

# Using the binder to build your application

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March 2014  
Session 15254



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# System z Social Media Channels

- **Top Facebook pages related to System z:**
  - IBM System z
  - IBM Academic Initiative System z
  - IBM Master the Mainframe Contest
  - IBM Destination z
  - Millennial Mainframer
  - IBM Smarter Computing

- **Top LinkedIn groups related to System z:**
  - System z Advocates
  - SAP on System z
  - IBM Mainframe- Unofficial Group
  - IBM System z Events
  - Mainframe Experts Network
  - System z Linux
  - Enterprise Systems
  - Mainframe Security Gurus

- **Twitter profiles related to System z:**
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  - IBM DB2 on System z
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- **YouTube accounts related to System z:**
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  - Mainframe Insights
  - Smarter Computing
  - Millennial Mainframer
  - Mainframe & Hybrid Computing
  - The Mainframe Blog
  - Mainframe Watch Belgium
  - Mainframe Update
  - Enterprise Systems Media Blog
  - Dancing Dinosaur
  - DB2 for z/OS
  - IBM Destination z
  - DB2utor



# Agenda

- What is the binder?
- What does the binder do?
- How do I tell the binder to do what it does?
- What else comes with the binder?
- What else can I tell the binder to do?

# What is the binder?

- Wikipedia® under [linker \(computing\)](#):

... a computer program that takes one or more object files generated by a compiler and combines them into a single executable program.

In IBM mainframe environments such as OS/360 this program is known as a linkage editor.”

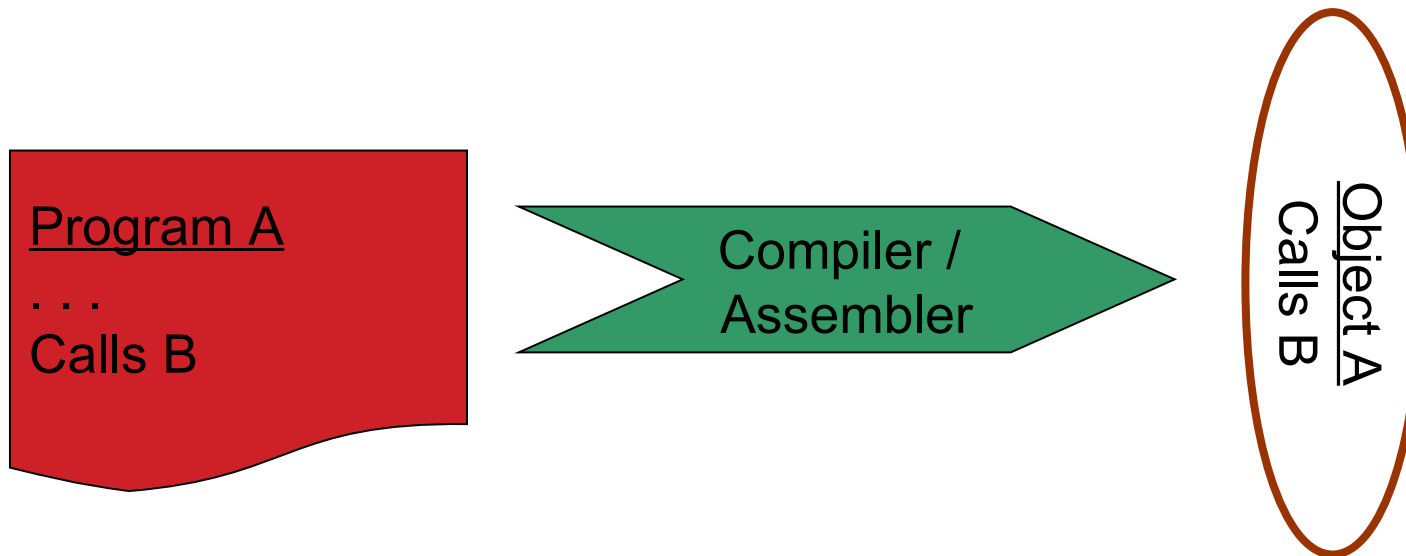
- In z/OS the program management binder does this and more!

# linkage editor



- In the old days!

# compiler / assembler



# compiler / assembler object modules

```

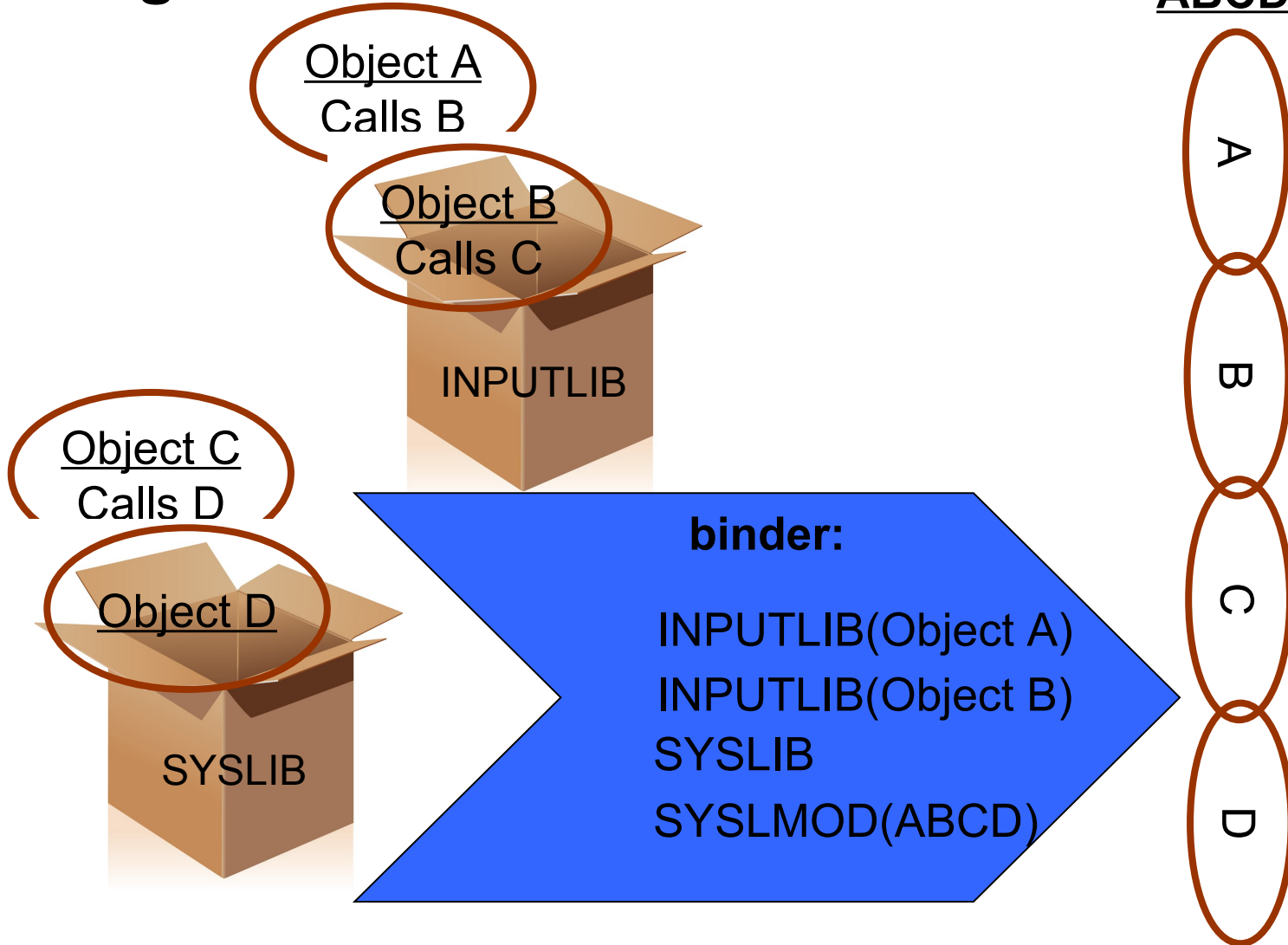
.ESD      ..  ..A      .....B      ....      00000001
.TXT     ...  ..      .....[X]OBJ Object A - Calls B      00000002
.RLD     ..  .....      .....      00000003
.END     ..  .....      1569623400 010613030      00000004
  
```

```

.0.....
.....
.....B.....
.....Ø.....B_IDRL..
.....Ø.....B_PRV..
.....GOFF Object B - Calls C.....B_TEXT..
.....B.....
.....C.....
.....
.....569623400 01062013030130829500.....
  
```



# linkage editor ...



# executable programs

- Load Module (LM), always in a PDS
  - Records, so this is truly a top-to-bottom view

## Load Module ABCD

```
.Ø.....0@@PPA2 .....C .....çA .....B .....CFUNC
Øx.....
Ø..5695PMB01 ..... "
ØIdØ..5694A01 .....Ø..569623400 ..... Øâ.569623400 ..... ".....
.....M..... ..K.....ç.....Q.....Q.....Q.....Q.....Q.....
.....&......20130130134316011300.>.....H.
```

\* Chopped off on right and bottom and deleted other lines to make it fit

# executable programs

- Program Object (PO), always in a PDS/E or UNIX file
  - Linear (binary), so bottom-left is maybe the middle

```

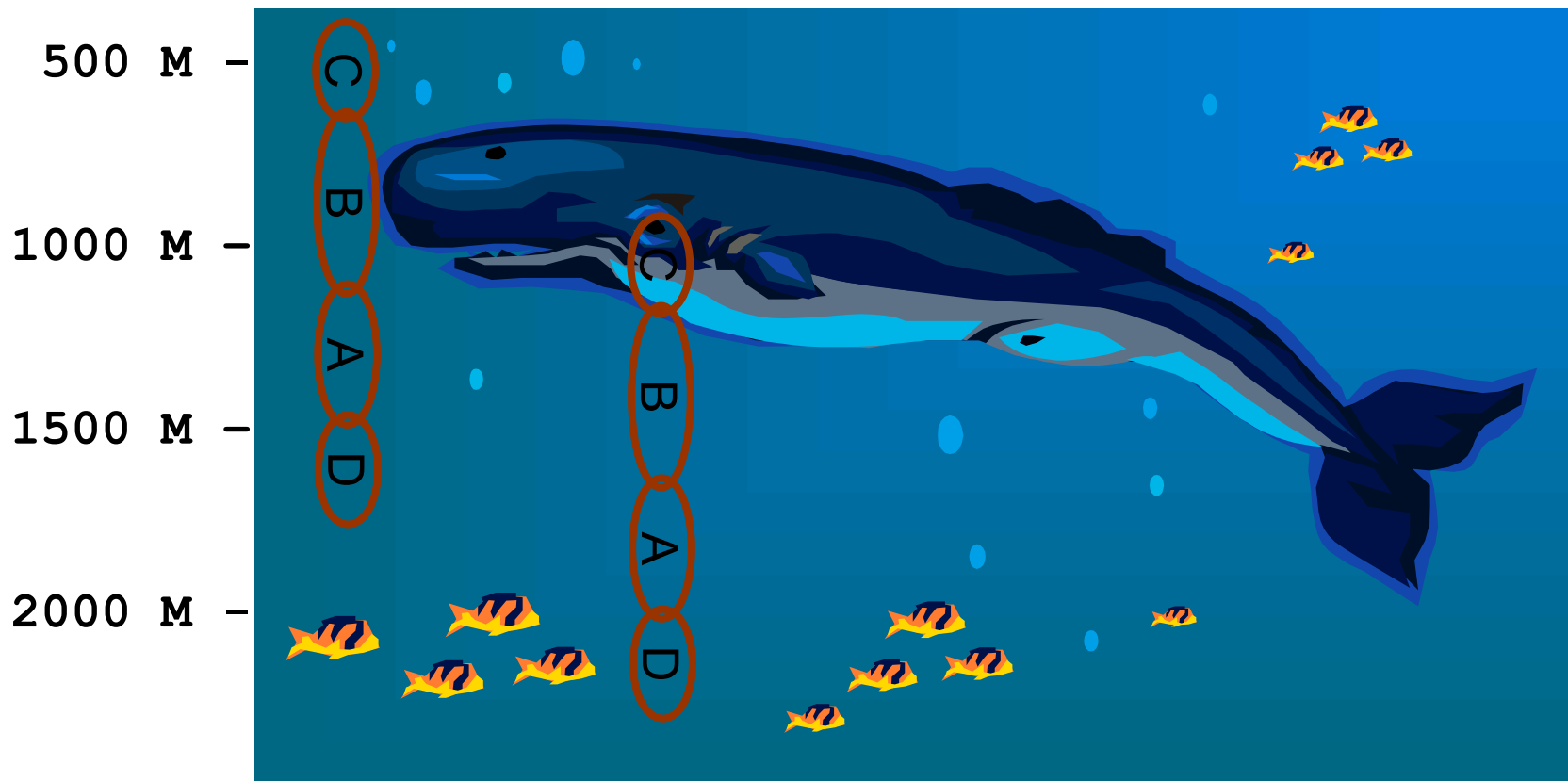
Program Object ABCD

IEWPLMH . . . ì . . . . . ì . . . . . ð . . . . . m . . h . . . . .
. . . . . à . . . . . °O} . . . . . ^ . . . . . ÈCEESTART . . ì0 . . . . . ù . . . . . Ú
. . . . . Ø . . . . . Ø . . . . . Ø . . . . . ED . . . . .
L . . . . . Ø{ . . . . . Ø . . . . . Ø . . . . . & . . . . . & . . . . . PRPRL . . . . .
SDSD . . . . . Ø . . . . . Ø . . . . . Ø . . . . . Q . . . . . 8 . . . . . ED
. . . . . SDS . . . . . Ø . . . . . Ø . . . . . à . . . . . Ø . . . . .
. . . . . SDS . . . . . Ø . . . . . Ø . . . . . - . . . . . Ø . . . . . &
. . . . . ERWX . . . . . /Ø . . . . . I . . . . . Ø . . . . .

```

# linkage editor ...

... *and* loader



**MEMORY**

# linkage editor ...

- Symbol resolution
  - all *external* symbol references which need to be satisfied
    - between all input parts
- Relocation
  - all modules combined, relocated relative to origin address
    - zero (or start of segment)
  - final relocation is done by the loader
    - based on information created by the binder

# Program Management Binder

- BCP exclusive base element
  - Wave 0, along with SMP/E and High Level Assembler
- z/OS system linker
  - more than the linkage editor!
- Related utilities
- Programming interfaces

# object file format summary

- Documented
  - Can be produced by non-IBM products
    - Dignus Systems/ASM, Systems/C, Systems/C++ cross-assembler/compiler
- Produced by IBM language translators
  - High Level Assembler (HLASM)
  - Language Environment translators
    - XL C/C++
    - Enterprise COBOL
    - Enterprise PL/I
  - ... and their predecessors
- binder supports 3 flavors
  - OBJ
    - Traditional circa 360 object format
  - XOBJ
    - Initially produced by C/370 for use with the Prelinker
  - GOFF
    - Initially produced by XL C/C++ for XPLink
    - Also produced by High Level Assembler

# better than the linkage editor!

## Load Modules

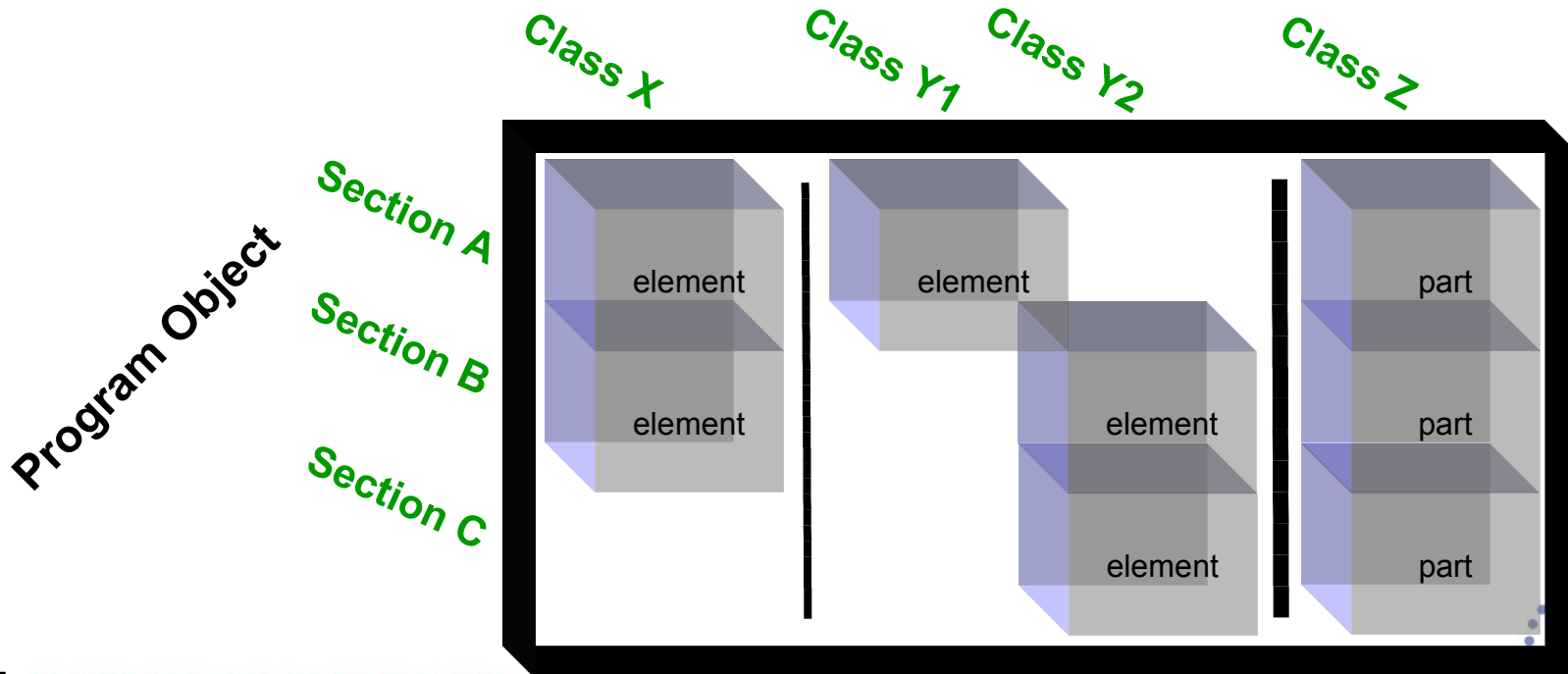
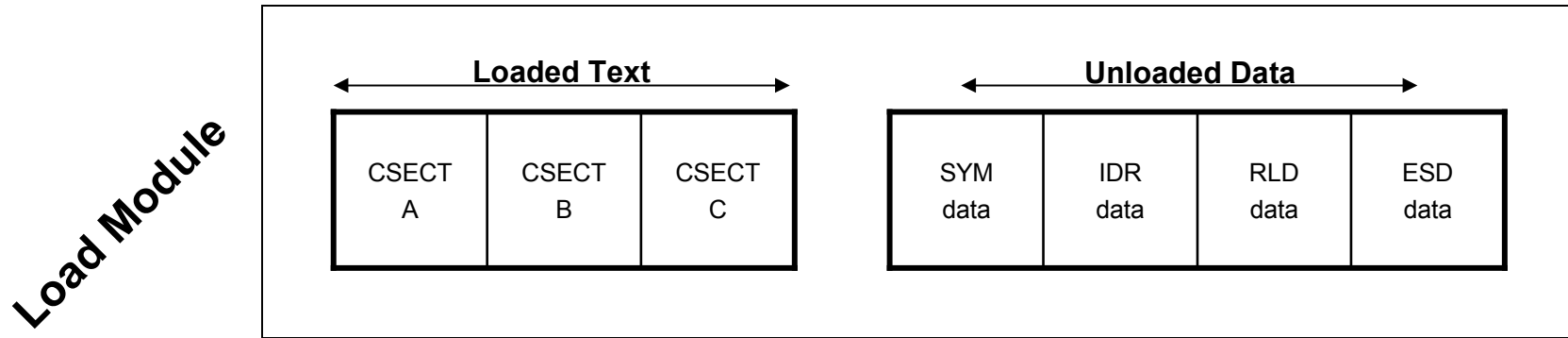
- Defined almost 50 years ago for S/360™
- Designed specifically for PDS members
  - Depends on hardware keys, format U data
  - Has critical data in directory entries
  - Can only be stored in PDSs
- Significant limitations
  - Symbol names limited to 8 characters
  - 32K maximum external symbols
  - Max size 16M, no split above/below 16M
- Pack maximum data in minimum bytes
  - Great goal, but limits extensibility
- Documented format is exploited by customers
  - Difficult to change

## Program Objects

- Supported by first release of binder
- Designed to be device independent
  - Developed in conjunction with PDSEs
  - Essential for z/OS UNIX support
  - Can only be stored in PDSEs or UNIX files
- Supports symbol names up to 32767 in length and a module length of up to 1 gigabyte
- Designed to support system paging
  - All loadable data is in 4K blocks
  - Loader can treat as extension of page files
- More non-executable data saved
  - Reprocessing is faster and more automatic
  - Supports extra data for debuggers
- Undocumented so allows rapid enhancements
  - 5+ formats to date...



# load module vs. program object



# binder invocation

- **PGM=IEWL** (in JCL)
  - True name
    - **IEWBLINK** (default Link-Edit Utility for **SMP/E**)
  - aliases ala linkage editor names
    - HEWL, HEWLH096
    - HEWLDRGO, HEWLOAD, HEWLOADR
  - aliases of the modern day for binder loader
    - IEWBLDGO, IEWBLODI, IEWBLOAD
    - LOADER
    - IEWLDRGO, IEWLOADI, IEWLOAD, IEWLOADR
  - binder aliases of the modern day
    - IEWL, LINKEDIT
  - alias for customized options
    - IEWBODEF
    - Caution! for sysprogs, rarely used

# but not this, the linkage editor !

- *Invocations of actual linkage editor and batch loader*
  - *HEWLD\* (HEWLD)*
    - *Any remaining invocations of these are batch loader*
  - *IEWL\* (IEWLF880) or HEWL\* (HEWLKED)*
    - *Any remaining invocations of these are linkage editor*
  - *If you use any of these, I'd like to know!!!*
- **NOTE:** *Program Management loader used for PGM=yourpgm*
  - *That is not the Binder!*
  - *It's what is mostly used for program invocation*

## *more binder invocations...*

- The usual suspects:
  - Batch LINKEDIT, IEWL, etc.
- Invoked as a program call:
  - SMP/E (it's *not really* JCL!)
  - TSO LINK, LOAD, LOADGO
  - Id command (UNIX)
- Using the binder Application Programming Interfaces (APIs)
  - c89 (c++), cob2, pli, xlc (xLC)
  - IEBCOPY (sometimes!)
  - SPZAP
  - AMBLIST

# Control Statements

- Your Wish is My Command!
  - Placement
    - Some depend on where they appear relative to others
    - Some depend on where they appear only relative to the same ones
  - Read into the program
  - Change or replace symbol names
  - Change relative locations
  - Specify entry points and their names
  - Specify where to find missing names and find them
  - Write out the program
  - Override options for a single program
- All control statements have analogous API calls

# Control Statements ... Read into the program

- Binder program (not API) starts by reading **SYSLIN**
  - Could be anything!
- **INCLUDE**
  - Explicitly, so always done
- **AUTOCALL**
  - Autocall, so only if it's found
- **IDENTIFY**
  - Not really reading, but associates user identification information to a section which was read in

# Control Statements ...

## Change or replace symbol names

- **CHANGE**
  - Give a symbol definition and references a new name
- **REPLACE**
  - Delete a symbol, optionally give references to it a new name
    - If it's a section, delete the entire section
- **RENAME**
  - Give a renameable symbol a new name
    - Only if there are unresolved symbols
      - *Prelinker compatibility*

# Control Statements ...

## Change relative locations

- **ORDER**
  - Explicitly move a section before everything else
  - Optionally PAGE align it
- **PAGE**
  - Align a section to a 4K (or 2K) page boundary
- **ALIGN**      *New in z/OS V2R1 !*
  - Align a section, or element or part of it, on a specified boundary
- **EXPAND**
  - Add extra space (set to zeroes) at the end of a section or element



# Control Statements ...

## Specify entry points and their names

- **ALIAS**

- Give another name to call the program by
  - For partitioned datasets these are aliases
    - *Optionally give an entry point symbol name where that program name begins execution*
    - *Or it will default to an entry point name that matches this name, if there is one*
    - *Or the primary name if there is not a matching name*
  - For UNIX files these are either (hard) links or symbolic links
    - *However there is only ever one entry point, the same as the primary name*

- **ENTRY**

- Give an entry point symbol name where the primary name of the program begins execution

- **NAME**

- Give the primary name to call the program by

# Control Statements ...

## Specify where to find missing names and find them

- Binder program (not API) starts by reading **SYSLIB**
  - After all else is done, before preparing to write out program
- **LIBRARY** (autocall)
  - Augments SYSLIB
  - Changes where symbols may or may not be found
- **IMPORT** (DLLs)
  - Tells what DLL an unresolved symbols should be in at run-time

# Control Statements ... Write out the program

- Binder program (not API) writes to **SYSLMOD**
- Allocated to either a partitioned dataset or a UNIX pathname
  - May also include the NAME, in lieu of a NAME control statement
- **NAME**
  - Give a name to the program
    - For partitioned dataset, a member name
    - For UNIX, a filename
    - Optionally tells if the an existing program of that name may be replaced

# Control Statements ...

## Override options for a single program

- PARMs are global, these affect only the NAMEd program being bound
  - **MODE** - see AMODE, RMODE options
  - **SETCODE** - see AC option
  - **SETOPT** - generalization for any PARM
  - **SETSSI** - see SSI option
  - **ENTRY** - see EP option

# Options

## Who needs 'em !?

- Binder program (not API) will by default write a SUMMARY LIST to SYSPRINT (which must be allocated) containing:
  - Control statements
  - Most all messages
  - Processing options
  - Summaries of the saved program (if successful)
    - Name (location), type, time
    - Attributes
    - Entry points and aliases
  - Final return code

# Options ...

## Who needs 'em !?

- UNIX command invocations (c89, ld) by default will write to **stderr**:
  - All messages severity 4 (WARNING) and higher
    - That is, no informational messages
  - Use the **-V** option to get most everything written to **stdout**

# Options precedence rules (low to high)

1. Installation options from IEWBODEF
2. Primary invocation options, from one of the following:
  1. The PARM field of the JCL EXEC statement
  2. The first parameter passed to IEWBLINK, IEWBLOAD, etc.
  3. The PARMS parameter of IEWBIND FUNC=STARTD
3. ***The IEWPARMS DD statement – introduced in z/OS V1R11 !***
4. The OPTIONS parameter of IEWBIND FUNC=STARTD
5. IEWBIND\_OPTIONS environment variables via the ENVARS parameter of IEWBIND FUNC=STARTD
6. Dynamic option changes from either:
  1. Options set from attributes by an INCLUDE -ATTR control statement or
  2. The SETOPT control statement, or
  3. The PARMS parameter, followed by the OPTION/OPTVAL parameter, of IEWBIND FUNC=SETO

# OPTIONS option

- **OPTIONS=***ddname*
  - primarily invented to overcome JCL limitations...
    - typically in-stream data set
  - but can be convenient for example to have files of options common to a set of JCL
    - *making it easy to update options without changing JCL etc.*



# Other option sources from UNIX

- makefiles
  - Environment variables which become make macros
    - LDFLAGS
- c89 – YAEV (“yet another environment variable”)
  - `_C89_OPTIONS`
  - `_C89_OPERANDS`
- ld – yikes, just like (you can guess why!)...
  - `_LD_OPTIONS`
  - `_LD_OPERANDS`

# Types of options

- Options for **SYSPRINT**
  - Most common
- Behavior changing options
  - Next most common
- Program changing options
  - Depends on functional requirements

# Options for SYSPRINT

- **LIST, MAP, XREF**
  - SMP/E Link-Editor Utility defaults:
    - LET, LIST, NCAL, XREF
    - NCAL once upon a time was unconditionally set
      - *now based on CALLIBS*
    - If you specify overrides, you must list the others too!
    - SMP/E is picky (it's *not really* JCL)
    - Avoid using control statements to specify options (SMP/E won't know)

# Options for SYSPRINT ...

- SYSPRINT

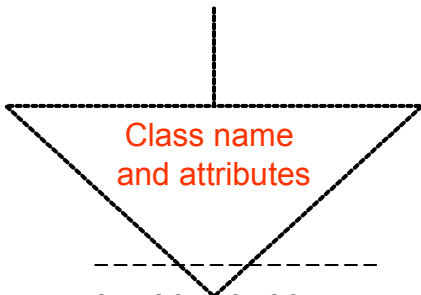
- Messages (IEW2nnnns)                      also *SYSTEM*
- DDname cross-reference
- Message Summary
  
- **LIST**ing of processing information
- Module **MAP**
  - Includes Data Set Summary
- Cross(**X**) **REF**erence between symbol definitions and references
  - includes DLL IMPORT/EXPORT table

# Options for SYSPRINT ...

- SYSPRINT extras; requires **MAP** or **XREF**
  - **Renamed symbol cross-reference**
    - Usually only for special predefined list of C symbol names
    - Also RENAME control statement
  - **Long symbol abbreviation table**
  - **Short Mangled Name report**
  - **Symbol References Not Associated with any AdCon**
    - “Dangling” External References
    - Also produced with **LIST**
    - Heading may be there even if no symbols
    - Due to external reference ESD entry from object module

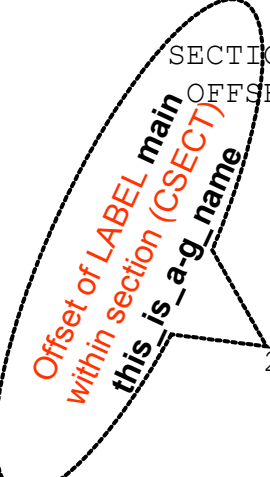
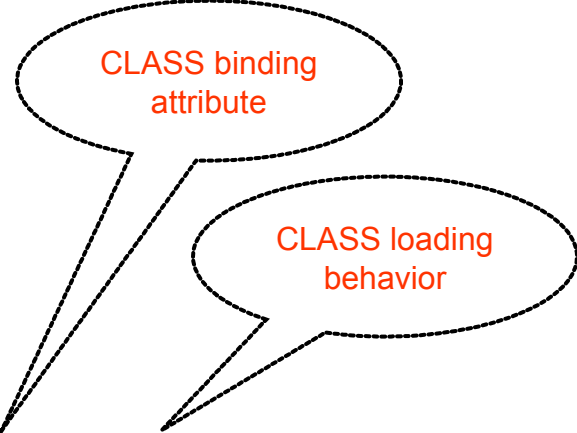
# Options for SYSPRINT ... MAP

\*\*\* MODULE MAP \*\*\*

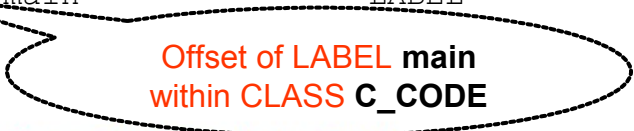


```
-----
CLASS  C_CODE
-----
```

```
LENGTH =      160  ATTRIBUTES = CAT,  LOAD, RMODE=ANY
OFFSET =         0 IN SEGMENT 001    ALIGN = DBLWORD
```

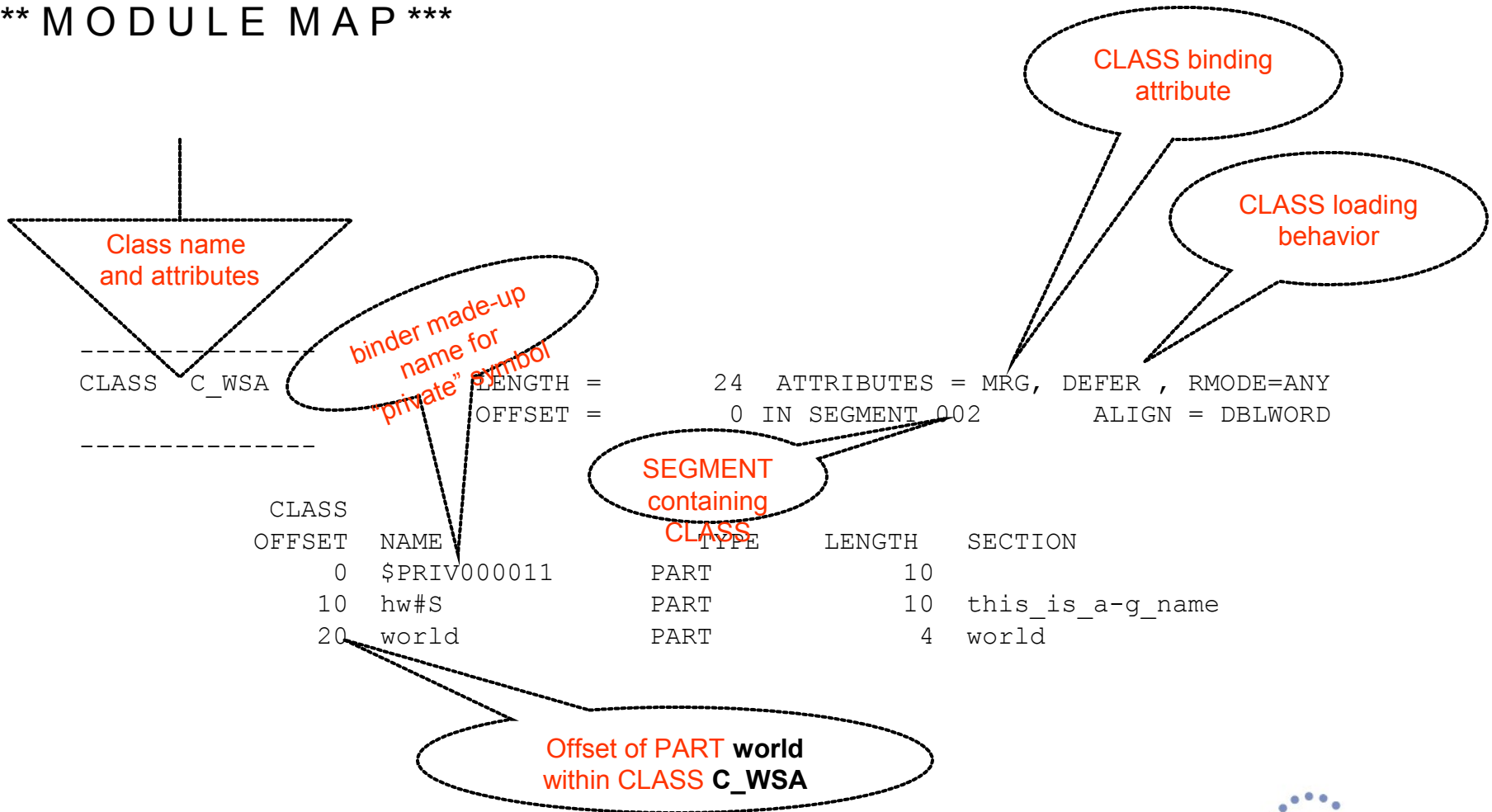


SECTION OFFSET	CLASS OFFSET	NAME	TYPE	LENGTH	DDNAME	SOURCE SEQ	MEMBER
	0	CEESTART	CSECT	7C	/0000001	01	
0	0	CEESTART	LABEL				
	80	this_is_a-g_name	CSECT	E0	/0000001	01	
0	80	this_is_a-g_name	LABEL				
28	A8	main	LABEL				



# Options for SYSPRINT ... MAP ...

\*\*\* MODULE MAP \*\*\*



# Options for SYSPRINT ... XREF

## CROSS-REFERENCE TABLE

TEXT CLASS = C\_CODE

REFERENCE			TARGET				
CLASS	OFFSET	SECT/PART (ABBREV)	ELEMENT OFFSET	TYPE	SYMBOL (ABBREV)	SECTION (ABBREV)	ELEMENT OFFSET CLASS NAME
	2C	CEESTART	2C	V-CON	CEEMAIN	CEEMAIN	0 C_DATA
	68	CEESTART	68	V-CON	CEEFMAIN	<b>\$UNRESOLVED</b>	
	6C	CEESTART	6C	V-CON	CEEBLLST	CEEBLLST	0 B_TEXT
	74	CEESTART	74	V-CON	CEEBETBL	CEEBETBL	0 B_TEXT
	78	CEESTART	78	V-CON	CEEROOTD	CEEROOTA	0 B_TEXT
	14C	this_is_a-g_name	CC	A-CON	CEESTART	CEESTART	0 C_CODE

**All address constants in section CEESTART in CLASS C\_CODE**

**Location to which adcons in section CEESTART have resolved**

**We can see that section CEESTART begins CLASS C\_CODE**



# Options for SYSPRINT ... XREF ...

## CROSS-REFERENCE TABLE

Symbol world is a part... we know from the Module MAP...

Adcon at X'1C' in section hw#S refers to IMPORTED symbol printf. Location of printf not known until run-time.

```
TEXT CLASS = C_WSA
```

R E F E R E N C E				T A R G E T			
CLASS	OFFSET	SECT/PART (ABBREV)	ELEMENT OFFSET TYPE	SYMBOL (ABBREV)	SECTION (ABBREV)	ELEMENT OFFSET CLASS NAME	
	10	hw#S	10 A-CON	world	\$PRIV000003	20 C_WSA	
	18	hw#S	18 R-CON	printf			
	1C	hw#S	1C V-CON	printf	<b>\$IMPORTED</b>		
	20	world	20 A-CON	this_is_a-g_name	this_is_a-g_name	0 C_CODE	
	18	hw#S	18 A-CON			B_IMPEXP	
	1C	hw#S	1C V-CON	CEETHLOC	CEETLOCE	8 B_TEXT	

# Options for SYSPRINT ...

- **INFO** about service level of binder
- **MSGLEVEL** of lowest severity messages to write
  - Default is all (0)
  - Suppresses text, no change to return code!
- **LISTPRIV** for a listing of “private code” sections
  - and if so make it an error (YES)
  - or just informational (INFORM)
- **SYMTRACE** *New in z/OS V2R1 !*
  - Messages for all instances of a named symbol during processing

# Behavior changing options

## LET my program be executable

- **LET=number**
  - “LET this be an executable, even if the return code is equal to or less than number”
  - EXECUTABLE is an attribute in the program and in the case of datasets, in the directory
    - NX in ISPF member list means “Not Executable”
    - Nothing to do with the UNIX execute permission
  - “LET” in batch means LET=8
    - Unspecified or “NOLET” means LET=4

# Behavior changing options ...

## Save a non-executable program

- **STORENX**

- STORENX controls whether the “Not Executable” program is saved
  - The default is NOREPLACE (same as NO)...
  - That means by default, a “Not Executable” program **WILL BE SAVED** if it does not already exist!
  - STORENX=NEVER
    - *Did not always exist, so not the default*

# Behavior changing options ...

## Execute an non-executable program

- What happens if I try to execute an NX program?
  - from batch

```
CSV016I REQUESTED MODULE STOREDNX IS NOT EXECUTABLE
CSV028I ABEND706-04 JOBNAME=BARRYL  STEPNAME=GO
IEA995I SYMPTOM DUMP OUTPUT 467
SYSTEM COMPLETION CODE=706 REASON CODE=00000004
```

- from UNIX... usually you will see...

```
BARRYL [478] /u/barryl/binder/SHARE/SHARE116 $ ./a.out
IEWPLMH: ./a.out 14: FSUM7351 not found
```

- ...shell semantics for a failed spawn, to treat as a shell script
- as a DLL

```
CEE3512S An HFS load of module SNX.dll failed. The system return code was 000000130; the reason code was 053B006C.
From entry point main at compile unit offset +000000A8 at entry offset +000000A8 at address 20F1AA10.
```

# Behavior changing options ...

- **CASE**
  - Applies to option values, control statements and API parameters
  - **UPPER** – Default is to uppercase
  - **MIXED** – Preserve the input as-is
    - c89 default

# Program changing options

- **COMPAT**

- The “compatibility” level of the program
- Specified as z/OS releases
  - Or CURRENT
  - Or (older convention) as PM levels
- Each COMPAT release means the program can be fully functional on that release and above
  - May execute on prior releases but other things may not work

- *Like rebind, IEBCOPY, AMBLIST...*

# Program changing options ...

- **STRIPSEC/STRIPCL** to remove and list “unneeded” stuff
  - To see the “removed” report requires **MAP** option
  - **STRIPSEC=YES**
    - remove unneeded stuff
  - **STRIPSEC=PRIV** *New in z/OS V1R13 !*
    - just unneeded “private” stuff
  - **STRIPCL=YES**
    - Remove class marked as “removable”



# Program changing options ...

- **COMPRESS=YES (default is AUTO)**
  - Can significantly shrink size of program object on disk
  - **No Change** to size of in-storage program!
    - No Change to the program itself (loader / run-time data), only binder owned data
  - Distinguished in **Save Module Attributes (LIST output)**:

```

MODULE SIZE (HEX)      00002BFC
DASD SIZE (HEX)       0000D000 (this had been 00015000)
  
```

- Requires COMPAT(ZOSV1R7)

```

PROGRAM TYPE          PROGRAM OBJECT (FORMAT 4 OS COMPAT LEVEL
z/OS V1R7 )
  
```

- AUTOMatically happens, if beneficial, with this or later COMPAT level
  - *default is COMPAT(MIN)*
  - *will still execute back to ZOSV1R3*
    - *but no rebind, AMBLIST, ZAP, etc.*

# Program changing options ...

- **EDIT=NO**

- *Permanently deletes* the data that COMPRESS would have compressed
- Thus *limited* rebind, AMBLIST, ZAP, etc. *anywhere*

```
MODULE SIZE (HEX)    00002BFC
DASD SIZE (HEX)     00005000
```

- Limitation is binder based so:
  - *AMBLIST of LM works because it doesn't use binder*
  - *Binder supports limited processing of INTENT=ACCESS LM*

# Program changing options ...

- **FILL=xx**
  - All uninitialized areas (but not EXPANDED areas) will be set to this value
    - Some of the areas may be written to disk
    - Some “gaps” will only be “filled” when they are loaded
  - Program Object COMPAT=PM2 or later only! Else RC=4...
    - IEW2695W 4B37 OPTION SPECIFICATION FOR FILL IS NOT VALID FOR VERSION 1 PROGRAM OBJECT OR LOAD MODULE.
  - Intended as debugging aid (not to overcome poor programming!)
    - Also see Language Environment STORAGE options

# Program changing options ...

- **DYNAM=DLL** – Dynamic Link Library
  - exported symbols to SYSDEFSD as IMPORT control statements
  - Control information (visible in **MAP** and AMBLIST output, macros in ‘SYS1.MACLIB’)
    - IEWBLIT section B\_LIT class – Loader Information Table
    - IEWBCIE section B\_IMPEXP class – Import/Export table
- Language Environment high-level languages and High Level Assembler (LE provides macro)
- Execution requires Language Environment run-time support
  - Function “descriptors” enable dynamic linking
- Exploits deferred load C\_WSA[64] class
  - Writable / Static Area
  - LE controls unique instance for each “enclave” of execution
- Dynamic resolution follows all static resolution

# Program changing options ...

- **SIGN=YES** – Program Signing *New in z/OS V1R11*
  - Digital signature is written into program object
    - Constructed based on program data
    - Becomes part of program
    - PDSEs supported only!
  - Requires SAF/RACF setup & services
    - Require keyring or PKCS #11 token to sign
    - Program must be identified as requiring digital signature for execution
      - ... loader verifies correct digital signature prior to execution
  - Cannot use traditional (SMP/E) service methodology since only signer can bind
    - Could use EDIT=NO

# Option-less output

- Written to if exists
- **IEWDIAG**
  - All messages, as if MSGLVEL=0 and LIST=ALL
  - Useful when options cannot be passed (particularly API users)
- **IEWTRACE**
  - IBM service aid, shows key trace points throughout processing
  - TRACE option can limit range (default is ALL)
- **IEWDUMP**
  - IBM service aid, SNAP dump and binder formatted dump
  - Automatic on terminal (level 16) error
  - DUMP option can activate for specific ECODE (binder message or trace point)

# So what comes with the binder?

- Batch binder
- Batch binder loader
  
- Legacy batch linkage editor
- Legacy batch loader
  
- TSO invocations of the above
- UNIX **ld** command to invoke batch binder

# What else comes with the binder?

## Service aids

- **AMASPZAP** (Superzap)
  - Service aid to modify existing program objects
    - binders owns PO support, BCP service aids owns the LM
    - Can modify program text, but not change size, offsets, etc.
- **AMBLIST**
  - Service aid to list the contents of OBJ, GOFF, LM and PO
    - Fully deconstruct
    - PMAR, data and IDRs for programs
    - Segment map for POs
  - **amblist** UNIX command



# What else comes with the binder? Binder APIs

- copy
  - IEBCOPY
  - cp, mv
- bind
  - write your own binder!
    - could have a direct-to-program compiler
    - c89 uses binder APIs
    - ld calls batch binder program

# What else comes with the binder? Binder APIs ...

- edit without rebinding
  - superZAP (change text so long as length is same)
  - change AMODE, RMODE, entry point, reusability attributes
  - add or delete aliases or IDRUs
- extract data
  - AMBLIST
  - Debuggers
  - Performance analyzers
  - nm
- regular APIs support both executable modules formats
  - So need not code separately (PO vs. LM)

# What else comes with the binder? Binder APIs ...

- 1 - Regular (original)
  - Establish dialog with binder (IEWBIND) and create one or more workmods under dialog
  - APIs have a version number indicative of parameter list and functionality
    - Default is Version 1 – don't use it!
  - Binder converts all executables into an internal format called ***workmod***

# What else comes with the binder? Binder APIs ...

- 2 - Fast Data Access
  - Only for Program Objects (Load Module format documented)
  - No **workmod** is created thus processing is streamlined
  - Read-Only access (cannot make *ANY* modifications!)
  - There are two interfaces
    - Request code interface
      - *Introduced in z/OS V1R5*
      - *Simplified parameter list*
      - *More dialog-like (as 'regular' API)*
      - *More functionality*
      - *As of z/OS V1R9 it is completely rewritten and internally an AMODE=64 program*
    - Unitary interface (original)
      - *Macro (IEWBFDA) provided for access and to simplify coding parameters*
      - *Limited functionality (comparable to GD request code only)*
      - *Functionally stabilized*

# What else comes with the binder?

## Binder APIs ...

- 3 – C/C++ DLLs
  - Not really a different flavor!
  - Simplified C interfaces to both regular APIs and fast data access APIs
  - Simplifies management of binder (loading modules, creating buffers)
    - oriented to buffer data (records) returned
  - Provides extra utility interfaces
    - Create lists needed by some API calls
    - Test for end-of-data on get calls
    - Get Return/Reason codes (new APIs)
    - Get/Set cursor
  - Uses *contexts* – for regular APIs this represents workmod+dialog (no facility for multiple workmods in a single dialog)

# What else comes with the binder?

## Binder APIs ...

- 3 – C/C++ DLLs ...
  - APIs in Dynamic Link Library (DLL)
    - **iewbndd.so**
    - **iewbnddx.so** *XPLINK New in z/OS V1R12*
  - C/C++ header file provides buffer structures, API prototypes and other needed data types – **\_\_iew\_api.h**
  - Side file links with application to access DLL
    - **iewbndd.x**
    - **iewbnddx.x** *XPLINK New in z/OS V1R12*
  - Installs into UNIX file system (/usr/lib, header in /usr/include)
  - Installs into datasets (SYS1.SIEAMIGE and SYS1.SIEASID)
    - ***New back to z/OS V1R13!***

# What else comes with the binder?

## Binder APIs ...

- Module data is returned in a buffer provided by the API caller
- IEWBUFF macro can help (but is not required)
- Same buffer format used by both regular APIs and fast data APIs
- Buffers have version numbers indicative of buffer format
  - **Until z/OS V1.10** regular APIs required matching version numbers
  - Version numbers are ubiquitous
- The buffer ID must be consistent with the type of data being requested
  - For example, the buffer ID for ESDs is IEWBESD

# What else comes with the binder?

## Binder APIs ...

- Earlier buffer versions may not contain all information available from later PO formats
  - APIs will attempt to convert data to a format compatible with the buffer version
  - In some cases the conversion cannot be performed and the request will fail.
  - The most likely scenario in which this would happen is using a version 1 ESD buffer to retrieve information from PO format PO2 or greater with multiple text classes
    - *The differences between later PO versions are much smaller*



# What else comes with the binder? Binder APIs ...

buffer ID		length	version
entry length	maximum count	<i>reserved</i>	1 <sup>st</sup> string ptr



# What else comes with the binder?

## Binder APIs ...

- IEWBUFF usage
  - Must specify BUFFER TYPE
    - ESD, RLD, NAME, TEXT etc.
  - Must specify FUNCTION
    - *MAPBUF* - generate buffer mapping for selected buffer type
    - *GETBUF* - acquire storage for buffer
    - *INITBUF* - initialize buffer header
    - *FREEBUF* - release storage acquired via *GETBUF*
  - MAPBUF must be used first since it specifies the buffer size used by GETBUF and values to be inserted in the buffer header.
    - *Buffer size can be specified as SIZE (record count) or BYTES*
    - *Should specify version number (VERSION). Default is version 1 - probably NOT what you want*

# What else comes with the binder?

## Binder APIs ...

- Class name are limited to 16 bytes
- Other ESD names are limited to 32K-1 bytes
- Binder generated names, demangle named and abbreviated names as they appear in the printed output are not how they look in the program
  - You *must* use the *real internal name* in the API
  - C/C++ APIs work with strings representing binder generated names
    - `__iew_api_name_to_str`
- Binder-generated names for sections and symbols are 4-byte binary numbers
  - Printed as \$PRIVxxxxxx, where xxxxxx is the hexadecimal representation of the binary number
- C++ mangled names are used directly as is
  - no demangling provided by APIs

# binder documentation

- SA23-1393 - z/OS MVS Program Management:  
User's Guide and Reference

options & control  
statements

- SA23-1392 - z/OS MVS Program Management:  
Advanced Facilities

binder **APIs**

- GA32-0905 - z/OS MVS Diagnosis:  
Tools and Service Aids

**AMBLIST** and **SPZAP**

- SA32-0975 - z/OS TSO/E Command Reference

**LINK** and  
**LOADGO**

- SA23-2280 - z/OS UNIX System Services  
Command Reference

**c89** and **ld**

# Using the binder to build your application

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March 2014  
Session 15254

