Binder for Beginners

Things You Ought to Know About Link Editing, Whether You Knew It or Not!

Session 09828

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Agenda

• What is the binder and why you need to know about it

• The most prominent users (Where you see it)

• The most frequently used options etc. (Let’s talk options)

• The less obvious users (That was the binder?)

• Deeper dive into binder processing

• Problem diagnosis

• More advanced stuff
What is the binder?

- Wikipedia® under [linker (computing)]: “In IBM mainframe environments such as OS/360 this program is known as a linkage editor.”

- In z/OS it is the program management binder
program management binder

• BCP exclusive base element
  • Wave 0

• z/OS system linker

• Related utilities

• Programming interfaces
program management binder …

• The binder converts the output of language translators and compilers into an executable program unit …

  • … that can either be read directly into virtual storage for execution or stored

• The binder processes object modules, load modules and program objects…

  • *link-editing* or *binding* multiple modules into a single load module or program object
  • … with contiguous virtual storage addresses
program management binder …

- control language
- dynamic library
- object
- static library

binder
invoked with options

- dynamic library
- program
- side files

- static library
- text reports
- error messages
program management binder ...

- 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
binder inputs

• SYSLIN ddname
  • object modules
    • OBJ, XOBJ, GOFF
  • program modules (executables)
    • load modules
    • program objects
• control statements
binder outputs

- **SYSPRINT ddname**
  - text reports
  - error messages

- **SYSLMOD ddname**
  - program module / static or dynamic libraries

- **SYSDEFSD ddname**
  - side-file for dynamic libraries
Where you see it

- **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
a reflection on the past …

- Invocations of actual linkage editor and batch loader
  - HEWLD*
    - Any remaining invocations of these are batch loader
  - IEWL* or HEWL*
    - Any remaining invocations of these are linkage editor
  - If you have any of these, we’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
Let’s talk options!

- options for SYSPRINT
- to LET or not to LET
- options, options everywhere
- program changing options
options for SYSPRINT

- LIST, MAP, XREF
  - most common (more on these later…)

- 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)
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)
- **STRIPSEC/STRIPCL** to remove and list “unneeded” stuff
  - To see the “removed” report requires **MAP** option
  - **STRIPSEC=PRIV** – just unneeded “private” stuff
  - *introduced in z/OS V1R13!*
to LET or not to LET

- \texttt{LET} = \text{number}
  - “LET this be an executable, even if the return code is equal to or less than number”
  - \texttt{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 \texttt{LET}=8
    - Unspecified or “NOLET” means \texttt{LET}=4
to LET or not to LET…
what was the question ??

• 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

  • introduced in z/OS V1R8 -- but not the default!
to LET or not to LET… what if I LET it STORENX?

- Depends where and how invoked…
  - from batch
    
    ```
    CSV016I REQUESTED MODULE STOREDNX IS NOT EXECUTABLE
    CSV028I ABEND706-04 JOBNAME=BARRYLR  STEPNAME=GO
    IEA995I SYMPTOM DUMP OUTPUT 467
    SYSTEM COMPLETION CODE=706  REASON CODE=00000004
    ```

  - from UNIX… usually you will see…
    
    ```
    BARRY [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.```
Options, options everywhere!

- **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.*
Options, options everywhere! …

- Options on control statements
  - MODE - AMODE, RMODE options
  - ENTRY - EP option
  - SETOPT – just about everything!
    - Nothing “environmental” please!
Options, options everywhere! …

Options precedence (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 EN_VARS 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
Program changing options

- **COMPRESSion=YES**
  - 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) | DASD SIZE (HEX) |
    |-------------------|-----------------|
    | 00002BFC          | 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.

- **EDIT=NO**
  - **Permanently deletes** the data that COMPRESS would have compressed
  - Thus **limited** rebind, AMBLIST, ZAP, etc. anywhere
    
    | MODULE SIZE (HEX) | DASD SIZE (HEX) |
    |-------------------|-----------------|
    | 00002BFC          | 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 …

- **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 – *introduced 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
That was the binder?

- Who was that masked binder?
  - The usual suspects:
    - Batch LINKEDIT, IEWL, etc.
  - Invoked as a program call:
    - SMP/E (it’s *not really* JCL!)
    - TSO LINK, LOAD, LOADGO
    - ld command (UNIX)
  - Using the binder Application Programming Interfaces (APIs)
    - c89 (c++), cob2, pli, xlc (xIC)
    - IEBCOPY (sometimes!)
    - ZAP
    - AMBLIST
That was the binder? …

- Where did *that* come from?? (the wonderful world of UNIX)
  - makefiles
    - Watch out for 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
That was the binder? ...

- You know it’s the binder if...
  - **All** IEW2xxxx messages
    - *SYSPRINT and SYSTEM in batch*
    - *IEWDIAG also!*
  - IEWBIND environment variables
    - **IEWBIND_DIAG**
      - to catch a message
    - **IEWBIND_OPTIONS**
      - from regular API only, no *known* users
Deeper dive into binder processing

- All about AUTOCALL
- A closer look at the logical structure
All about AUTOCALL

- SYSLIB ddname
- AUTOCALL control statements
- LIBRARY control statements

- PDSs and PDSEs
  - “C370LIB” Object Libraries
- UNIX archive files

- Traditionally
  - The unresolved symbol name is searched for as the member name
    - The expectation is that the member, if found, will contain the symbol

- Object Libraries and UNIX archives extend this
  - They have their own directories of defined symbol names
All about AUTOCALL …

• CALL (default) or NCAL
  • CALL=YES or NOCALL or CALL=NO

• SYSLIB ddname
  • Concatenation of data sets
    • All kinds – object modules, load modules, program objects

• Searched for only after reading all SYSLIN input
All about AUTOCALL …

• AUTOCALL
  • UNIX “incremental”
  • Use this library right now
  • Then, forget about it!

• LIBRARY
  • Qualified with member/symbol for:
    • additional CALL (like INCLUDE but only if unresolved)
    • restricted NO-CALL
    • NEVER-CALL
  • Unqualified support added for UNIX final autocall
    • couldn’t do it with SYSLIB concatenation
  • Searched in order just before SYSLIB
load module vs. program object

Loaded Text

<table>
<thead>
<tr>
<th>CSECT</th>
<th>CSECT</th>
<th>CSECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

Unloaded Data

| SYM data | IDR data | RLD data | ESD data |

Class X

Class Y1

Class Y2

Class Z

Section A

Section B

Section C

element

part

element

part

element

part

element

part
load module vs. program object …

• Load modules
  • Single-dimensional
  • Documented format
  • Format never to be (substantially) be changed

• Program objects
  • Multi-dimensional
    • Class vs. section
  • Format never to be documented
    • Changes regularly – COMPAT(PMnn) levels and zOSVnRn sublevels
      • Currently 8 levels and sublevels
Problem diagnosis

• A little more of what goes on inside

• Understanding the outputs
  • For when that program won’t bind
  • For when the program needs to be debugged

• Common problems and helpful tips
program management binder ...

symbol resolution

- In Section A there is a call (reference) to B which will be statically linked to A
- Location of B relative to the call in Section A is determined at bind time
- Final relocation of entire executable program module determined at load time

![Diagram showing symbol resolution process]
relocation

- There is an External Symbol Dictionary (ESD) entry for the location of B
- There is an Relocation Dictionary (RLD) entry for the location in A to write the location of B
- What if B is unresolved?

```
<table>
<thead>
<tr>
<th>Module A</th>
<th>Module AB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section A</strong></td>
<td><strong>Section A</strong></td>
</tr>
<tr>
<td>ESD</td>
<td>ESD</td>
</tr>
<tr>
<td>reference to B $00000000$</td>
<td>reference to B $00000200$</td>
</tr>
<tr>
<td>TXT</td>
<td>TXT</td>
</tr>
<tr>
<td>L R15,=A(B+10)</td>
<td>L R15,=A(B+10)</td>
</tr>
<tr>
<td>adcon for B+10 $0000000A$</td>
<td>adcon for B+10 $0000020A$</td>
</tr>
<tr>
<td>RLD</td>
<td>RLD</td>
</tr>
<tr>
<td>relocation for B</td>
<td>relocation for B</td>
</tr>
</tbody>
</table>
```

```c

```

```
SYSPRINT details

• **SYSPRINT**
  - Messages (IEW2nnnns) also **SYSTERM**
  - 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
SYSPRINT details …

- 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
MAP

*** MODULE MAP ***

CLASS name and attributes

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

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

*** MODULE MAP ***

CLASS C_WSA

LENGTH = 24
OFFSET = 0 IN SEGMENT 002
ALIGN = DBLWORD

CLASS binding attribute

CLASS loading behavior

---

binder made-up name for "private" symbol

CLASS binding

attribute

CLASS loading

behavior

SEGMENT containing CLASS

CLASS binding attribute

CLASS loading behavior

Offset of PART world within CLASS C_WSA

CLASS binding

attribute

CLASS loading behavior

Offset of PART world within CLASS C_WSA
XREF

CROSS-REFERENCE TABLE

<table>
<thead>
<tr>
<th>TEXT CLASS = C_CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>CLASS</th>
<th>OFFSET</th>
<th>SECT/PART (ABBREV)</th>
<th>ELEMENT</th>
<th>OFFSET</th>
<th>TYPE</th>
<th>SYMBOL (ABBREV)</th>
<th>SECTION (ABBREV)</th>
<th>OFFSET</th>
<th>CLASS NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>2C</td>
<td>CEESTART</td>
<td>V-CON</td>
<td>CEEMAIN</td>
<td>0</td>
<td>C_DATA</td>
<td>CEEMAIN</td>
<td>CEEMAIN</td>
<td>0</td>
<td>C_DATA</td>
</tr>
<tr>
<td>68</td>
<td>CEESTART</td>
<td>V-CON</td>
<td>CEEFMAIN</td>
<td>$UNRESOLVED</td>
<td>0</td>
<td>B_TEXT</td>
<td>CEEFMAIN</td>
<td>$UNRESOLVED</td>
<td>0</td>
</tr>
<tr>
<td>6C</td>
<td>CEESTART</td>
<td>V-CON</td>
<td>CEEBLLST</td>
<td>CEEBLLST</td>
<td>0</td>
<td>B_TEXT</td>
<td>CEEBLLST</td>
<td>0</td>
<td>B_TEXT</td>
</tr>
<tr>
<td>74</td>
<td>CEESTART</td>
<td>V-CON</td>
<td>CEEBETBL</td>
<td>CEEBETBL</td>
<td>0</td>
<td>B_TEXT</td>
<td>CEEBETBL</td>
<td>0</td>
<td>B_TEXT</td>
</tr>
<tr>
<td>78</td>
<td>CEESTART</td>
<td>V-CON</td>
<td>CEEROOTA</td>
<td>CEEROOTA</td>
<td>0</td>
<td>B_TEXT</td>
<td>CEEROOTA</td>
<td>0</td>
<td>B_TEXT</td>
</tr>
<tr>
<td>14C</td>
<td>this_is_a-g_name</td>
<td>A-CON</td>
<td>CEESTART</td>
<td>0</td>
<td>C_CODE</td>
<td>CEESTART</td>
<td>CEESTART</td>
<td>0</td>
<td>C_CODE</td>
</tr>
</tbody>
</table>
**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.

<table>
<thead>
<tr>
<th>CLASS OFFSET SECT/PART(ABBREV)</th>
<th>ELEMENT OFFSET TYPE</th>
<th>SYMBOL(ABBREV)</th>
<th>SECTION (ABBREV)</th>
<th>CLASS OFFSET CLASS NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 hw#S</td>
<td>10 A-CON</td>
<td>world</td>
<td>$PRIV000003</td>
<td>20 C_WSA</td>
</tr>
<tr>
<td>18 hw#S</td>
<td>18 R-CON</td>
<td>printf</td>
<td>$IMPORTED</td>
<td>20 C_WSA</td>
</tr>
<tr>
<td>1C hw#S</td>
<td>1C V-CON</td>
<td>printf</td>
<td>$IMPORTED</td>
<td>20 C_WSA</td>
</tr>
<tr>
<td>20 world</td>
<td>20 A-CON</td>
<td>this_is_a-g_name</td>
<td>this_is_a-g_name</td>
<td>0 C_CODE</td>
</tr>
<tr>
<td>18 hw#S</td>
<td>18 A-CON</td>
<td>this_is_a-g_name</td>
<td>this_is_a-g_name</td>
<td>0 C_CODE</td>
</tr>
<tr>
<td>1C hw#S</td>
<td>1C V-CON</td>
<td>CEETHLOC</td>
<td>CEETLOC</td>
<td>8 B_TEXT</td>
</tr>
</tbody>
</table>
common problems & helpful tips

- Mixed-case input

IEW2456E 9207 SYMBOL myfunc UNRESOLVED. MEMBER COULD NOT BE INCLUDED FROM THE DESIGNATED CALL LIBRARY.

- Traditional names (from OBJ) are uppercase
  - Compatibility dictates the default CASE=UPPER
    - *Not to be confused with UPCASE=YES!*

- Affects options values and control statement symbols
  - Option names and control statement keywords are case insensitive
    - *INCLUDE, include, Include*

- Most often an issue for IMPORT control statements (DLLs)

- Recommendations
  - CASE=MIXED
    - *Import Code,a.dll,myFunc*
    - *quote_name*
      - *INCLUDE `/u/barryl/C/hello.o`*
      - *include PDSELIB('hello')*
common problems & helpful tips …

• Long symbol names

• Member names (at least in PDSs) are 8 characters

• Problem introduced when building the object modules…
  • C/C++ LONGNAME option required

• … or when creating the (object) libraries
  • UNIX archive libraries manage their own internal directory
  • data set based (“C370LIB”) Object Libraries have a special directory member
    • @@DC370$, @@DC390$
common problems & helpful tips …

• Long symbol names …

IEW2459W 9206 INCLUDED MEMBER s1 FAILED TO RESOLVE REFERENCE.

IEW2497W 9229 THE SYMBOL s1 WAS EXPECTED TO BE RESOLVED BY INCLUDING MEMBER SUB3 FROM THE LIBRARY DEFINED BY DDNAME C8961

• Worst case scenario!
  • Replacement object module incorrectly built (perhaps NOLONGNAME)
  • Directory member was previous built and not updated

• IEW2497W introduced in z/OS V1R12

• Module already included, may resolve other symbols!
common problems & helpful tips …

- Unresolved but it’s there?
  - DYNAM=DLL may be required!
    - If “definition” is on IMPORT statement
      - Otherwise binder processes IMPORTs but silently ignores them
common problems & helpful tips …

• Where did *that* thing come from?
  
  • Modules brought in by autocall
  
  • Turning on LIST=ALL
  
  • *IEW2340I introduced in z/OS V1R12*

IEW2340I 1036 MEMBER NAME CEEROOTD IN THE LIBRARY DEFINED BY DDNAME SYSLIB IS BEING INCLUDED TO RESOLVE REFERENCE TO CEEROOTD

IEW2308I 1112 SECTION CEEROOTA HAS BEEN MERGED.

• Especially for archives & C370LIBs
common problems & helpful tips …

• for situations where options cannot otherwise be passed

  • particularly API based programs

    • IEWPARMS
      • like OPTIONS

    • IEWDIAG
      • like SYSTERM with LIST=ALL, MSGLEVEL=0
        • useful if you are unable to pass those options
common problems & helpful tips …

- AMBLIST
  - LISTOBJ – all object modules
  - LISTIDR – all identification records; user IDENTIFY, language, binder, zap (EDIT=YES required)
common problems & helpful tips …

• AMBLIST …
  • LISTLOAD – all program modules (EDIT=YES required!)
    • Like binder MAP and XREF and more!
    • PMAR (partially) decoded and (fully) dumped
    • MODLIST
      • Section / Class information …
      • … including TEXT
        • Merge class part initializers decoded
        • IEWBCIE / B_IMPEXP decoded
    • MAP
      • SEGMENT map
      • Numerical MAP
    • XREF
      • SEGMENT map
      • Numerical MAP and XREF
      • Alphabetical MAP and XREF
  • AMBLIST LISTLOAD ebcdic translation for load modules — Introduced in z/OS V1R12!
More advanced stuff

- It’s truly not the linkage editor!
- Diagnostic DD’s
- EXITs
- APIs
It’s truly not the linkage editor!

• Really not the linkage editor!
  • Application programming interface
  • DLLs, XPLINK
  • Classes (INIT load, NO load and DEFER load)
  • …

• PDSE, UNIX
  • program object format – PO (COMPAT(PMx))
  • exclusively binder
  • loaded by program management loader

• PDS
  • load module format
  • just like the linkage editor used to do
    • HEWLKED anybody?
  • loaded by program management loader (program fetch)
Diagnostic DD’s

• IEWTRACE ddname – TRACE option
  - binder internal trace table
  - shows function entry / exit and other key processing points
  - shows ECODEs (part of which is 4 character code after message number)
  - can filter entries with TRACE=(start,end) or selectively TRACE=‘c[c…]’

• IEWDUMP – DUMP option
  - if allocated, automatically written upon terminal binder error or program check or abend
  - can be forced with DUMP option specifying ecode
    - binder continues processing for non-terminating condition
    - binder takes SNAP of binder storage and then formats key internal structures

  • note: these diagnostics are normally used only for IBM problem determination
  • limited information provided in program management documentation
Exits

• User exits – EXIT option
  • provide module exit name

• MESSAGE
  • filter all messages of specified severity or higher
  • prevent or allow the message to print
  • no effect on final return code of binder

• SAVE
  • notification of each primary (member) name and alias name to be saved
  • request retry for certain failures

• INTFVAL (Interface Validation)
  • after all input processing, including autocall
  • examine all references (resolved and unresolved) for each section
  • can allow unresolved, can change resolution to another symbol or glue
  • default processing can result in error if target & reference disagree in
    1. *ESD* signature fields
    2. *XPLINK* attributes
    3. *AMODE(64)* mismatch
    4. Namespaces (like code (instructions) vs. data)
    5. Certain class attributes (like catenate vs. merge)
APIs

• Application Programming Interfaces (APIs)
  
  • data is input or output via buffers unique to each type of data
    • for example, ESDs
    • IEWBUFF macro can simplify creating buffers
      • allocate, initialize, map and delete buffers
      • not required
  
  • regular binder APIs
    • IEWBIND macro
    • not required
  
  • fast data access
    • for program objects only
      • faster due to direct access, bypass workmod conversion
    • request code interface
      • obsoleted IEWBFDA macro “unitary” interface
  
• C APIs
  
  • NOXPLINK and XPLINK — introduced in z/OS V1R12!
  • buffers in a header, C language oriented structures
  • simplifies access by automatically managing buffers for you
  • both regular API and fast data access functions provided
program management documentation

- SA22-7643 - z/OS MVS Program Management: User’s Guide and Reference
  for options & control statements

- SA22-7644 - z/OS MVS Program Management: Advanced Facilities
  for binder APIs

- GA22-7589 - z/OS MVS Diagnosis: Tools and Service Aids
  for AMBLIST and SPZAP

- SA22-7782 - z/OS TSO/E Command Reference
  for LINK and LOADGO

- SA22-7802 - z/OS UNIX System Services Command Reference
  for c89 and Id