profile using the command RECOVERY ON.
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
***** Bottom of Data *****

```

OMVS

Interacting with z/OS – OMVS

- **OMVS** is the command to invoke the z/OS UNIX shell
- **Specify:**
 - At the TSO **READY** prompt
 - From the ISPF **Command Shell** (option 6)
 - From an ISPF **panel input field**

```
Menu RefList RefMode Utilities Help
Data Set List Utility
Option ==> tso omvs
blank Display data set list          P Print data set list
V Display VTOC information           PV Print VTOC information
Enter one or both of the parameters below:
Dsname Level . . .
Volume serial . . .
```



Interacting with z/OS – OMVS

```
IBM
Licensed Material - Property of IBM
5650-ZOS Copyright IBM Corp. 1993, 2015
(C) Copyright Mortice Kern Systems, Inc., 1985, 1996.
(C) Copyright Software Development Group, University of Waterloo, 1989.

U.S. Government Users Restricted Rights -
Use, duplication or disclosure restricted by
GSA ADP Schedule Contract with IBM Corp.

IBM is a registered trademark of the IBM Corp.

you have mail in /usr/mail/BIBOLET.
$

===>

INPUT
ESC=␣  1=Help      2=SubCmd    3=HlpRetrn  4=Top       5=Bottom   6=TSO
        7=BackScr   8=Scroll   9=NextSess 10=Refresh  11=FwdRetr 12=Retrieve
```

Opening screen

Interacting with z/OS – OMVS

```
drwxr-xr-x 27 BIBOLET DEPTD60 8192 Oct 15 2014 HBB77A0
drwxr-xr-x 24 BIBOLET DEPTD60 8192 Jan 23 10:36 HBB77B0
-rwxr-xr-x 1 BIBOLET DEPTD60 42 Mar 6 2015 LOGFILE
drwx----- 3 BIBOLET DEPTD60 8192 Feb 23 14:44 assemble
drwxr-xr-x 2 BIBOLET DEPTD60 352 Feb 4 2011 cmvclogdir
-rw-rw-rw- 1 TCP DEPTD60 1240 Mar 22 2016 dead.letter
-rwxr-xr-x 1 BIBOLET DEPTD60 0 Oct 15 2014 ezc.diag.err
-rwxr-xr-x 1 BIBOLET DEPTD60 647 Oct 15 2014 ezc.diag.out
-rwxr-xr-x 1 BIBOLET DEPTD60 49 May 6 2015 hbb77b0.extract
drwxr-xr-x 2 BIBOLET DEPTD60 320 May 23 2009 i-1-1-1-1-1-1
drwxr-xr-x 2 BIBOLET DEPTD60 256 Mar 1 2011 i-1-1-1-1-1-1
-rwxr-xr-x 1 BIBOLET DEPTD60 0 May 6 2011 i-1-1-1-1-1-1
-rwxr-xr-x 1 BIBOLET DEPTD60 16760 Dec 7 2011 i-1-1-1-1-1-1
-rwxr-xr-x 1 BIBOLET DEPTD60 116617 Mar 1 2011 i-1-1-1-1-1-1
-rwxr-xr-x 1 BIBOLET DEPTD60 117494 Feb 18 2011 i-1-1-1-1-1-1
-rwxr-xr-x 1 BIBOLET DEPTD60 117494 Feb 18 2011 i-1-1-1-1-1-1
-rwxr-xr-x 1 BIBOLET DEPTD60 117087 Feb 18 2011 i-1-1-1-1-1-1
-rwxr-xr-x 1 BIBOLET DEPTD60 117087 Feb 18 2011 i-1-1-1-1-1-1
drwxr-xr-x 2 BIBOLET DEPTD60 352 Mar 2 2011 i-1-1-1-1-1-1
$
===> cd assemble/source
```

RUNNING

```
ESC=⌘ 1=Help 2=SubCmd 3=HlpRetrn 4=Top 5=Bottom 6=TSO
7=BackScr 8=Scroll 9=NextSess 10=Refresh 11=FwdRetr 12=Retrieve
```

We use the **cd** command to **change** our **working directory**



Interacting with z/OS – OMVS

```
drwxr-xr-x    24 BIBOLET  DEPTD60    8192 Jan 23 10:36 HBB77B0
-rwxr-xr-x     1 BIBOLET  DEPTD60     42 Mar  6 2015 LOGFILE
drwx-----   3 BIBOLET  DEPTD60    8192 Feb 23 14:44 assemble
drwxr-xr-x    2 BIBOLET  DEPTD60    352 Feb  4 2011 cmvclogdir
-rw-rw-rw-    1 TCP      DEPTD60   1240 Mar 22 2016 dead.letter
-rwxr-xr-x    1 BIBOLET  DEPTD60     0 Oct 15 2014 ezc.diag.err
-rwxr-xr-x    1 BIBOLET  DEPTD60    647 Oct 15 2014 ezc.diag.out
-rwxr-xr-x    1 BIBOLET  DEPTD60    49 May  6 2015 hbb77b0.extract
drwxr-xr-x    2 BIBOLET  DEPTD60    320 May 23 2008 jcljobs
drwxr-xr-x    2 BIBOLET  DEPTD60    256 Mar  1 2010 new
-rwxr-xr-x    1 BIBOLET  DEPTD60     0 May  6 2015 nohup.out
-rwxr-xr-x    1 BIBOLET  DEPTD60  16760 Dec  7 2009 ted
-rwxr-xr-x    1 BIBOLET  DEPTD60 116617 Mar  1
-rwxr-xr-x    1 BIBOLET  DEPTD60 117494 Feb 18
-rwxr-xr-x    1 BIBOLET  DEPTD60 117494 Feb 18
-rwxr-xr-x    1 BIBOLET  DEPTD60 117087 Feb 19
-rwxr-xr-x    1 BIBOLET  DEPTD60     0 Feb 19
drwxr-xr-x    2 BIBOLET  DEPTD60    256 Feb 19
$ cd assemble/source
$
===> ls -al
```

Now **list the files** in
our **working**
directory

RUNNING

ESC=⌘ 1=Help 2=SubCmd 3=HlpRetrn 4=Top 5=Bottom 6=TSO
7=BackScr 8=Scroll 9=NextSess 10=Refresh 11=FwdRetr 12=Retrieve

Interacting with z/OS – OMVS

```
-rwxr-xr-x 1 BIBOLET DEPTD60 0 Oct 15 2014 ezc.diag.err
-rwxr-xr-x 1 BIBOLET DEPTD60 647 Oct 15 2014 ezc.diag.out
-rwxr-xr-x 1 BIBOLET DEPTD60 49 May 6 2015 hbb77b0.extract
drwxr-xr-x 2 BIBOLET DEPTD60 320 May 23 2008 jcljobs
drwxr-xr-x 2 BIBOLET DEPTD60 256 Mar 1 2010 new
-rwxr-xr-x 1 BIBOLET 6 2015 nohup.out
-rwxr-xr-x 1 BIBOLET 7 2009 ted
-rwxr-xr-x 1 BIBOLET 1 2010 ted.aqhfs
-rwxr-xr-x 1 BIBOLET 18 2010 ted.big
-rwxr-xr-x 1 BIBOLET 18 2010 ted.biger
-rwxr-xr-x 1 BIBOLET 19 2010 ted.ipcs
-rwxr-xr-x 1 BIBOLET 18 2010 ted.stuff
drwxr-xr-x 2 BIBOLET DEPTD60 Mar 2 2010 ted1
$ cd assemble/source
$ ls -al
total 48
drwx----- 2 BIBOLET DEPTD60 8192 Feb 23 15:00 .
drwx----- 3 BIBOLET DEPTD60 8192 Feb 23 14:44 ..
-rwx----- 1 BIBOLET DEPTD60 1892 Feb 23 14:54 helowrld
$
===>
```

Here we have our **helowrld** file

RUNNING

ESC=⌘ 1=Help 2=SubCmd 3=HlpRetrn 4=Top 5=Bottom 6=TSO
7=BackScr 8=Scroll 9=NextSess 10=Refresh 11=FwdRetr 12=Retrieve

Interacting with z/OS – OMVS

```
-rwxr-xr-x  1 BIBOLET  DEPTD60      0 Oct 15  2014 ezc.diag.err
-rwxr-xr-x  1 BIBOLET  DEPTD60    647 Oct 15  2014 ezc.diag.out
-rwxr-xr-x  1 BIBOLET  DEPTD60     49 May  6  2015 hbb77b0.extract
drwxr-xr-x  2 BIBOLET  DEPTD60    320 May 23  2008 jcljobs
drwxr-xr-x  2 BIBOLET  DEPTD60    256 Mar  1  2010 new
-rwxr-xr-x  1 BIBOLET  DEPTD60      0 May  6  2015 nohup.out
-rwxr-xr-x  1 BIBOLET  DEPTD60   16760 Dec  7  2008
-rwxr-xr-x  1 BIBOLET  DEPTD60  116617 Mar  1  2008
-rwxr-xr-x  1 BIBOLET  DEPTD60  117494 Feb 18  2008
-rwxr-xr-x  1 BIBOLET  DEPTD60  117494 Feb 18  2008
-rwxr-xr-x  1 BIBOLET  DEPTD60  117087 Feb 19  2008
-rwxr-xr-x  1 BIBOLET  DEPTD60      0 Feb 18  2008
drwxr-xr-x  2 BIBOLET  DEPTD60    288 Mar  1  2008
$ cd assemble/source
$ ls -al
total 48
drwx-----  2 BIBOLET  DEPTD60    8192 Feb 23 15:09 .
drwx-----  3 BIBOLET  DEPTD60    8192 Feb 23 14:44 ..
-rwx-----  1 BIBOLET  DEPTD60    1892 Feb 23 14:54 helowrld
$
==> oedit helowrld
```

RUNNING

```
ESC=⌘  1=Help      2=SubCmd    3=HlpRetrn  4=Top       5=Bottom    6=TSO
        7=BackScr   8=Scroll    9=NextSess 10=Refresh  11=FwdRetr  12=Retrieve
```

We use the **oedit** command to **edit the file**



Interacting with z/OS – OMVS

```
File Edit Edit_Settings Menu Utilities Compilers Test Help
EDIT      /u/bibolet/assemble/source/helowrld      Columns 00001 00072
Command ==>                                     Scroll ==> CSR
***** Top of Data *****
000001      Title 'Hello World Program For The Assembler Class'
000002 HeloWrld AMODE 31      Addressing mode is 31-bit
000003 HeloWrld RMODE 31      Residency mode is 31-bit
000004 HeloWrld CSECT ,
000005      SAVE (14,12)      Save caller's registers
000006      BASR R12,0      Obtain addressability address
000007      USING *,R12      Establish addressability
000008
000009 *****
000010 *      Chain our savearea to the caller's savearea
000011 *****
000012
000013      LA R2,SaveArea      Get address of our savearea
000014      ST R2,8(,R13)      Make caller SA point to our SA
000015      ST R13,SaveArea+4      Make our SA point to our      X
000016      caller's SA
000017      LR R13,R2      Setup SA to be used by code      X
000018      that we call
000019
```

Remote UNIX Interfaces



Interacting with z/OS - Telnet

- Remote command execution
- Connection may be encrypted
- Automatically converts EBCDIC on the mainframe side to ASCII on the user side
- Telnet client is needed
- Userid/password of valid z/OS userid required

Interacting with z/OS – Telnet



The image shows two windows from a Windows desktop. On the left is the 'PuTTY Configuration' dialog box. The 'Category' list on the left includes Session, Terminal, Window, and Connection. The 'Basic options for your PuTTY session' section is active, showing 'Host Name (or IP address)' as 'hostname.ibm.com' and 'Port' as '23'. The 'Connection type' section has 'Telnet' selected. The 'Saved Sessions' list contains 'Default Settings'. The 'Close window on exit' section has 'Only on clean exit' selected. At the bottom are 'About', 'Help', 'Open', and 'Cancel' buttons.

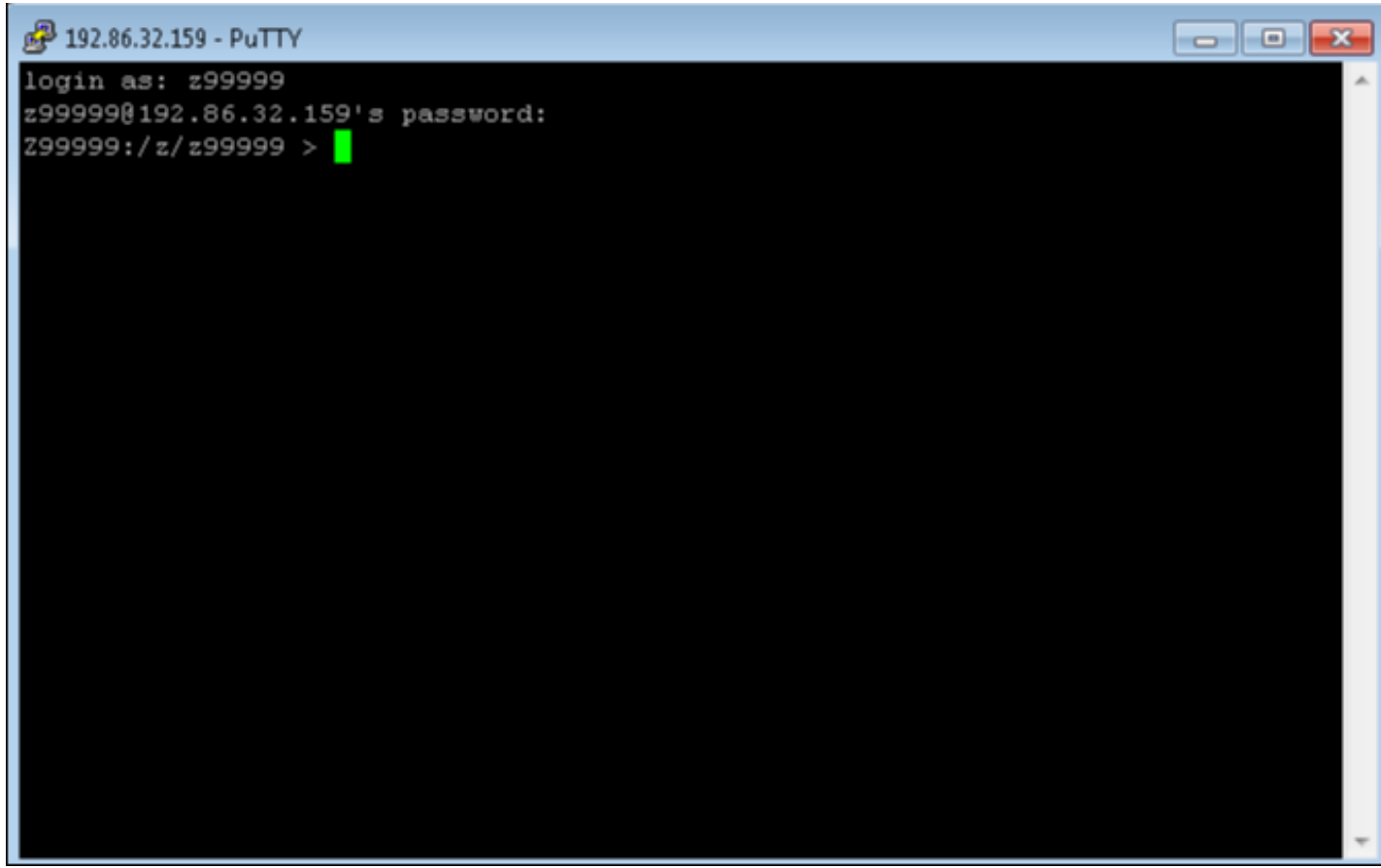
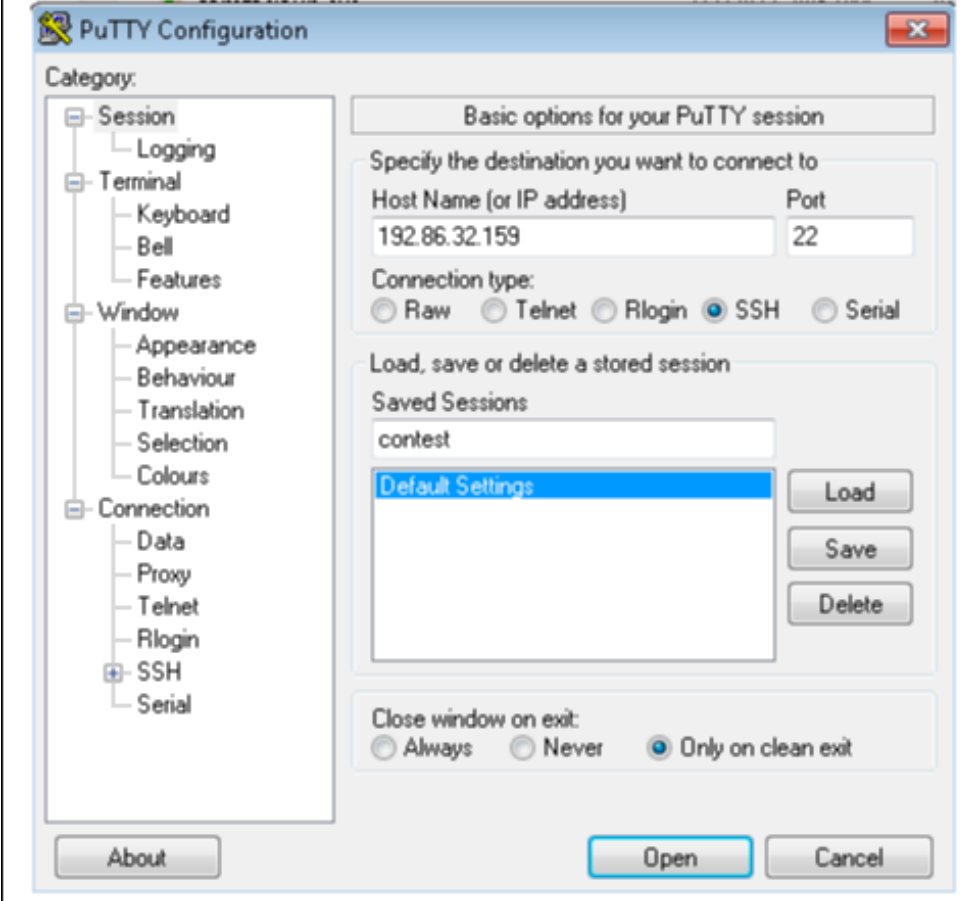
On the right is a terminal window titled 'hostname.ibm.com - PuTTY'. It displays a multi-line warning message enclosed in asterisks: 'IBM's internal systems must only be used for conducting IBM's business or for purposes authorized by IBM management. Use is subject to audit at any time by IBM management.' Below this is a line of asterisks, followed by the text: 'IBM Licensed Material - Property of IBM 5650-ZOS Copyright IBM Corp. 1993, 2017 (C) Copyright Mortice Kern Systems, Inc., 1985, 1996. (C) Copyright Software Development Group, University of Waterloo, 1989. U.S. Government Users Restricted Rights - Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp. IBM is a registered trademark of the IBM Corp. leaving .setup_dev /u/swarren:>'. The prompt is followed by a green cursor.

Interacting with z/OS – SSH



- Remote command execution
- Connection is encrypted
- Automatically converts EBCDIC on the mainframe side to ASCII on the user side
- SSH client is needed
- Public/private encryption key pair needs to be generated
 - No userid/password needs to be specified
 - Public key needs to be stored on z/OS

Interacting with z/OS – SSH





Interacting with z/OS – SSH

A screenshot of a PuTTY terminal window titled "192.86.32.159 - PuTTY". The terminal shows the following text:

```
login as: z99999
z99999@192.86.32.159's password:
Z99999:/z/z99999 > ls
zfile
Z99999:/z/z99999 > cat zfile
```

The terminal text is displayed in a monospaced font on a black background. The prompt character is uppercase 'Z'. The cursor is visible at the end of the last command line.



Interacting with z/OS – NFS

- Network file system
 - Acts as a file server to remote systems
- Client sees data sets or files as if they are local resources
- Access to both traditional z/OS data sets and z/OS UNIX files
- Connection may be encrypted
- Automatically converts EBCDIC on the mainframe side to ASCII on the user side
- NFS client is needed
- mvslogin command required to logon to z/OS
- mount command used to make a connection between a drive letter of local system and z/OS data sets or z/OS UNIX directories



Interacting with z/OS – NFS

```
c:\znfs-client-utils>mvslogin mvshost smith
GFSA968I UNIX uid=502/gid=1000 for user JSmith obtained
from local passwd file.
Password required
GFSA973A Enter MVS password for SMITH: ****
GFSA955I SMITH logged in ok.
```

```
c:\znfs-client-utils>mount \\mvshost\mvs\smith J:
J: is now successfully connected to \\mvshost\mvs\smith
The command completed successfully.
```

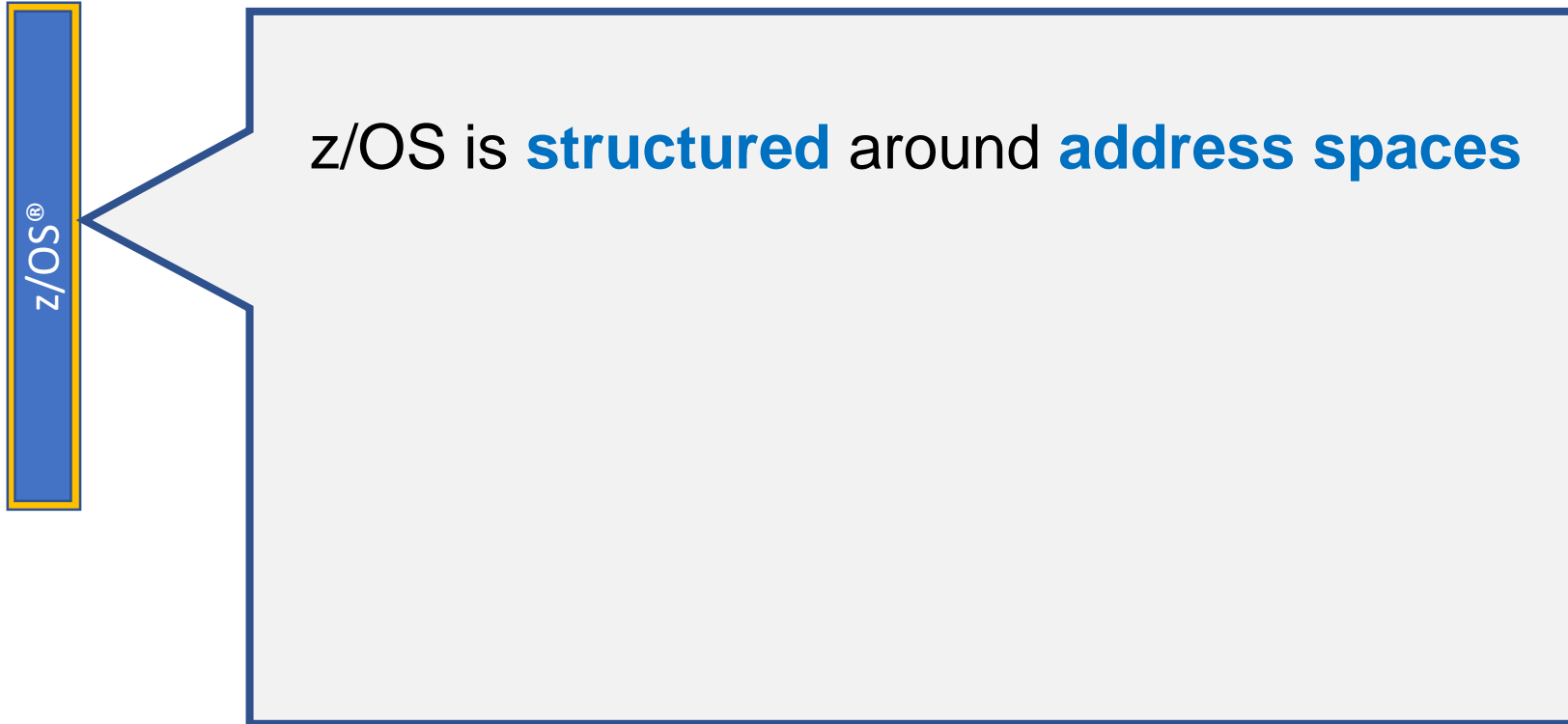
```
c:\znfs-client-utils> J:
```

```
j:\>
```

Address Spaces



z/OS Address Spaces





z/OS Address Spaces



z/OS is **structured** around **address spaces**

Address spaces **are ranges of addresses** in virtual storage



z/OS Address Spaces

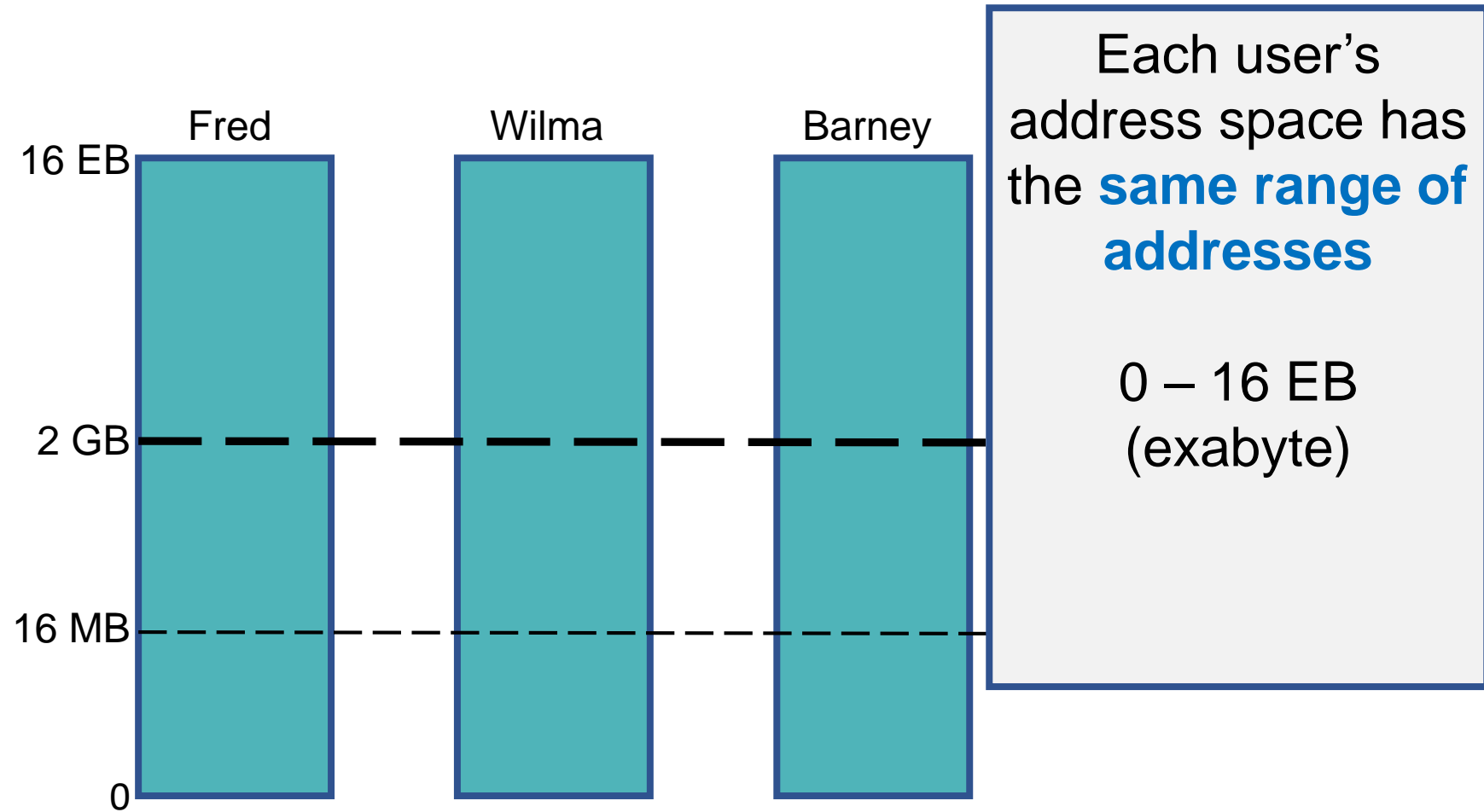


z/OS is **structured** around **address spaces**

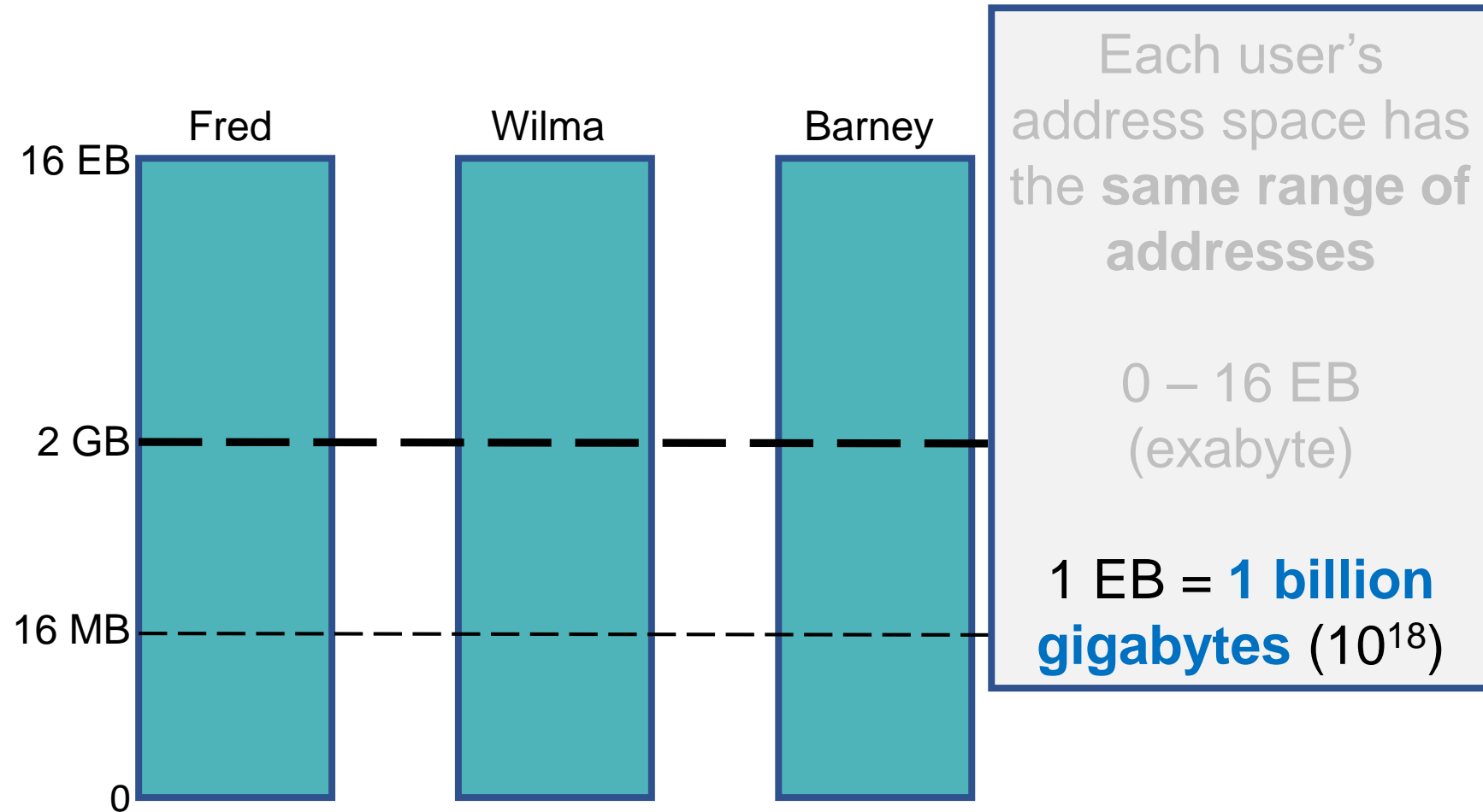
Address spaces are **ranges of addresses** in virtual storage

Each user gets an **address space** containing the **same range of addresses**

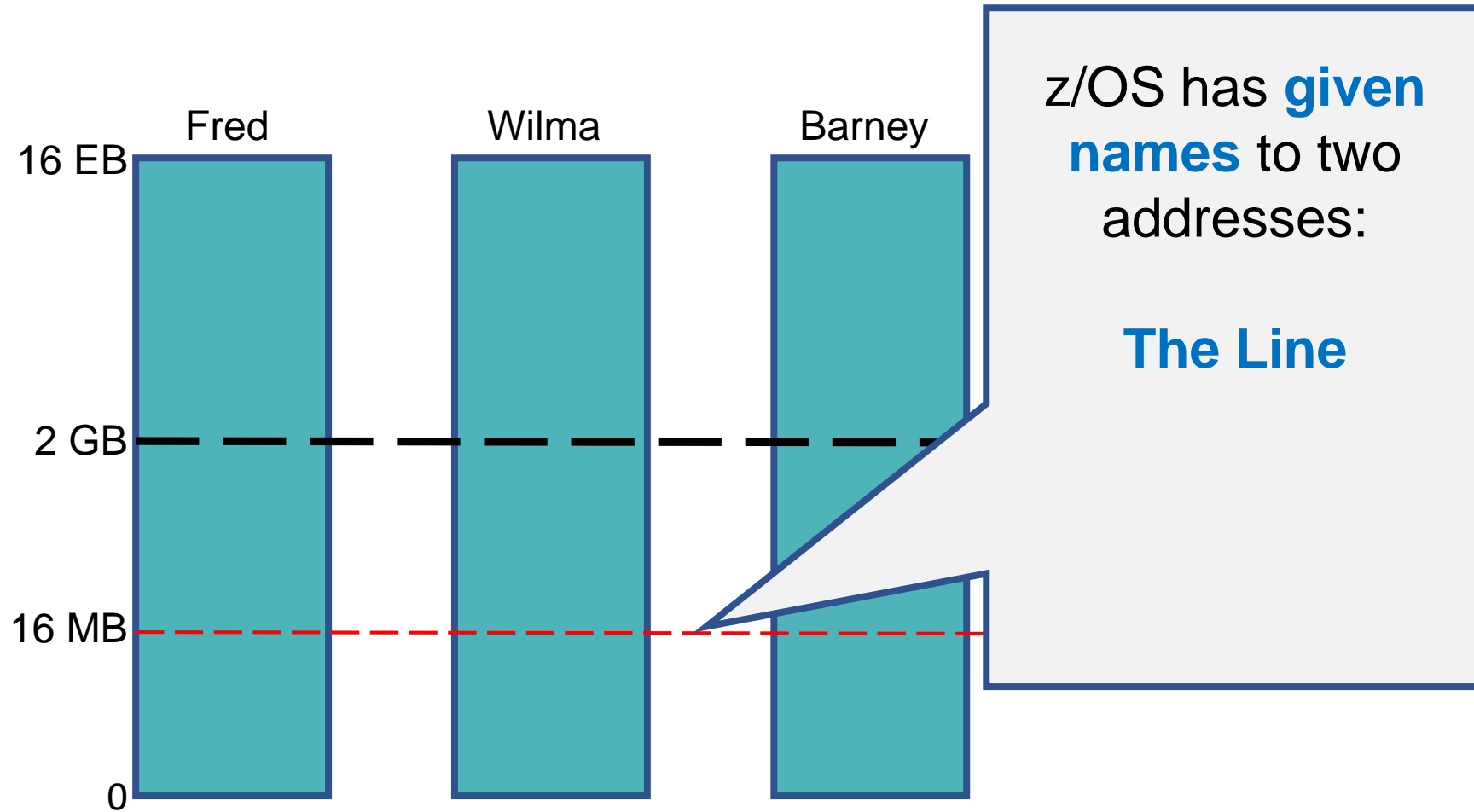
z/OS Address Spaces



z/OS Address Spaces

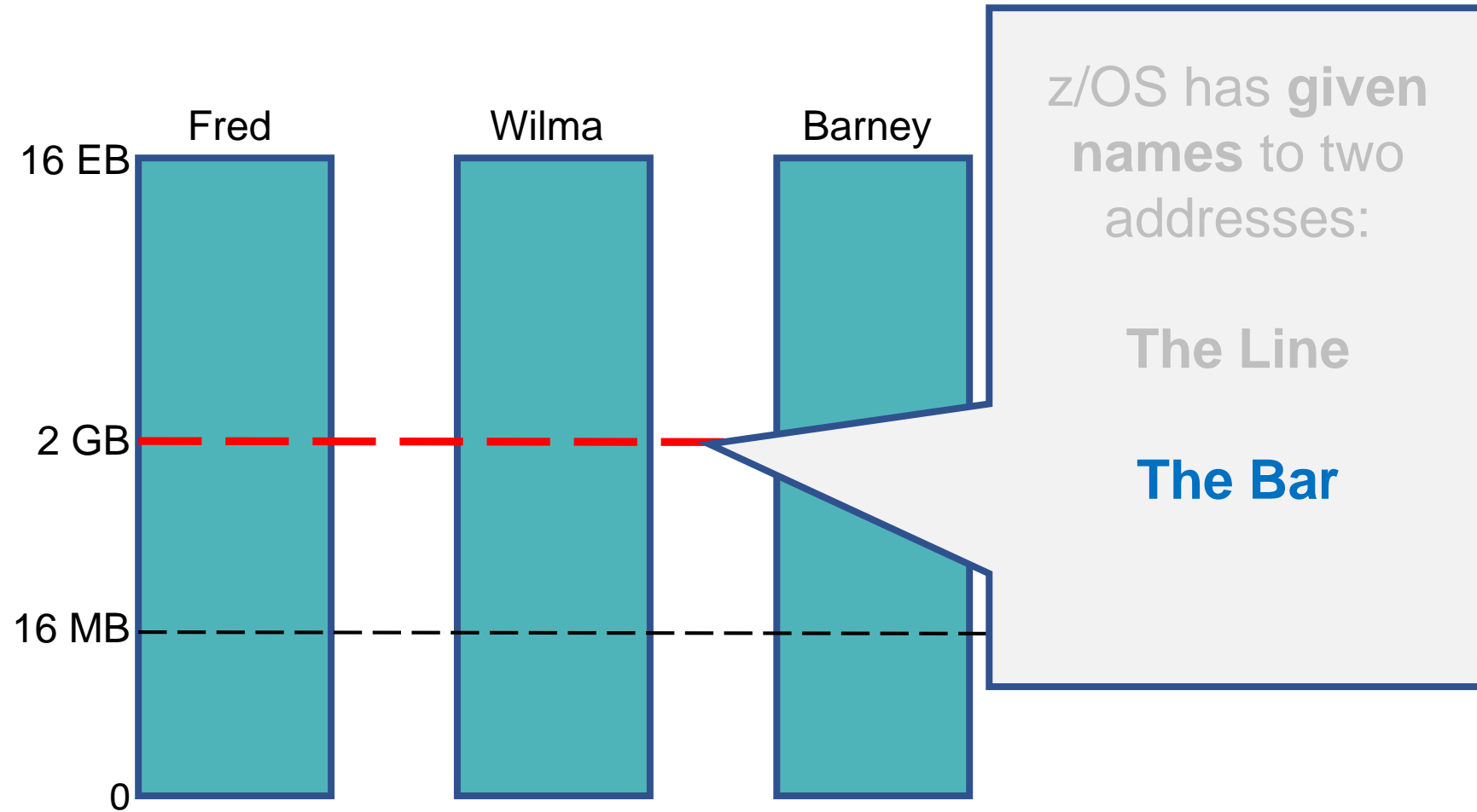


z/OS Address Spaces

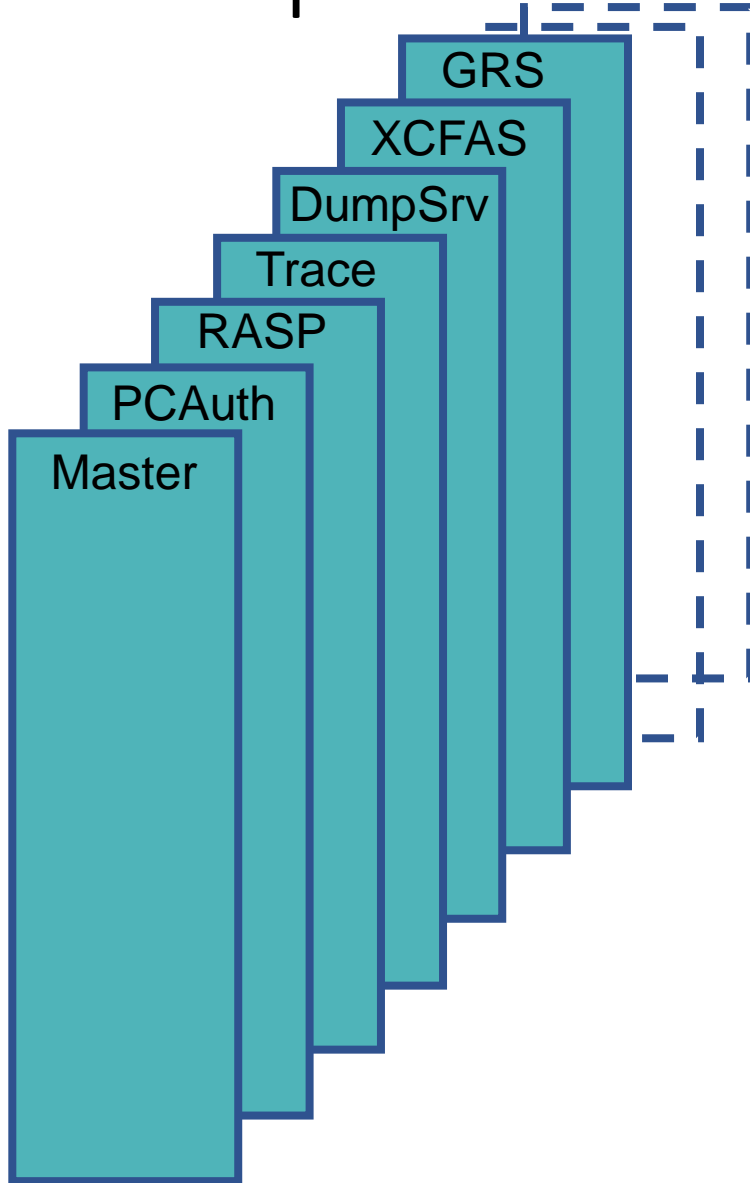




z/OS Address Spaces

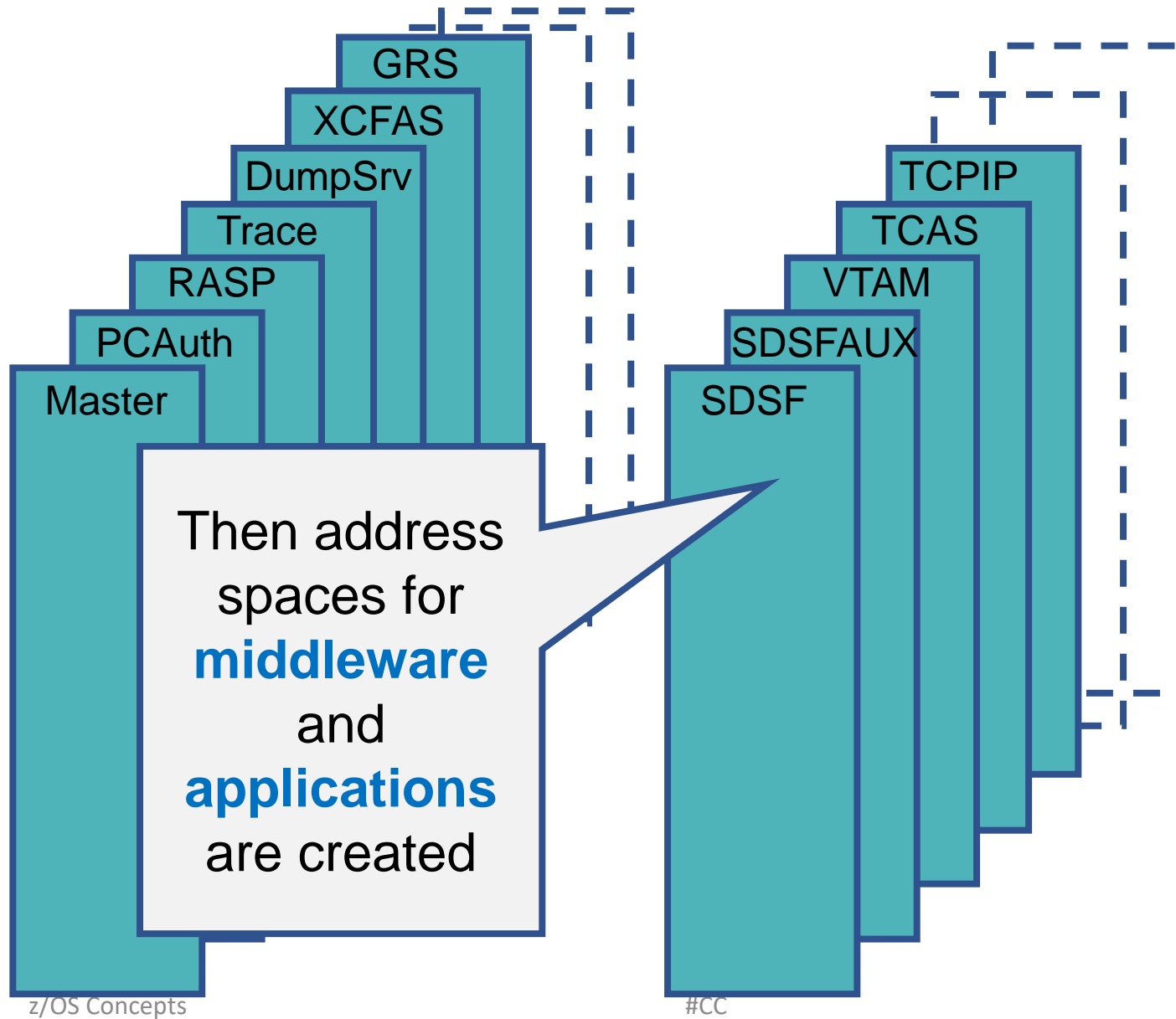


z/OS Address Spaces



Besides an address space for each user, **z/OS creates address spaces (~35)** for some of its **internal components**

z/OS Address Spaces



z/OS Address Spaces

```

SDSF DA S0W1      S0W1      PAG 0
COMMAND INPUT ==>
PREFIX=*  DEST=(ALL)  OWNER=*  S
NP      JOBNAME    StepName ProcStep
*MASTER*
PCAUTH  PCAUTH
RASP    RASP
TRACE   TRACE
DUMPSRV DUMPSRV  DUMPSRV
XCFAS   XCFAS   IEFPROC
GRS     GRS
SMSPDSE SMSPDSE
CONSOLE CONSOLE
WLM     WLM       IEFPROC
ANTMAIN ANTMAIN  IEFPROC
ANTAS000 ANTAS000 IEFPROC
DEVMAN  DEVMAN  IEFPROC
GTZ     GTZ
OMVS    OMVS
IEFSCHAS IFSCHAS
JESXCF  JESXCF  IEFPROC
ALLOCAS ALLOCAS
SMS     SMS     IEFPROC
IOSAS   IOSAS   IEFPROC
IXGLOGR IXGLOGR IEFPROC
AXR     AXR     IEFPROC
CEA     CEA     IEFPROC
SMF     SMF     IEFPROC
RESOLVER RESOLVER EZBREINI
LLA     LLA
JES2MON JES2MON IEFPROC
JES2    JES2   IEFPROC
VLF     VLF
TN3270C TN3270C TN3270
SDSF    SDSF
EPWFFST FFST     EPWFFST
DBBGMSTR DBBGMSTR IEFPROC
JMON     JMON     JMON
HZSPROC HZSPROC HZSSTEP
SDSFAUX SDSFAUX SDSFAUX

```

Address spaces listed in SDSF

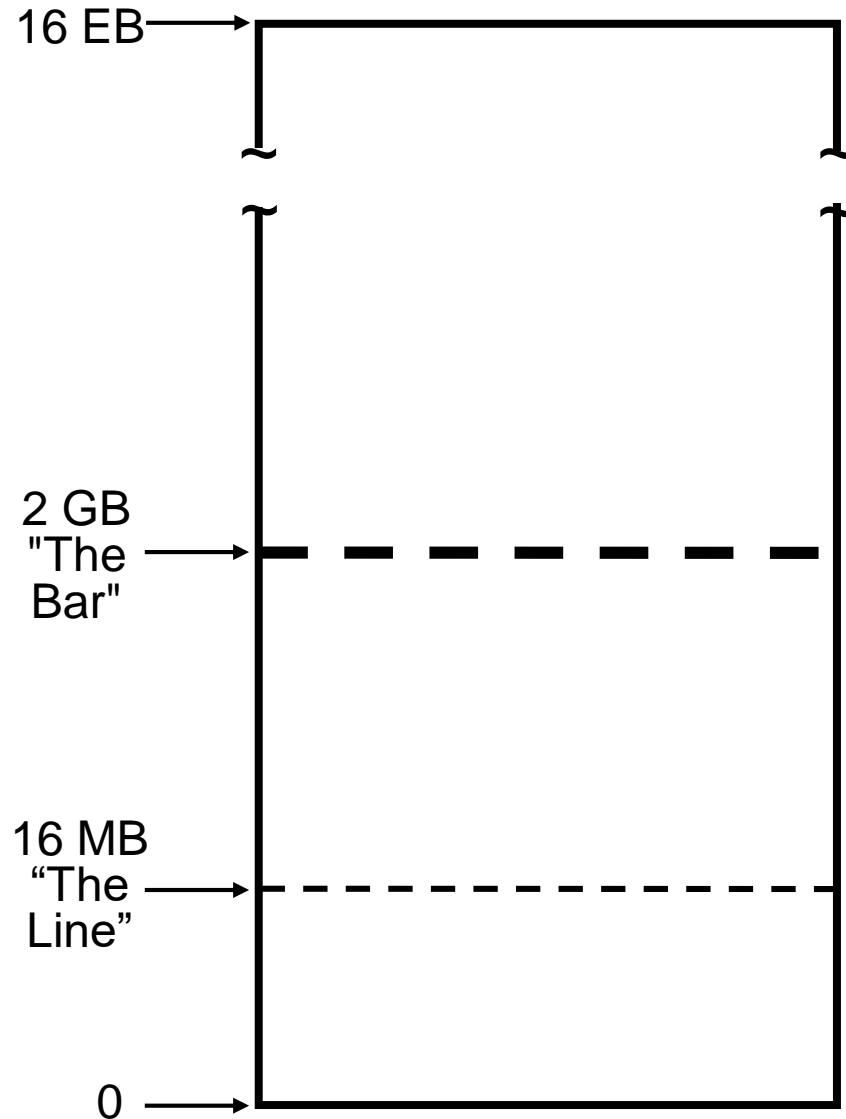
```

SDSF DA S0W1      S0W1      PAG 0
COMMAND INPUT ==>
PREFIX=*  DEST=(ALL)  OWNER=*  S
NP      JOBNAME    StepName ProcStep
EPWFFST EPWFFST FFST     EPWFFST
DBBGMSTR DBBGMSTR IEFPROC
JMON     JMON     JMON
HZSPROC HZSPROC HZSSTEP
SDSFAUX SDSFAUX SDSFAUX
VTAM     VTAM
DBBGIRLM DBBGIRLM
RRS      RRS
RSED3    STEP1
OAM      OAM      IEFPROC
RACF     RACF     RACF
CATALOG  CATALOG  IEFPROC
ZFS      ZFS      ZFZGO
JES2AUX  JES2AUX
DBBGDBM1 DBBGDBM1 IEFPROC
DBBGADMT DBBGADMT STARTADM
RSED3    STEP1
BPX0INIT BPX0INIT BPX0INIT
SSHD1    STEP1
RSED1    STEP1
FTPSEVER STEP1
DBBGDIST DBBGDIST IEFPROC
RSED2    STEP1
TNF      TNF      IEFPROC
RSED     RSED     RSED
CSF      CSF      CSF
VMCF     VMCF     IEFPROC
TCPIP    TCPIP    TCPIP
TN3270   TN3270   TN3270
EXITMVS  EXITMVS  ST01
TCAS     TCAS     TCAS
RSED4    STEP1
RSED5    STEP1
SSHD7    STEP1
SSHD6    STEP1
AU00880  *OMVSEX

```

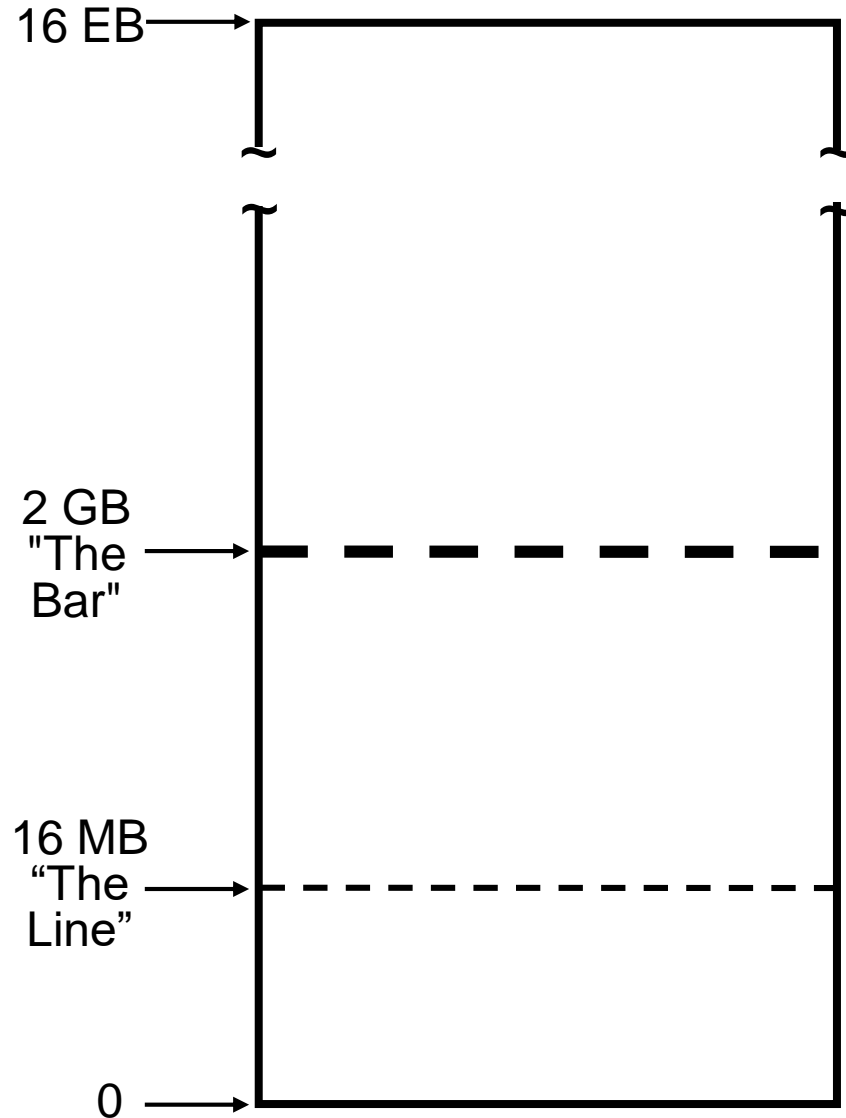
What makes up an
Address Space?

What Makes Up an Address Space?



So you have 16 exabytes **all for your use. Right?**

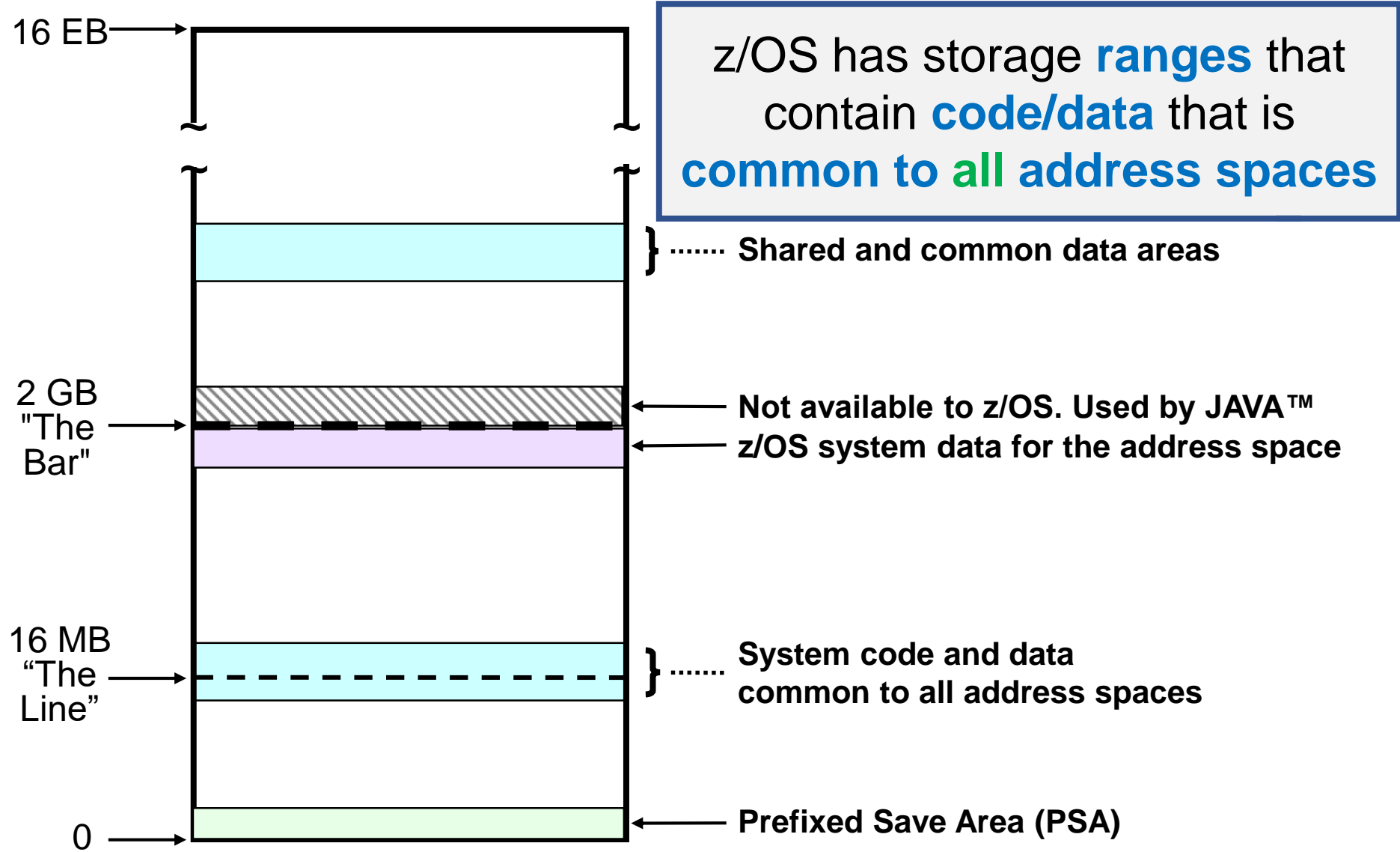
What Makes Up an Address Space?



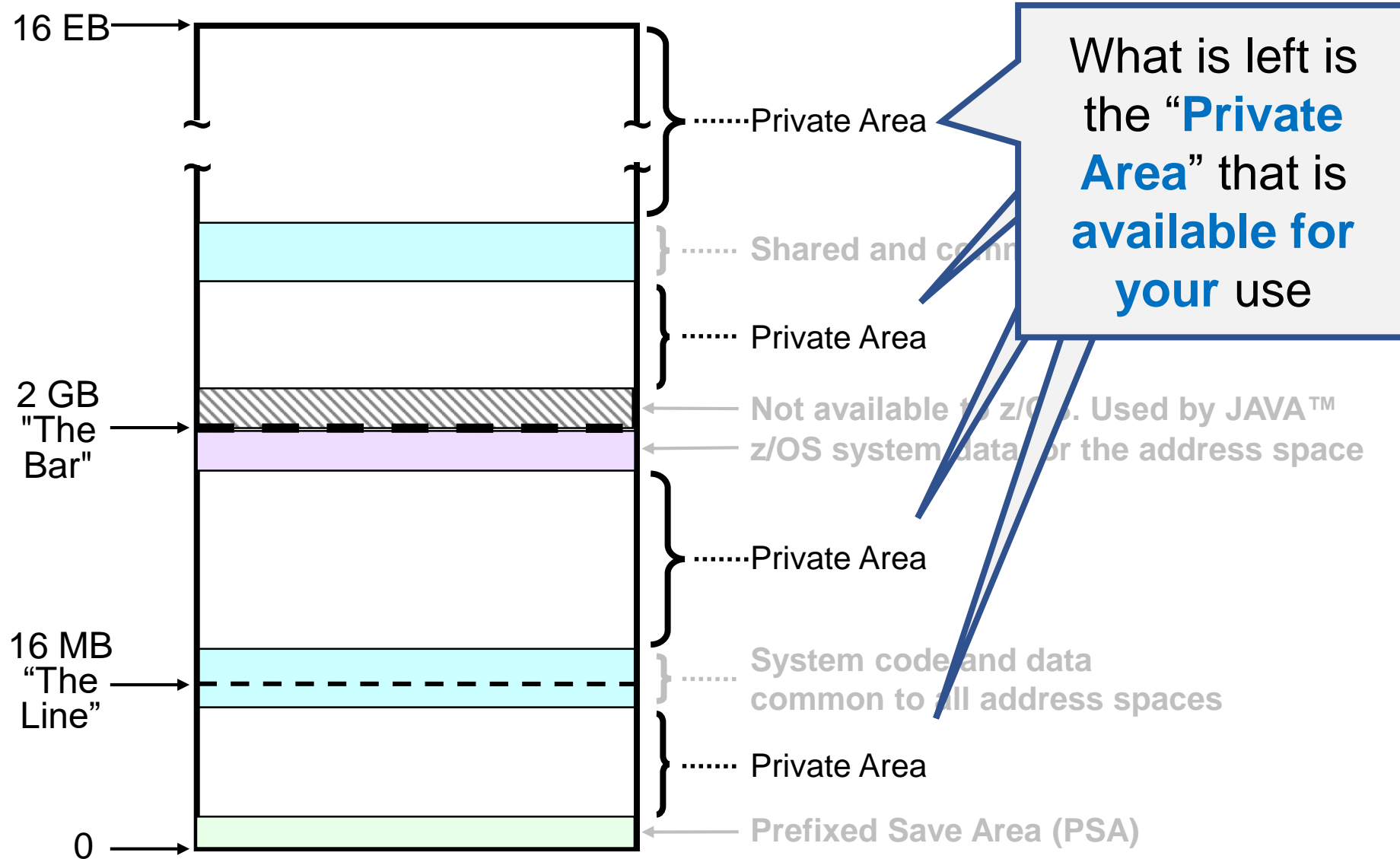
So you have 16 exabytes **all for your use. Right?**

Wrong!

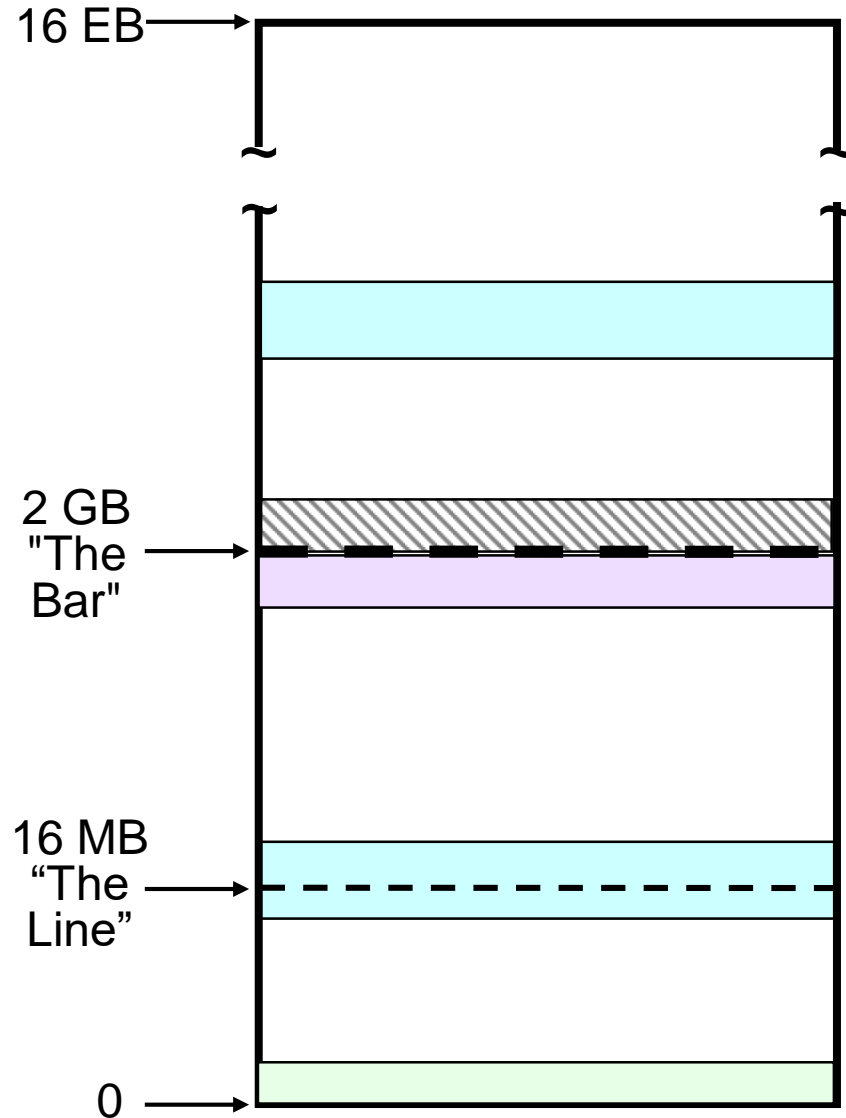
What Makes Up an Address Space?



What Makes Up an Address Space?



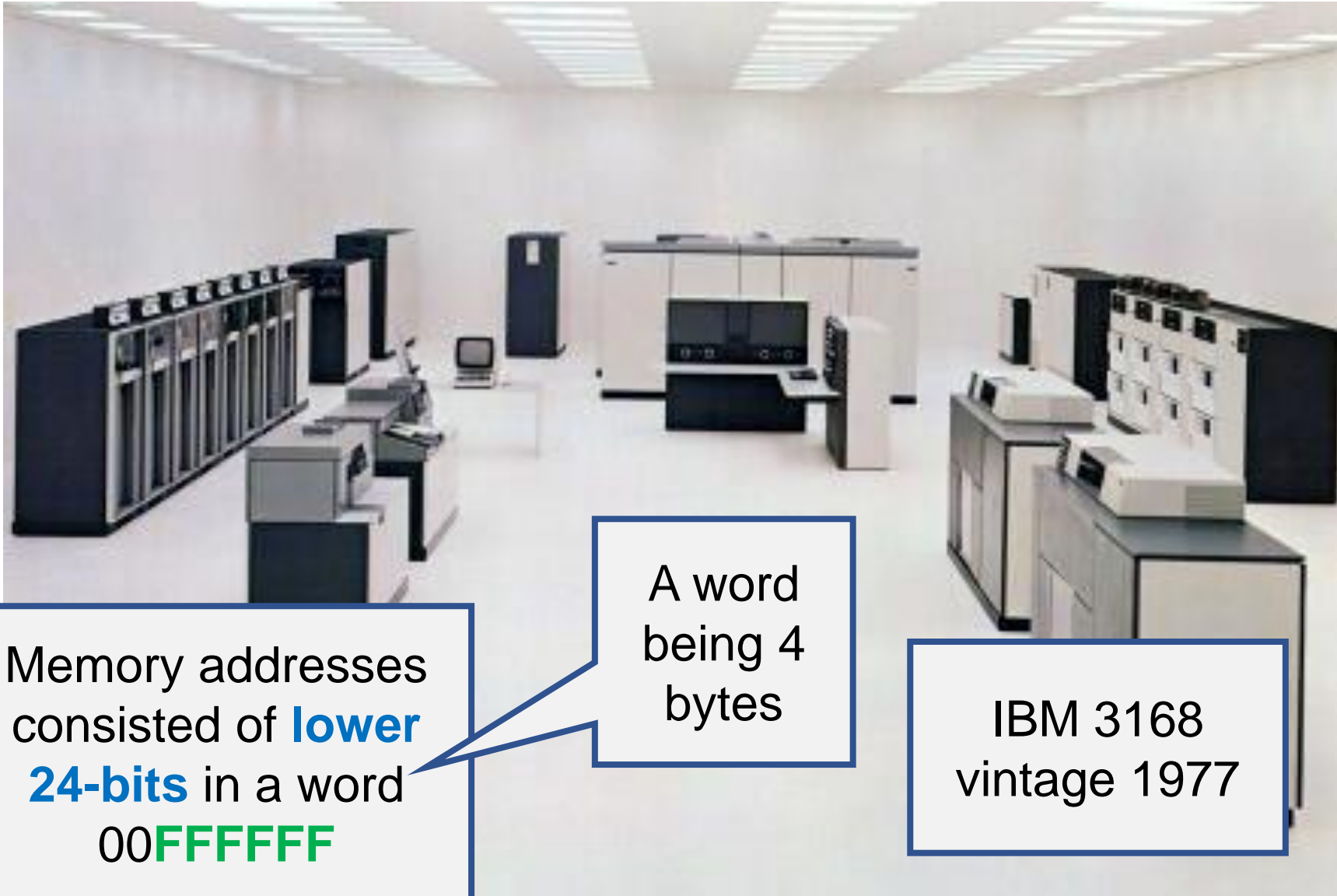
What Makes Up an Address Space?



But **how much**
can your
program see
(i.e., **address**)?

Addressing Modes

Addressing Modes



Memory addresses consisted of **lower 24-bits** in a word
00**FFFFFF**

A word being 4 bytes

IBM 3168
vintage 1977

Addressing Modes



Memory addresses consisted of **lower 24-bits** in a word
00FFFFFF

Memory Addressability
range:
0 – 16,777,215 bytes
or
16,777,216 bytes
or
16 MB

Addressing Modes

An address space **size** is **limited to** the amount of **memory that can be addressed**

In 1977, an address space was **limited to 16 MB**



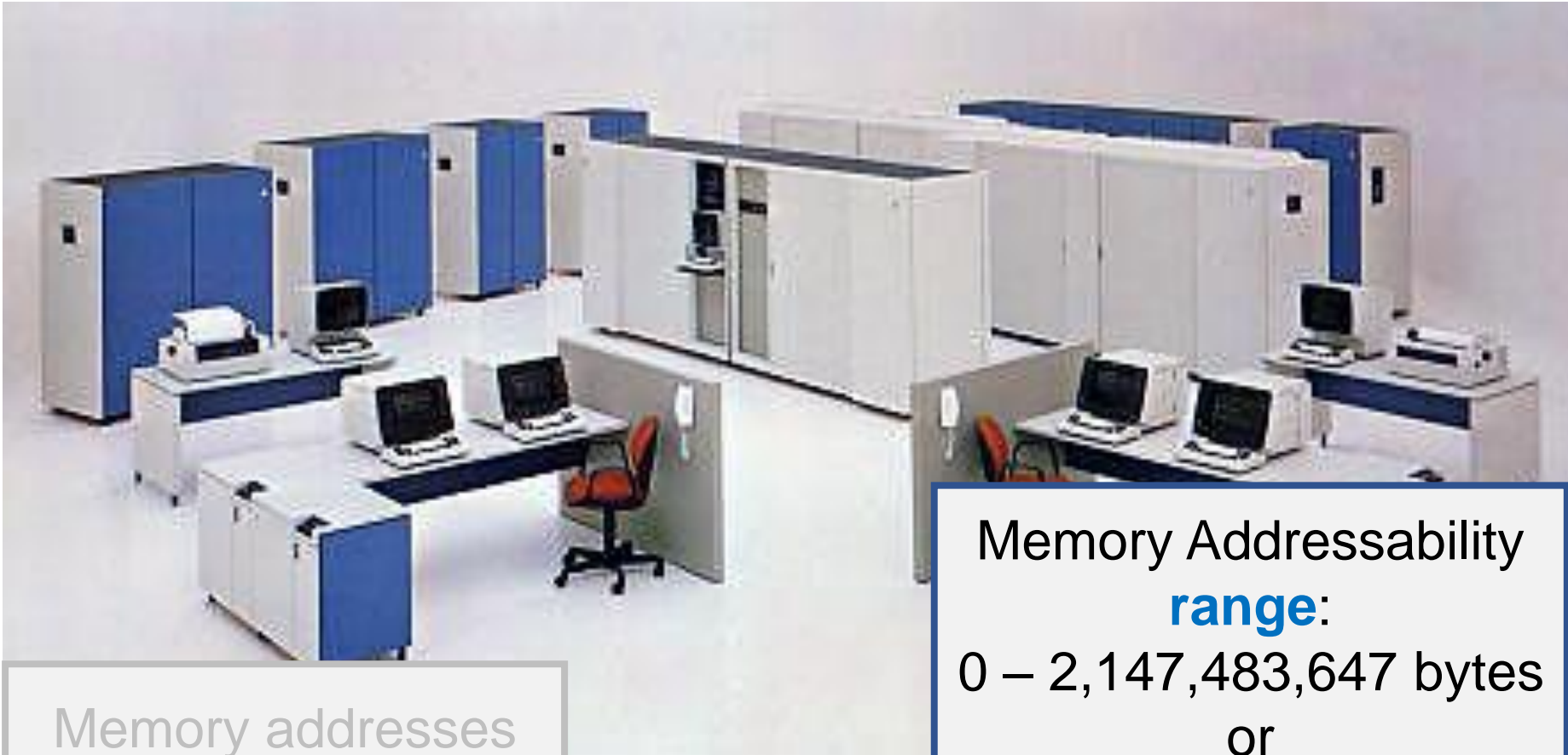
Addressing Modes



Memory addresses
consisted of **lower**
31-bits in a word
7FFFFFFF

IBM 3081
vintage 1981

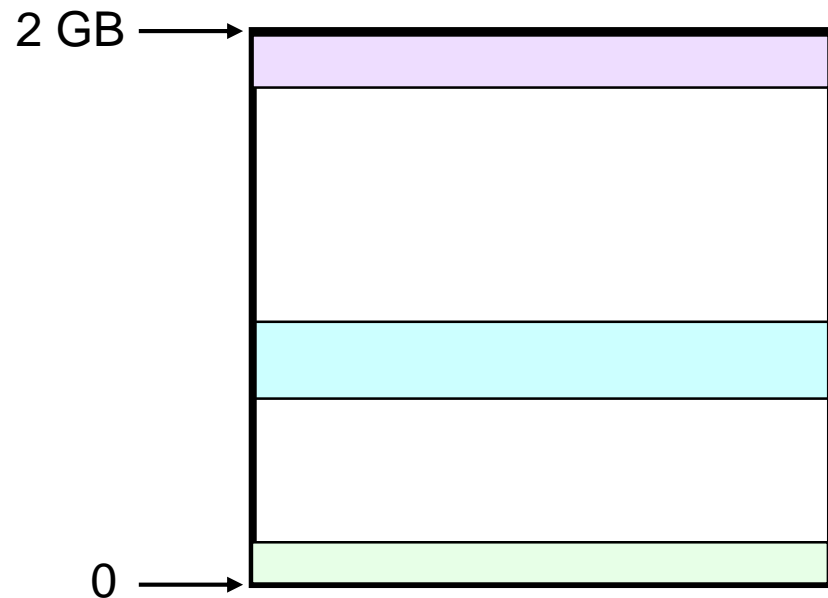
Addressing Modes



Memory addresses consisted of **lower 31-bits** in a word
7FFFFFFF

Memory Addressability
range:
0 – 2,147,483,647 bytes
or
2,147,483,648 bytes
or
2 GB

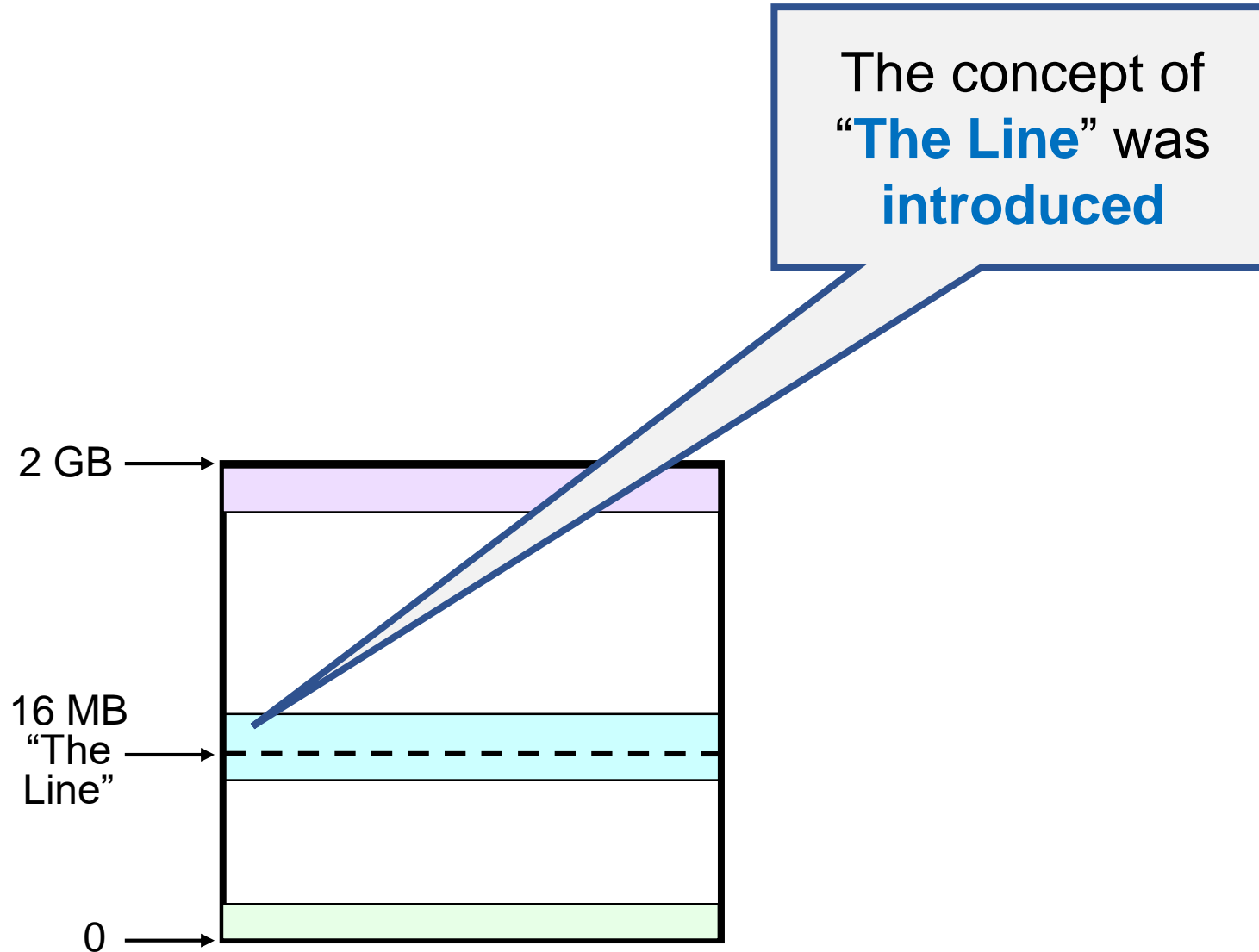
Addressing Modes



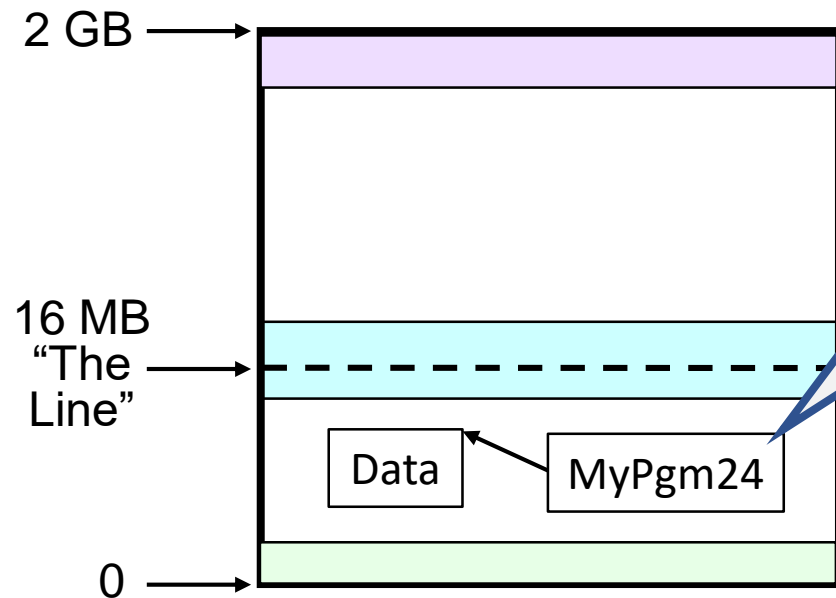
An address space **size** is **limited to** the amount of **memory that can be addressed**

In 1981, an address space was **limited to 2 GB**

Addressing Modes



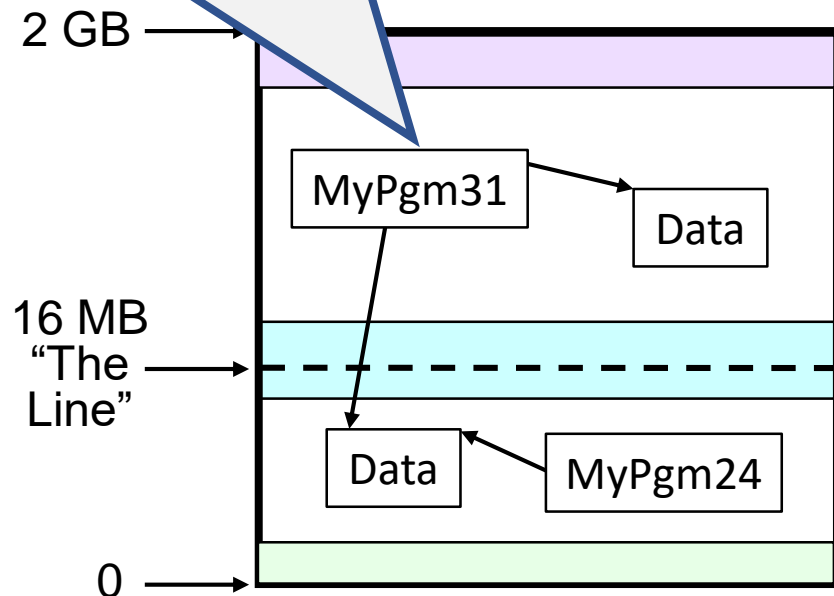
Addressing Modes



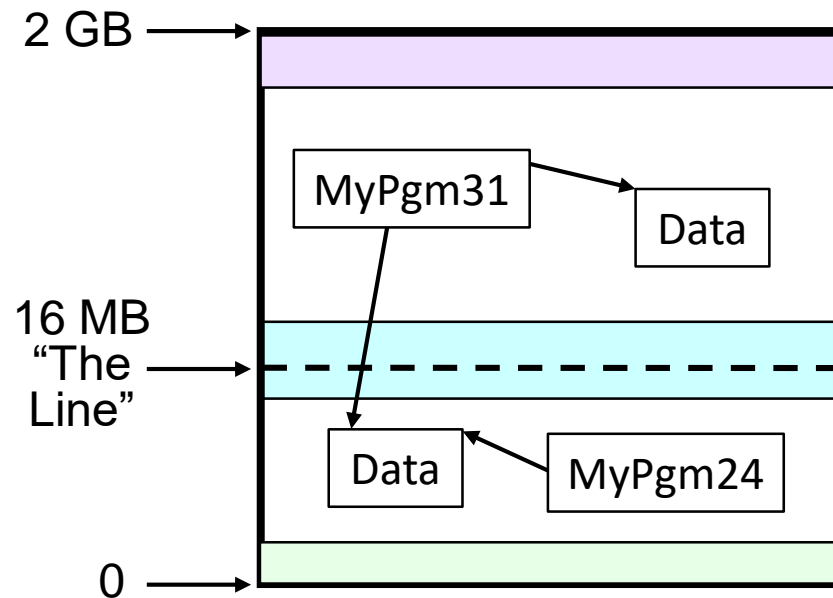
Programs **not changed** to support 31-bit addressing **had to run** and could **only access data** that was **"Below the line"**

Addressing Modes

Programs **changed** to support 31-bit addressing **could run** and could also **access data** that was **“Above the line”**



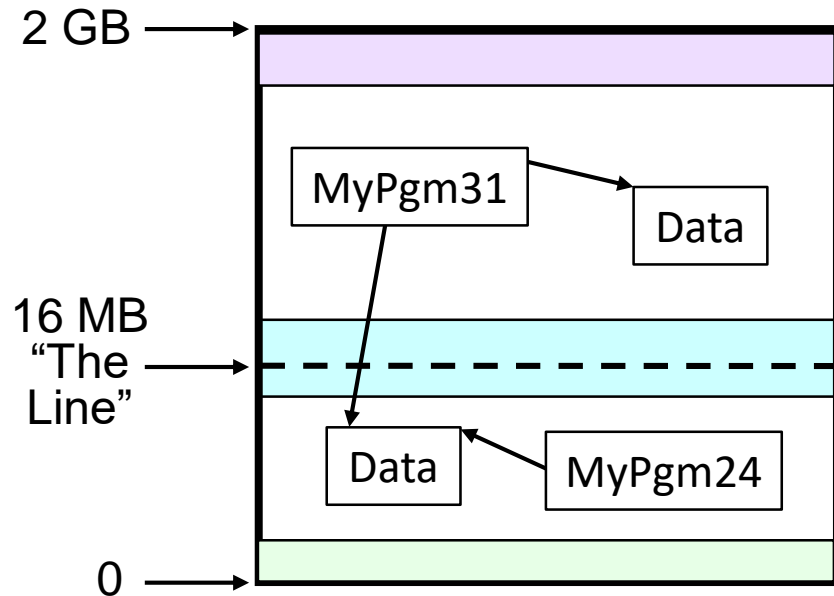
Addressing Modes



Needed a way to **indicate which addressing mode** the program **supported**

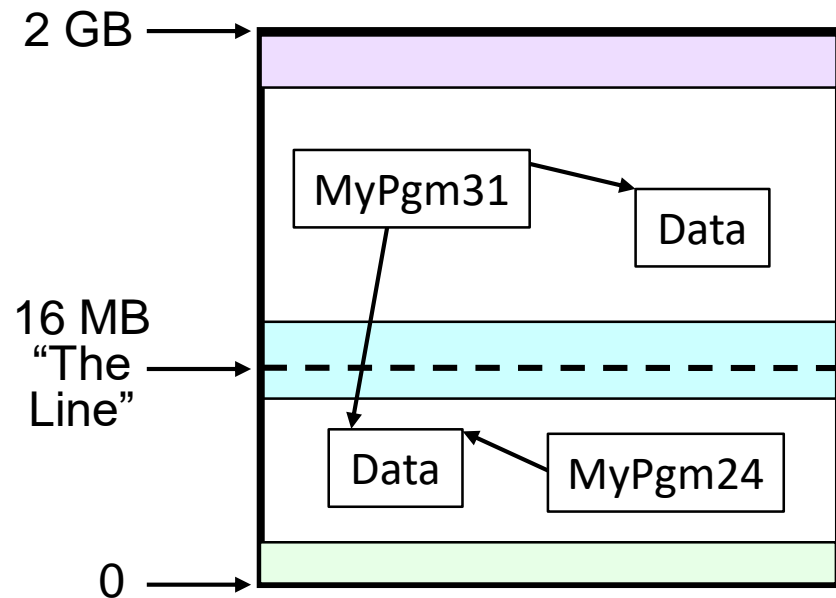
Programs now have to specify:
AMODE 24 or
AMODE 31

Addressing Modes



Since AMODE 31 programs **could run** (i.e., be loaded) **above or below the line**, a way was **needed to request** where the program should **reside**

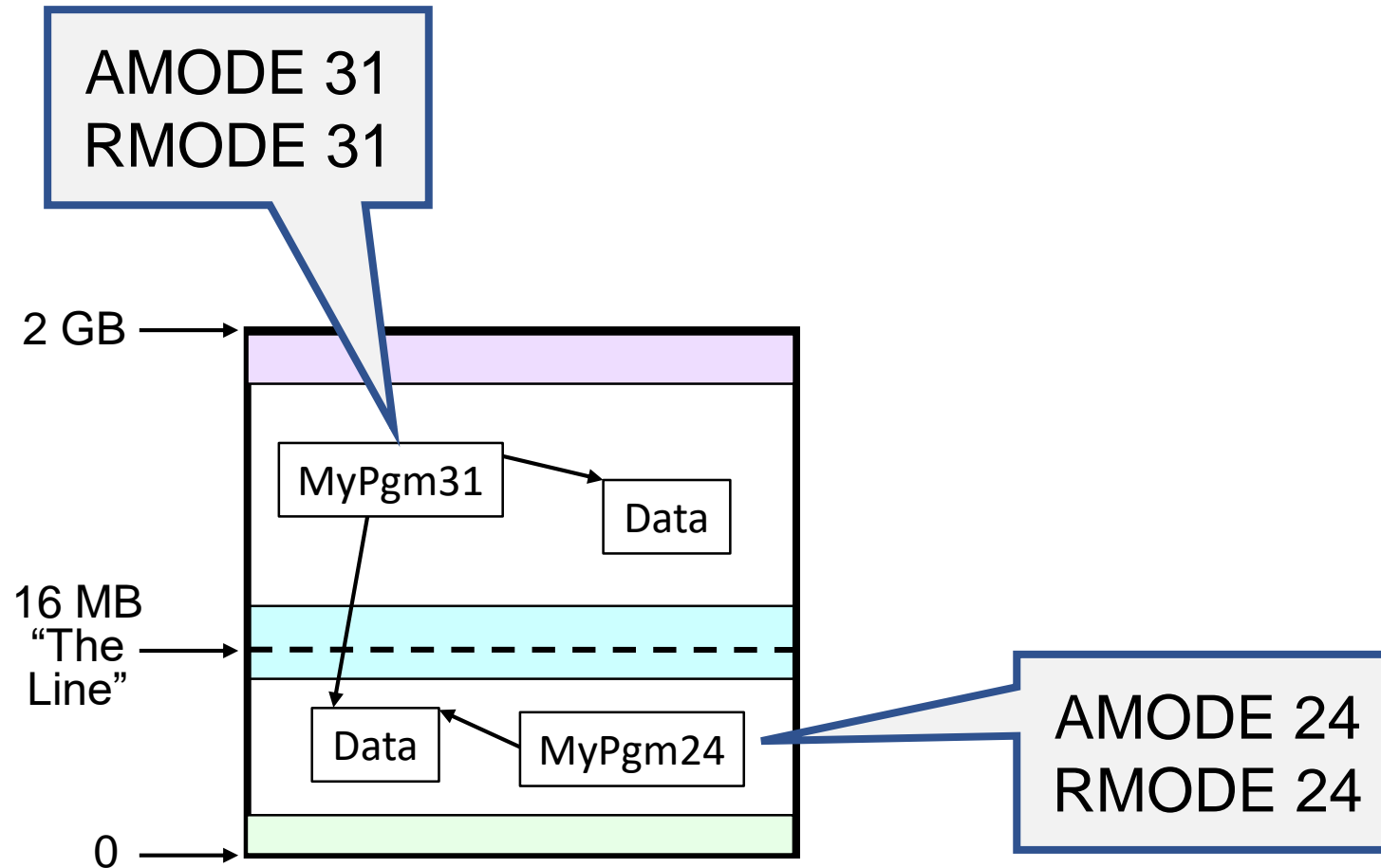
Addressing Modes



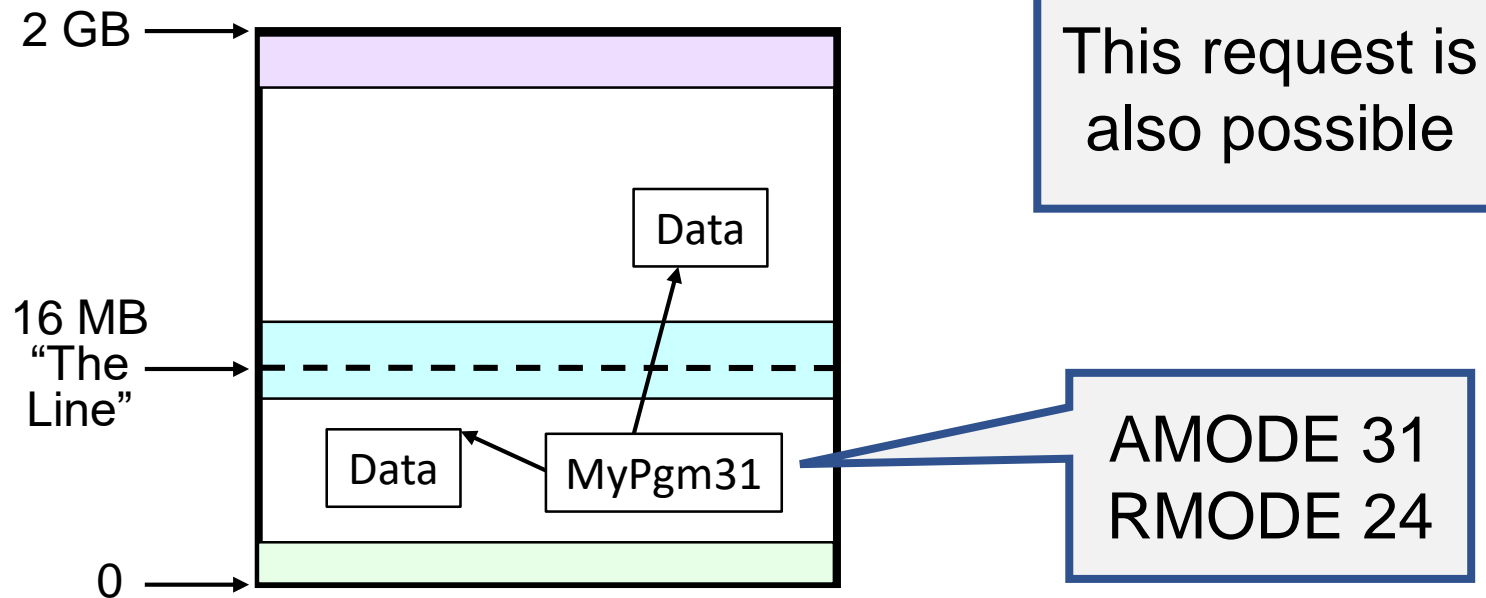
Programs now have to **specify a residency mode:**
RMODE 24 or
RMODE 31

so **z/OS** knows **where** to **load** the program

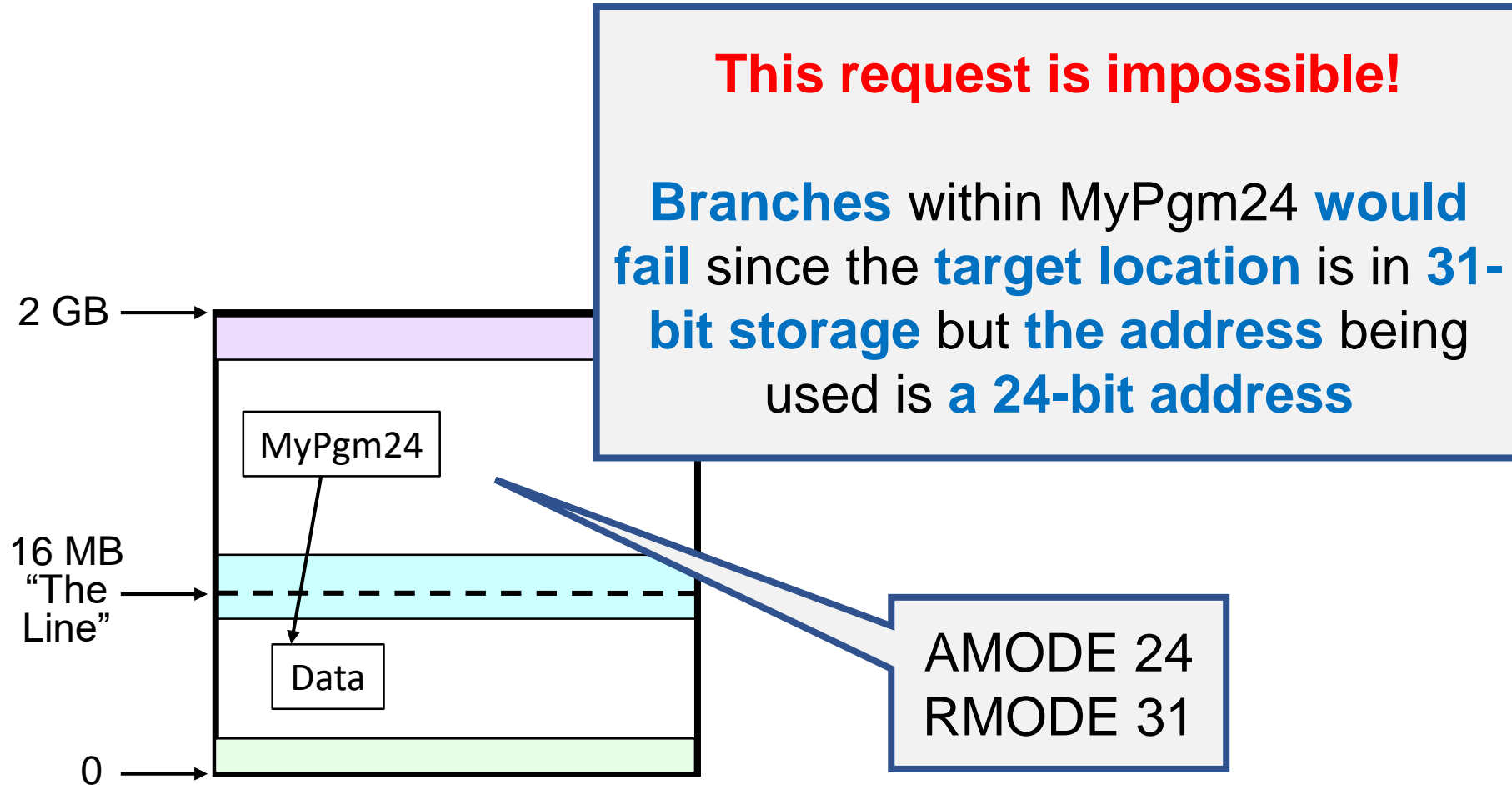
Addressing Modes



Addressing Modes



Addressing Modes



Addressing Modes


Memory addresses consisted of **all 64-bits** of a doubleword
FFFFFFFF FFFFFFFF



Addressing Modes

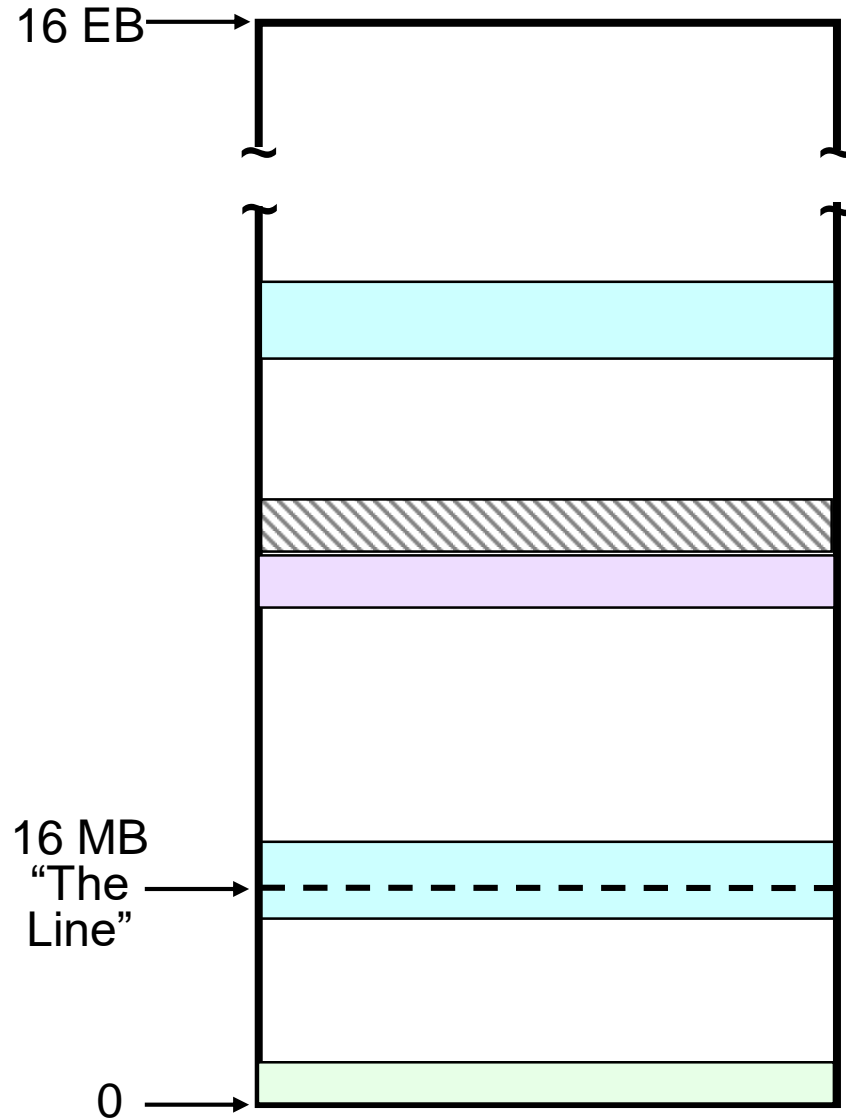
IBM z900
vintage 2000

Memory addresses
consisted of **all 64-bits**
of a doubleword
FFFFFFFF FFFFFFFF



Memory Addressability **range**:
0 – 18,446,744,073,709,551,615 bytes
or
18,446,744,073,709,551,616 bytes
or
16 EB

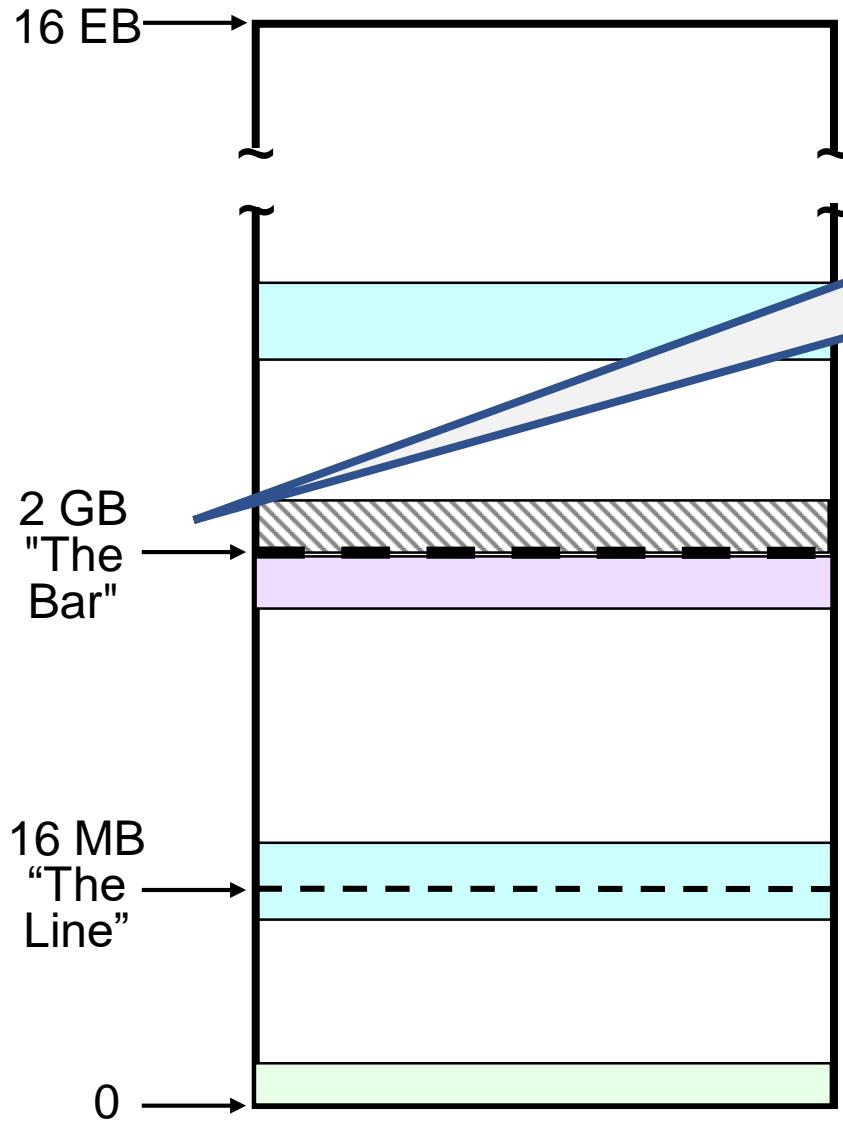
Addressing Modes



An address space **size** is **limited to** the amount of **memory that can be addressed**

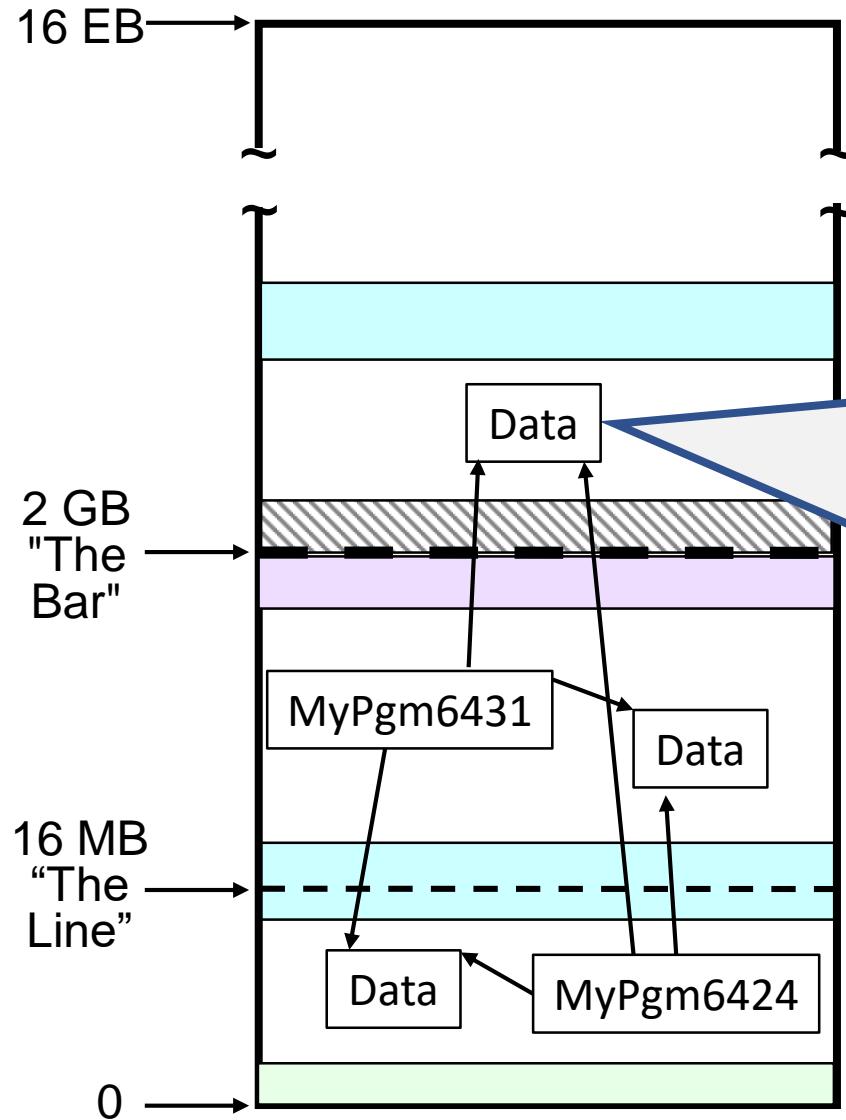
In 2000, an address space is **limited to 16 EB**

Addressing Modes



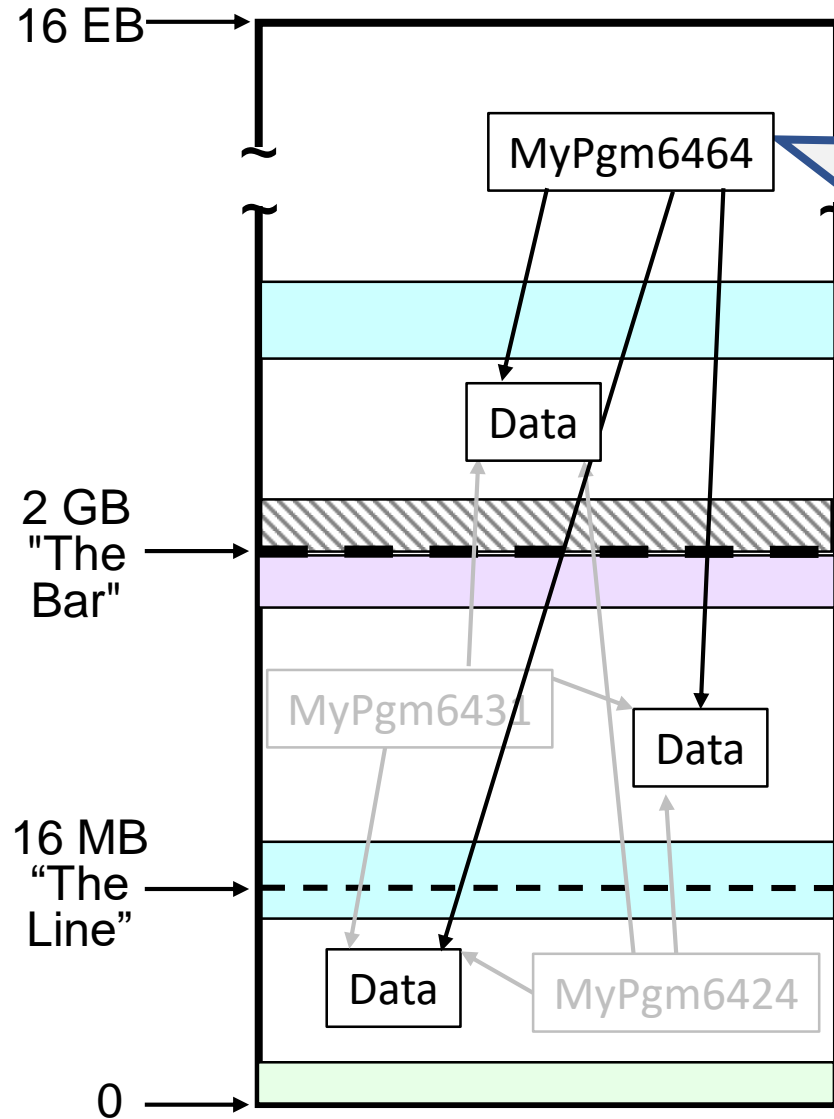
The concept of "The Bar" was introduced

Addressing Modes



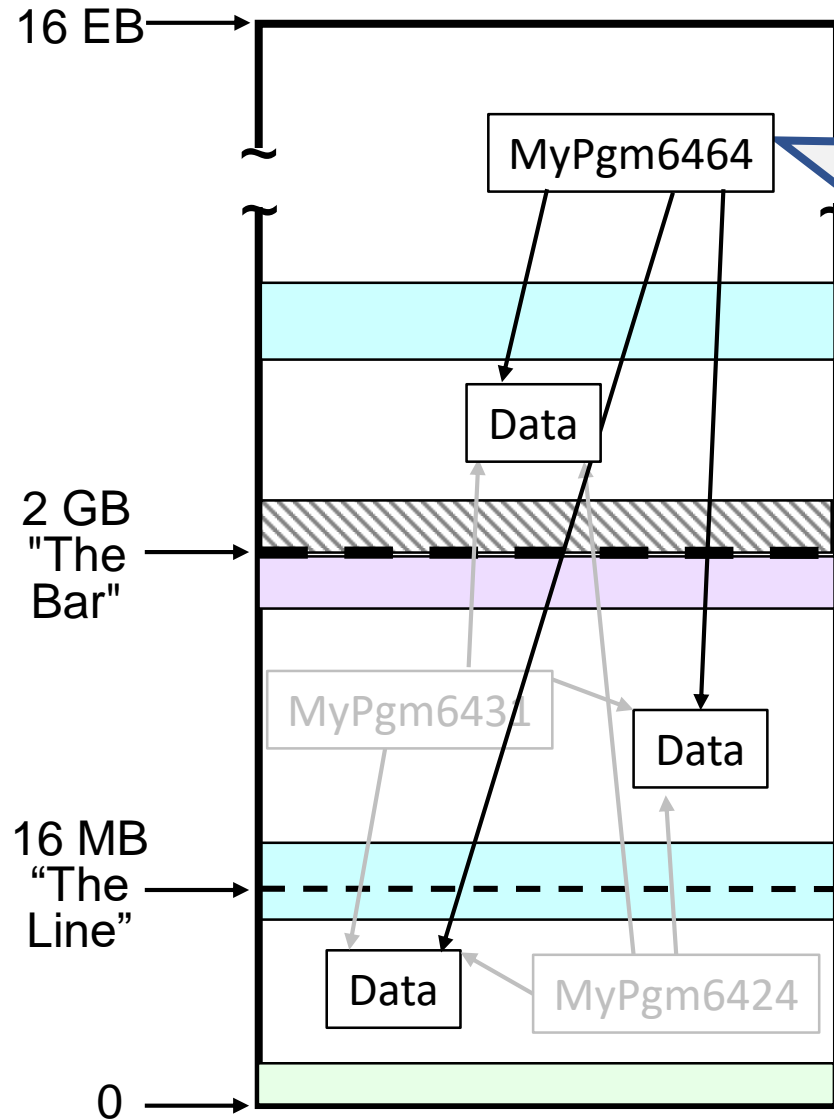
AMODE 64 is introduced and **data** can now be accessed **"Above the Bar"**

Addressing Modes



With z/OS V2R3 (2017),
**z/OS supports
RMODE 64
With restrictions**

Addressing Modes



With z/OS V2R3 (2017),
z/OS supports
RMODE 64
With restrictions

Programs will be loaded
"Above the Bar"

Check your
Knowledge



Check Your Knowledge

- **(T or F)** Each user gets an address space containing the same range of Addresses?



Check Your Knowledge

- **(T or F)** Each user gets an address space containing the same range of Addresses? **TRUE**
- **(T or F)** A module's RMODE value can be greater than its AMODE value.



Check Your Knowledge

- **(T or F)** Each user gets an address space containing the same range of Addresses? **TRUE**
- **(T or F)** A module's RMODE value can be greater than its AMODE value. **FALSE**
- What is the address range for area below the bar?



Check Your Knowledge

- **(T or F)** Each user gets an address space containing the same range of Addresses? **TRUE**
- **(T or F)** A module's RMODE value can be greater than its AMODE value. **FALSE**
- What is the address range for area below the bar? - **0 - 2GB**



Check Your Knowledge

- **(T or F)** Each user gets an address space containing the same range of Addresses? **TRUE**
- **(T or F)** A module's RMODE value can be greater than its AMODE value. **FALSE**
- What is the address range for area below the bar? - **0 - 2GB**
- To address data that resides "above the bar", what mode is required?



Check Your Knowledge

- **(T or F)** Each user gets an address space containing the same range of Addresses? **TRUE**
- **(T or F)** A module's RMODE value can be greater than its AMODE value. **FALSE**
- What is the address range for area below the bar? - **0 - 2GB**
- To address data that resides "above the bar", what mode is required?
– **AMODE 64**

Storage



Storage

- Programs are written to **utilize** a given amount of **memory**.



Storage

- Programs are written to **utilize** a given amount of **memory**.
- The amount of **memory** required by **all** the running **tasks** is usually much **greater** than the amount of **real storage available**.

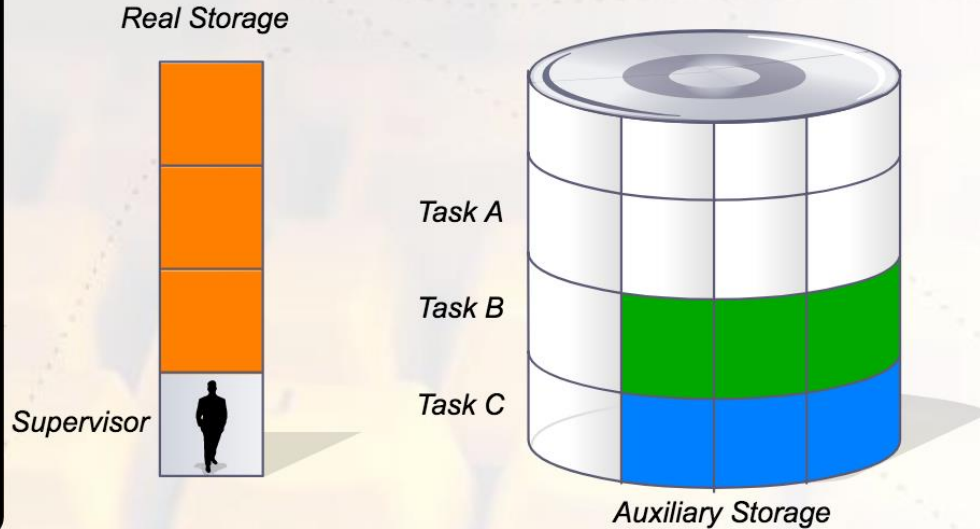
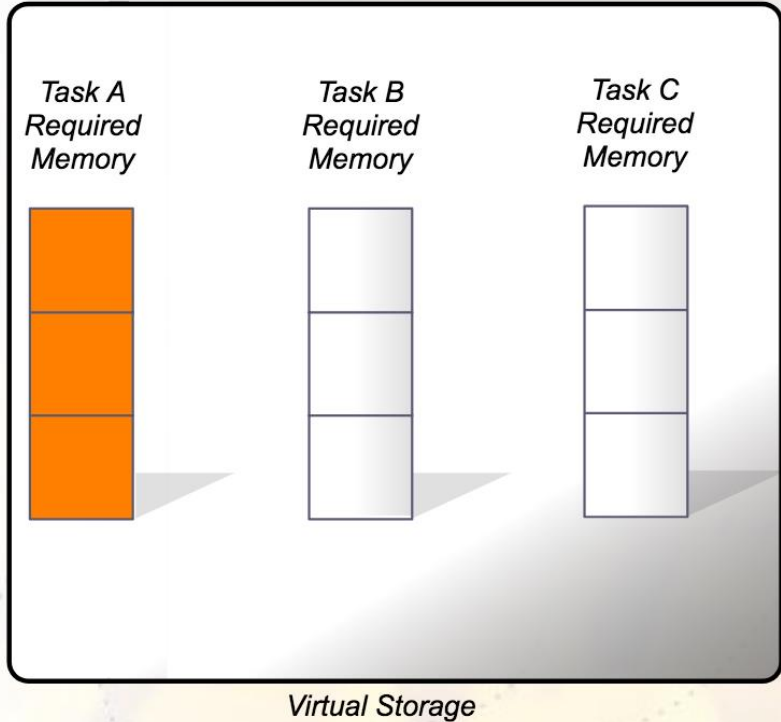


Storage

- Programs are written to **utilize** a given amount of **memory**.
- The amount of **memory** required by **all** the running **tasks** is usually much **greater** than the amount of **real storage available**.
- This is facilitated by the use of **virtual storage**.

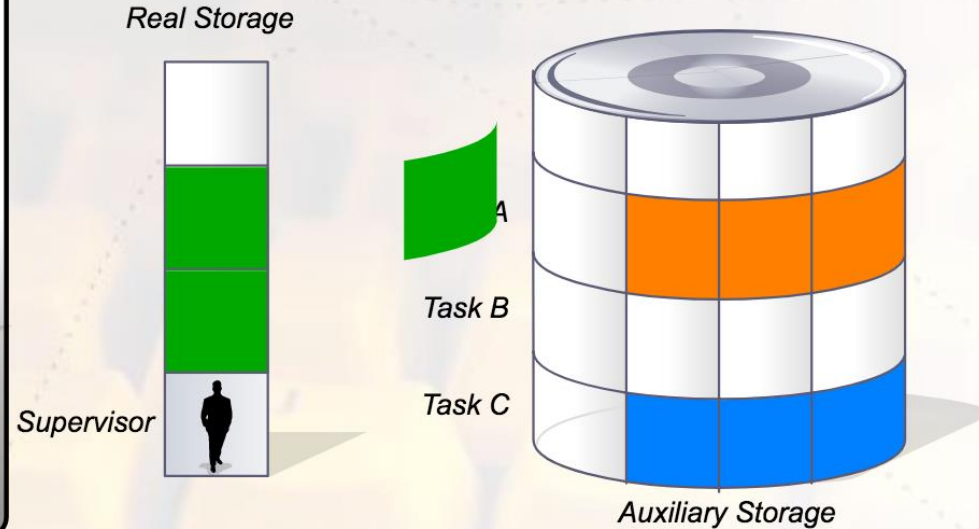
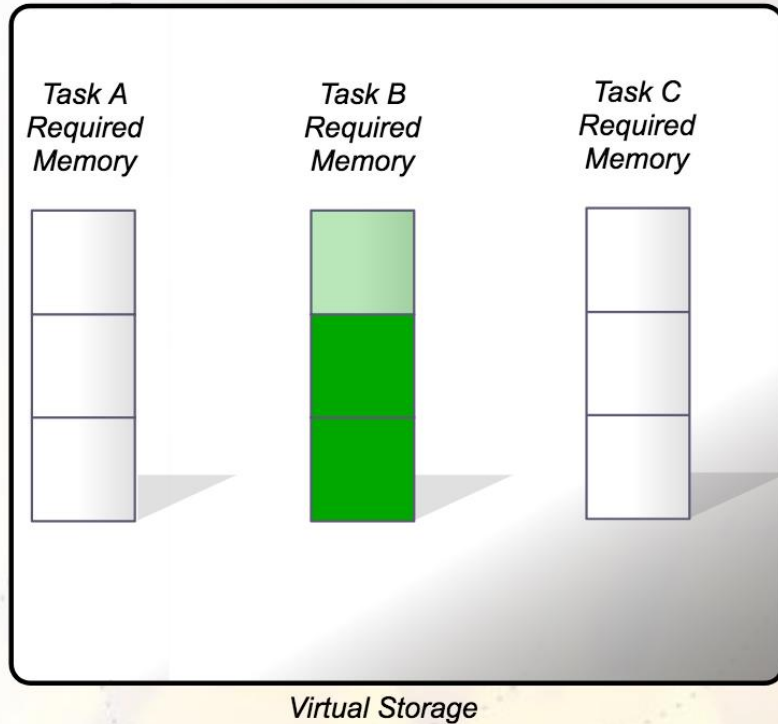
Storage

When a task is **active**, its memory is brought into **real storage**.



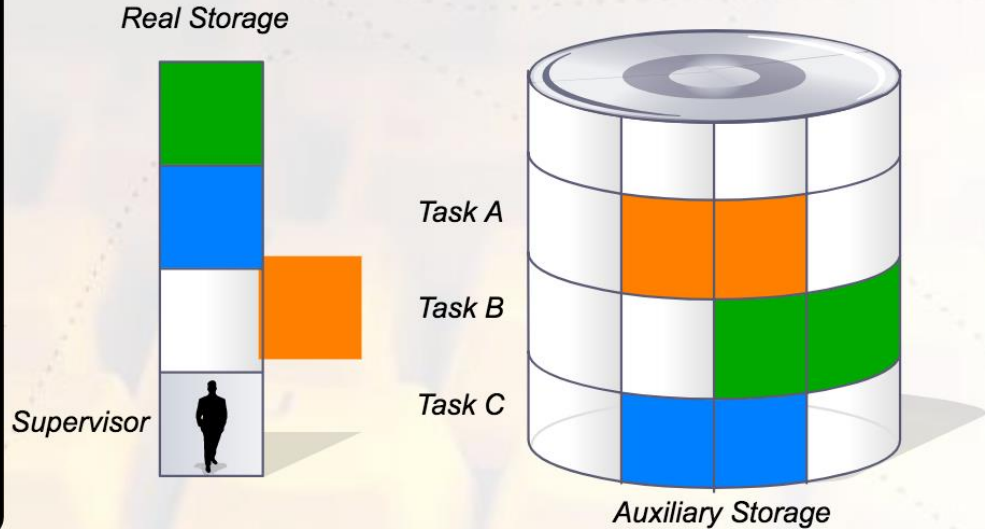
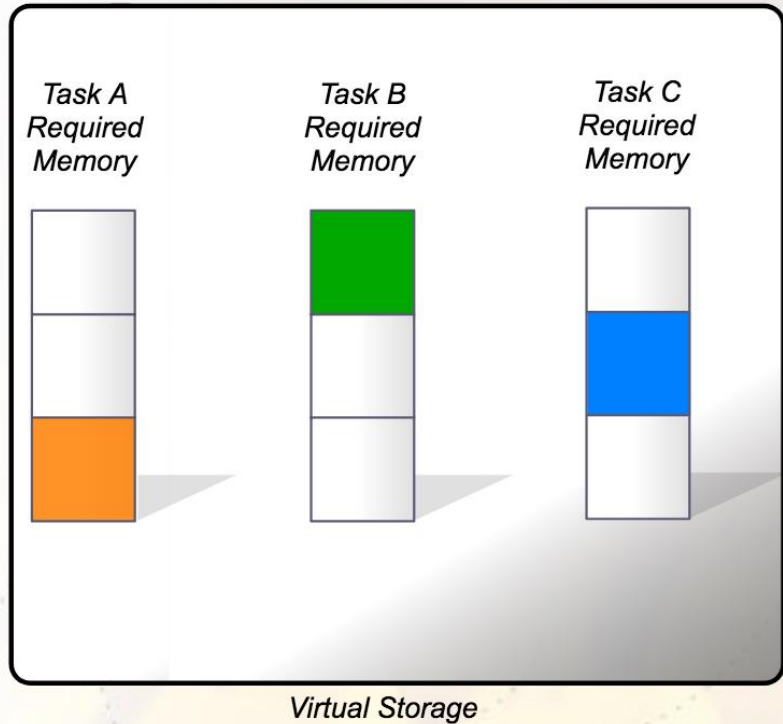
Storage

When a task is **not active**, the **real storage** that it used can be **used by another task**.



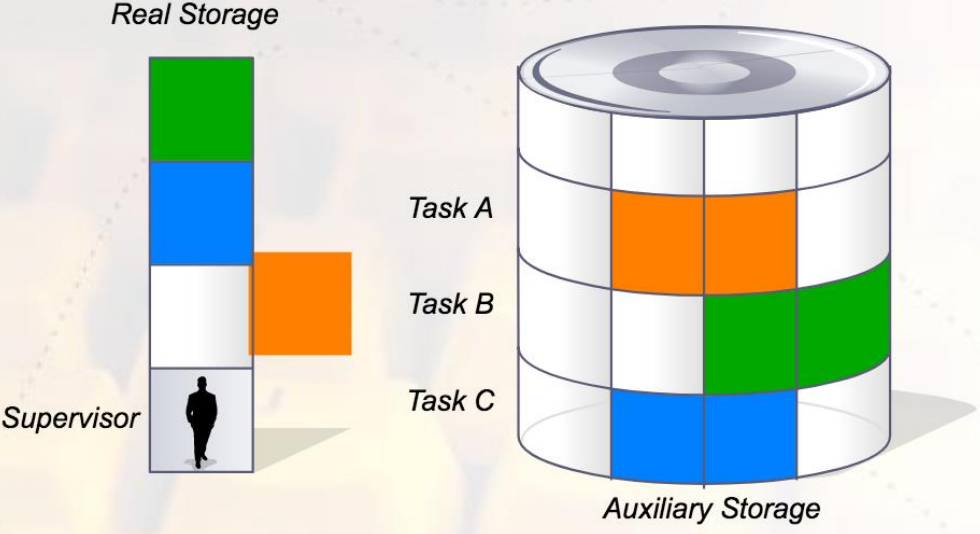
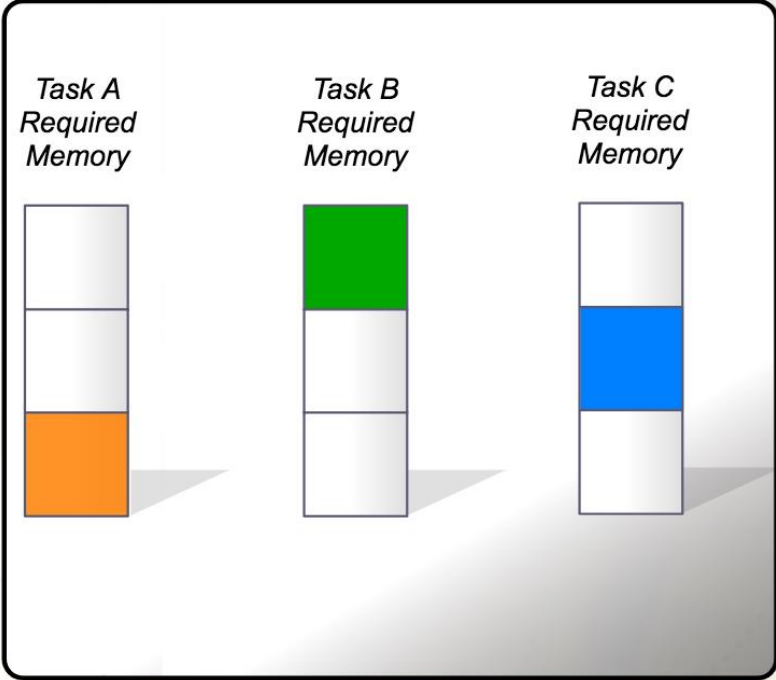
Storage

When the task is **reactivated**, its memory is **restored** from auxiliary storage.



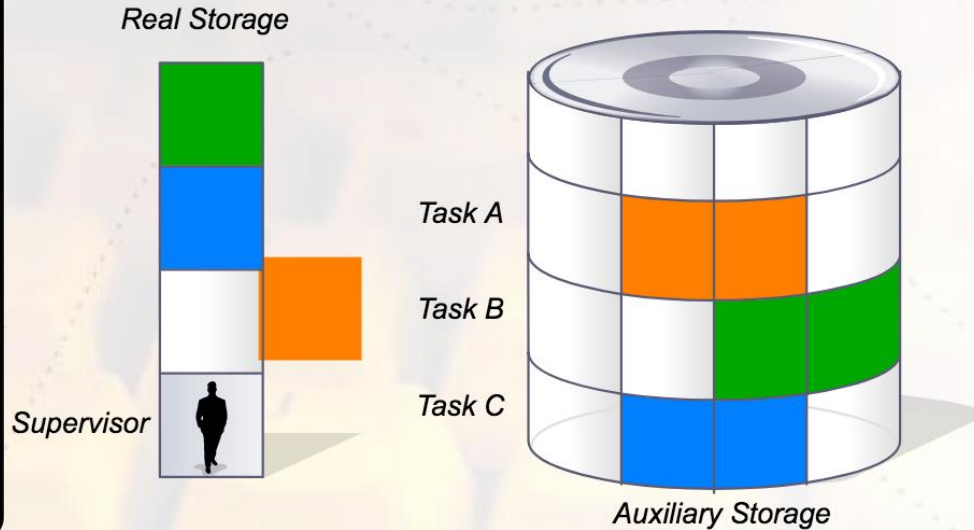
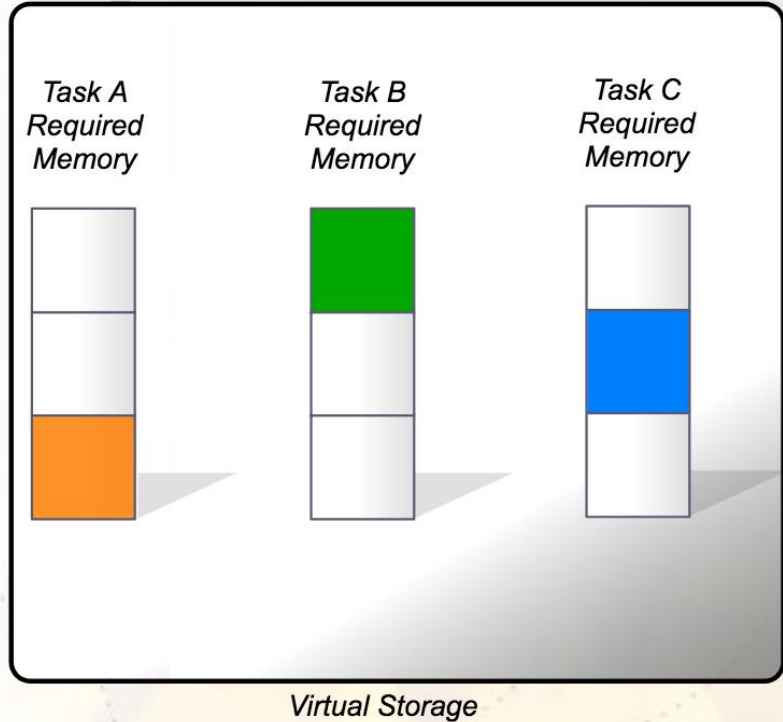
Storage

Only the virtual storage that is being **used** needs to be in real storage.



Storage

The rest can **stay** in **auxiliary storage**, enabling the **remaining** real storage to be **used for other programs**.





Storage

- **Virtual** storage is divided into **4KB** pieces called **pages**.



Storage

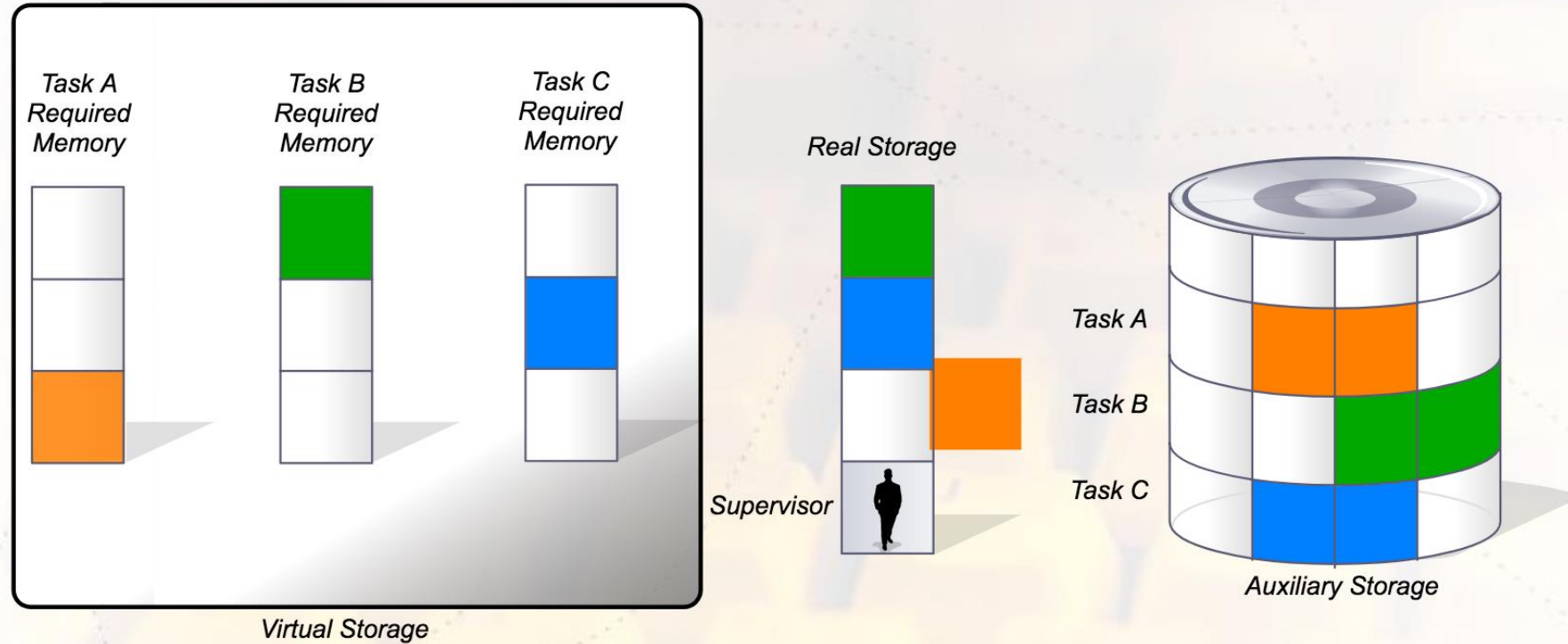
- **Virtual** storage is divided into **4KB** pieces called **pages**.
- **Real** storage is divided into **4KB** pieces called **frames**.



Storage

- **Virtual** storage is divided into **4KB** pieces called **pages**.
- **Real** storage is divided into **4KB** pieces called **frames**.
- **Auxiliary** storage is divided into **4KB** pieces called **slots**.

Storage



Dynamic Address Translation (DAT)



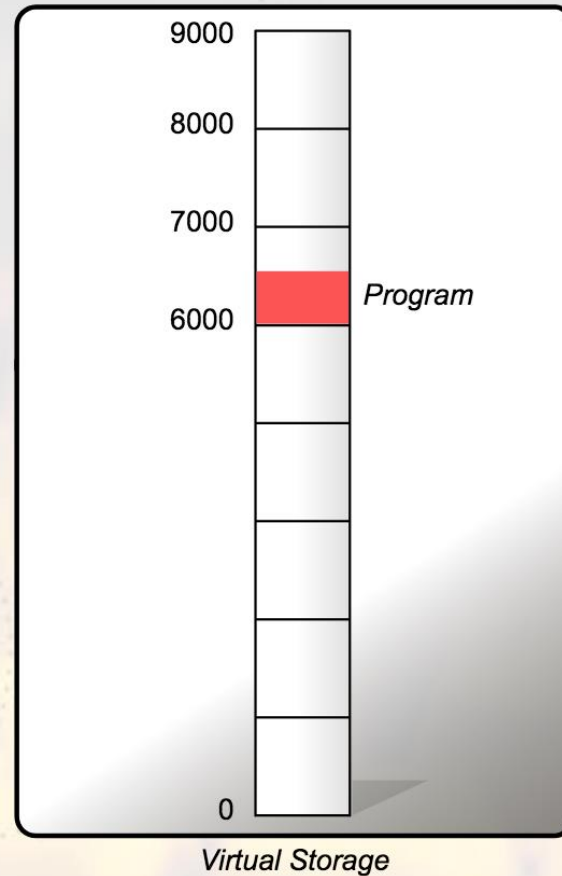
Address Translation

- When a program is **running**, the processor must be able to **locate** its virtual **pages** in real storage.

Address Translation

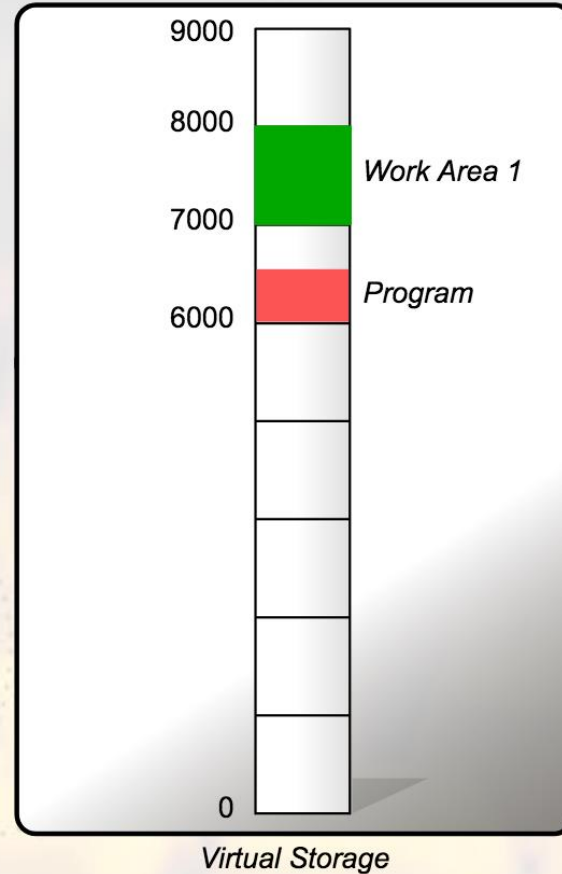
- When a program is **running**, the processor must be able to **locate** its virtual **pages** in real storage.
- **Address translation** is the process that enables a processor to **convert virtual addresses into real addresses**.

Address Translation



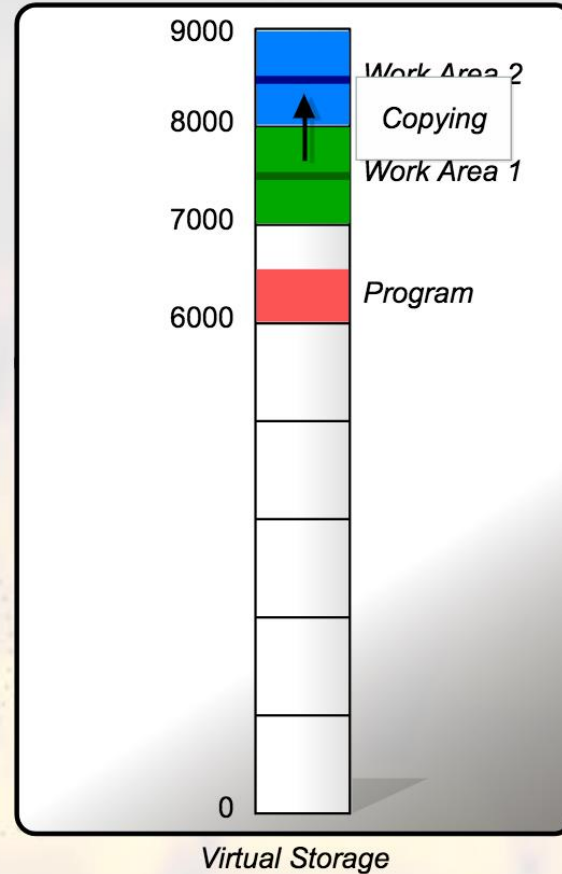
A program is **loaded** at address 6000.

Address Translation



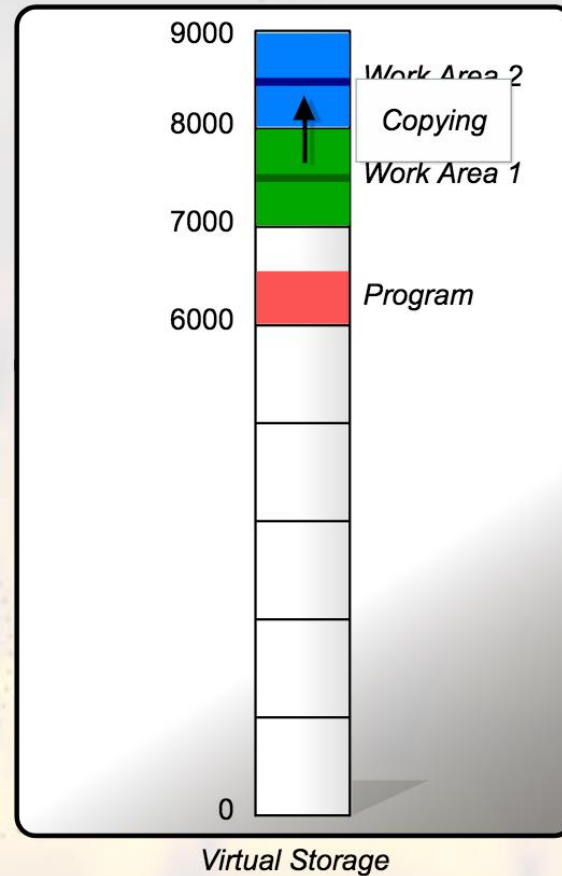
A 4KB work area is
obtained at address
7000.

Address Translation



256 bytes of data are **copied** from address 7800 to 8800.

Address Translation



The hardware feature that makes all this possible is called the **dynamic address translation (DAT)**.


Intro to z/OS: Part 2
Wednesday, 10:15am in Suzuka (Here)

Please submit your session feedback!

- Do it online at <http://conferences.gse.org.uk/2019/feedback/af>
- This session is **AF**



1. What is your conference registration number?


 This is the three digit number on the bottom of your delegate badge

2. Was the length of this presentation correct?

 1 to 4 = "Too Short" 5 = "OK" 6-9 = "Too Long"


1 2 3 4 5 6 7 8 9

3. Did this presentation meet your requirements?

 1 to 4 = "No" 5 = "OK" 6-9 = "Yes"

1 2 3 4 5 6 7 8 9

4. Was the session content what you expected?

 1 to 4 = "No" 5 = "OK" 6-9 = "Yes"

1 2 3 4 5 6 7 8 9

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