Implementing LE in an IMS Environment at Telcordia

Session C02

Steve Nathan
stephen.nathan@telcordia.com

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    - aadleman@telcordia.com
- They have spent MANY hours studying this topic and working with IMS and LE development to make this environment work

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Presentation Outline

- Overview – What is LE?
- Migrating to LE
- Runtime Options
- Debugging LE

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Introduction

- This session will cover Language Environment (LE) setup and options that pertain to an IMS environment
- Topics will include runtime and initialization options and any differences in setting up IMS online, BMP and batch environments
- The new IMS Version 8 Dynamic Runtime Options will also be discussed
- This presentation was prepared at the OS/390 V2R10 level and updated for z/OS
  - It is now at the z/OS1.4 level
- This presentation will make no attempt to discuss applications which may also use OS/390 UNIX Systems Services

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LE Overview

- What is Language Environment (LE)?
  - Single runtime environment for High Level Languages
    - Basic support routines
      - Initialization, termination, storage, messages, conditions
    - Callable Services
      - Date, time, etc
    - Language specific routines
      - C/C++
      - Cobol
      - PL/I
      - Fortran

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LE Overview

- What is Language Environment (LE)?
  - LE “Process”
    - Address space (ASID)
  - LE “Enclave”
    - Main program and called subroutines
    - Main to Main calls create new Enclaves
  - LE “Thread”
    - Task (TCB)

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LE Overview

- Why use LE?
  - Because you have to
  - Base element of OS/390 & z/OS
  - Prerequisite for applications built with newer compilers
  - Replaces obsolete/stabilized runtime library products

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Migration – Multiple LE Releases

- LE is upward compatible
  - Applications built on one level of LE will continue to run on later releases of LE without the need to relink or recompile
- Starting with OS/390 R10 – LE is also downward compatible
  - You may develop applications on higher releases of LE for use on platforms running lower releases of LE
  - The LE Programming Guide lists guidelines and restrictions
    - This is NOT a rollback of new function to prior releases
    - The system used to build the applications must be at least OS/390 V2R10
  - Toleration PTFs for lower OS/390 releases are in a PSP bucket
    - Upgrade OS390R10 subset LANGENV
    - Not in z/OS

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Migrating/Upgrading IMS For LE

- Make sure applications are ready
  - Read the language-specific LE Migration Guides
    - LE guide
    - Language specific guide
  - PLAN
    - Know current/changed runtime options
  - Perform regression tests
    - Include error scenarios
- Make sure Vendor tools are LE enabled
  - There is a list in the LE Migration Guide – Appendix A or call the vendor

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Migrating/Upgrading IMS For LE

- Read the IMS specific portions of the LE manuals
  - "Running Applications Under IMS" in the LE Programming Guide
  - "Using Language Environment Under IMS" in the LE Customization Guide
  - Language Environment Run-Time Options" in the Customization Guide
- Bookmanager search for "IMS" in the LE bookshelf does not work well

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Migrating/Upgrading IMS For LE

- LPA, LNKLIST or STEPLIB for LE modules?
  - LNKLIST for most LE modules
    - SCEERUN (PDS) and SCEERUN2 (new PDSE – V2R10)
  - LPA for heavily used LE modules
    - SCEELPA contains LPA eligible LE modules
    - Also check language-specific recommendations in Migration Guides
  - See OS/390 Program Directory
    - LNKLSTxx Considerations
  - APAR II10425
    - How to install OS/390 without LE in the LNKLIST

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Migrating/Upgrading IMS For LE

- STEPLIB for LE modules
  - Use STEPLIB to test LE for the first time or new LE releases
    - CEE.SCEERUN and CEE.SCEERUN2
  - Use STEPLIB until LE migration is complete
  - There are considerations for IMS preload

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PLICALLA

- If your load module is using PLICALLA (as many IMS programs do)
  - In linked steps you must do one of the following:
    - Put SIBMCALL or SIBMCALL2 ahead of SCEELKED
    - Explicitly INCLUDE LE-provided PLISTART CSECT
- If your load module is not using PLICALLA
  - Do not do either of the above because they will needlessly increase your load module size

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IMS Data Capture Exit

- The IMS Customization manual says:
  - "IMS does not support exit routines running under Language Environment for OS/390"
- IMS Data Capture Exits can be written in high-level languages
  - These run with LE
- IBM has tested this environment and will now support it
  - The manuals will be updated
    - Still there in V8
  - Fixes will be required

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IMS Data Capture Exit

- OS/390 R10 or above requires an IMS APAR
  - DFSPCC40 must initialize the LINKX parameter list
  - PQ47639 (V7)
- APARs PQ35776 and PQ31566 document Abendu4087 with “F1SA” in Register 2 after AbendU4000 in IGZCFCC
  - These APARs were closed “CAN”
    - Use the ABPERC(U4000) runtime option to percolate the U4000
    - Tailor LE assembler exit CEEBXITA to set the runtime option

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Library Retention Routine

- Library Retention Routine (LRR)
  - Keeps LE resources in memory for better performance
    - Uses LE PREINIT
  - Can not be used for application programs
    - Use IMS Preload for that
- LRR setup
  - Specify CEELRRIN in the DFSINTxx member of the IMS PROCLIB
  - Specify ‘xx’ as the suffix on the PREINIT keyword in the IMS Dependent Region JCL
- Setting the STORAGE option to (NONE,NONE,NONE,0) is important for performance
  - This is the default for a non-CICS environment

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Library Retention Routine

- XPLINK (Extra Performance Linkage) is a performance option for C/C++ subroutine linkage
- It is documented as working in an IMS environment
  - Check PQ39145
- We are still trying to make it work
- It is documented as NOT working in an LRR environment
  - See PQ51511 – IMS incorrectly thought XPLINK was used
  - See PQ75251 – Create a non-XPLINK C/C++ environment for IMS LRR

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LRR Load Notification User Exit

- The LRR Load Notification User Exit can be used to improve performance by preventing the use count for frequently used modules from dropping below one
  - Invoked at region initialization
  - Invoked after each successful load by LE
    - Can issue a second load to increase the use count
  - Invoked at region termination
    - Can issue a delete to lower the use count to zero
- Exit name is CEEBLNUE and there is a sample of the same name in SAMPLIB
- See the LE Customization manual for details

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IMS Preload and PDSE

- If you are using the new LE C compiler for C/C++ and you are using the new DLL support then your load modules will be in PDSE's
- IMS documentation has stated that IMS Preload does not support PDSE's
- This is not true

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LE Runtime Options

- There are MANY LE runtime options
  - They have MANY parameters
- They are documented in the LE Programming Reference manual
- The LE Migration Guide lists current recommendations
  - Language specific
  - Mixed language applications
  - CICS environments
    - For some reason CICS always seems to be an exception
  - Non-CICS environments
    - This includes IMS

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LE Runtime Options

- ABPERC (NONE)
- ABTERMENC(ABEND)
- NOAIXBLD
- ALL31(ON)
- ANYHEAP(65536,65536,ANYWHERE,KEEP)
- NOAUTOTASK
- BELOWHEAP(32768,32768,KEEP)
- CBLOPTS(ON)
- CBLPSHPOP(ON)
- CBLQDA(ON)
- CHECK(OFF)
- COUNTRY(US)
- NODEBUG
- DEPTHCONDLMT(0)
- ENVAR(“”)
- ERRCOUNT(0)
- ERRUNIT(6)
- FILEHIST
- FILETAG(NOAUTOCVT,NOAUTOTAG)
- NOFLOW
- HEAP(5242880,1048576,ANYWHERE,KEEP, 32768,32768)
- HEAPCHK(OFF,1,0,0)
- HEAPPOOLS(OFF,8,20,32,100,128,100,256,100, 1024,10,2048,10)
- INFOMSGFILTER(OFF,,,,)
- INQPCOPN
- INTERRUPT(OFF)
- LIBRARY(SYSCEE)
- LIBSTACK(8192,8192,KEEP)
- MSGFILE(SYSOUT,FBA,121,0,NOENQ)
- MSGQ(15)
- NATLANG(ENU)
- NONONIPTSTACK
- OCSTATUS
- NOPC
- PLITASKCOUNT(20)
- POSIX(OFF)

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LE Runtime Options

- PROFILE(OFF,"")
- PRTUNIT(6)
- PUNUNIT(7)
- RDRUNIT(5)
- RECPAD(OFF)
- RPTOPTS(ON)
- RPTSTG(OFF)
- NORTEREUS
- RTLS(OFF)
- NOSIMVRD
- STACK(524288,524288,ANYWHERE,KEEP, 524288,131072)
- STORAGE(NONE,NONE,NONE,0)
- TERMTHDACT(UADUMP,,96)
- NOTEST(ALL,"*","PROMPT","INSPPREF")
- THREADHEAP(4096,4096,ANYWHERE,KEEP)
- THREADSTACK(OFF,4096,4096,ANYWHERE, KEEP,131072,131072)
- TRACE(OFF,4096,DUMP,LE=0)
- TRAP(ON,SPIE)
- UPSI(00000000)
- NOUSRHDLR(,)
- VCTRSAVE(OFF)
- VERSION()
- XPLINK(OFF)
- XUFLOW(AUTO)

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LE Runtime Options

- ABTERMENC
  - ABTERMENC sets the ***enclave*** termination behavior for an ***enclave*** ending with an unhandled condition of severity 2 or greater
  - TRAP(ON) must be in effect for ABTERMENC to have an effect
  - Valid values are RETCD or ABEND
  - ALWAYS specify ABEND for IMS
    - This is the default starting with OS/390 V2R9
    - Do not override it

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LE Runtime Options

- DEPTHCONDLMT
  - DEPTHCONDLMT specifies the extent to which conditions can be nested
  - The default is 10
  - The recommendation is 0
    - This allows an unlimited depth of condition handling
    - This also provides PL/I compatibility

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LE Runtime Options

- ERRCOUNT
  - ERRCOUNT specifies how many conditions of severity 2, 3, or 4 can occur per ***thread*** before the ***enclave*** terminates abnormally
  - After the number specified in ERRCOUNT is reached, no further Language Environment condition management, including CEEHDLR management, is honored.
  - The default starting with OS/390 V2R6 is zero
  - Zero is the recommedation

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LE Runtime Options

- TERMTHDACT
  - TERMTHDACT sets the level of information that is produced when Language Environment percolates a condition of severity 2 or greater beyond the first routine's stack frame
  - The default option is TRACE
    - LE generates a message indicating the cause of the termination and a trace of the active routines on the activation stack as well as an options report
  - The UADUMP option and a DD statement will get a U4039 dump
  - See the LE Programming Reference manual for all of the options and their meanings

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LE Runtime Options

- TRAP
  - TRAP specifies how Language Environment programs handle abends and program interrupts
  - This option is similar to the STAE | NOSTAE runtime option offered by COBOL, C, and PL/I, and the SPIE | NOSPIE option offered by C and PL/I in non-LE environments
    - But not really
  - TRAP(ON) must be in effect for the ABTERMENC runtime option to have effect

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LE Runtime Options for Performance

- ANYHEAP, BELOWHEAP, HEAP, THREADHEAP
  - ANYHEAP, BELOWHEAP and THREADHEAP are used by LE
  - HEAP is used by the application
- LIBSTACK, STACK, THREADSTACK (Save Areas)
  - LIBSTACK and THREADSTACK are used by LE
  - STACK is used by the application

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LE Runtime Options for Performance

- This is part of the output from a STROBE report where STACK was too small

```
#PUP                    ** PROGRAM USAGE BY PROCEDURE **.SYSTEM      SYSTEM
  SERVICES              .LELIB       LE/370 LIBRARY SUBROUTNE
MODULE  SECTION   FUNCTION                    % CPU TIME  MARGIN OF ERROR  2.13%
  NAME    NAME                                 SOLO  TOTAL  00      9.00    18.00
 CEEBINIT CEEVGTSI  GET A STACK INCREMENT     17.45  17.49  ********************
 CEEBINIT CEEVGTS1  CEEVGTSI STUB ROUTINE      2.74   2.74  ****
 CEEBINIT CEEVTOVF  STACK OVERFLOW ROUTINE     1.80   1.80  ***
 CEEPLPKA           LE/370 VECTOR CSECT         .05    .05
                                              -----  -----
  SECTION    .LELIB   TOTALS:                 22.04  22.08
```

LE Runtime Options for Performance

- The STACK logic is called throughout the program

```
#ACE                    ** ATTRIBUTION OF CPU EXECUTION TIME **

.LELIB   CEEBINIT CEEVGTSI  GET A STACK INCREMENT

---------------INVOKED BY-----------------    ------VIA-------     -CPU TIME %-

XACTION  MODULE   SECTION    RETURN   LINE     MODULE   SECTION      SOLO  TOTAL

         PGM001   *PGM0011   005E7A                                  1.70   1.70

         PGM001   *PGM0011   005E84                                  1.99   1.99

         PGM001   *PGM0011   00E67E                                  1.99   1.99

         PGM001   *PGM0011   00E6B4                                  1.99   1.99

         PGM001   *PGM0011   00E6BE                                  2.08   2.13

         PGM001   *PGM0011   00E6DA                                   .99    .99

         PGM001   *PGM0011   00E78A                                  2.55   2.55

         PGM001   *PGM0011   00EC38                                  1.80   1.80

         PGM001   *PGM0011   00F716                                  2.27   2.27

         PGM001   *PGM0011   01200C                                   .05    .05

         PGM001   *PGM0011   020F88                                   .05    .05

                                                                    -----  -----

                                                                    17.45  17.49
```

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LE Runtime Options for Performance

- RPTOPTS
  - Generate report of options in effect
- RPTSTG
  - Generate reports of actual storage used
  - Use RPTSTG suggested values to minimize GETMAINs
  - Do not generate reports during production!!!

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LRR Storage Tuning User Exit

- The LRR Storage Tuning User Exit has two functions
  - Collect LE storage tuning information without having to run with the RPTSTG option
  - Set the LE runtime options STACK, LIBSTACK, HEAP, ANYHEAP, and BELOWHEAP for each LE ***enclave***
- The exit name must be CEEBSTX (for non-CICS environments with LRR)
- There is a sample in SCEESAMP named CEEWBSTX
- See the LE Customization manual for details

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LE Runtime Options for Performance

- LE runtime options changed at z/OS 1.2
  - ALL31(ON)
    - Tell LE that no application routines are AMODE 24
  - STACK(,,ANY,,,)
    - Puts stack storage above the line
  - THREADSTACK(,,,ANY,,,)
    - Puts thread stacks above the line for multi-threaded applications
  - STORAGE(,,,0K)
    - Eliminates below the line reserved stack storage
- This is known as the Favor 31-Bit Application Enhancement

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LE Runtime Options for Performance

- ALL31
  - ALL31 specifies whether an application can run entirely in AMODE 31 or whether the application has one or more AMODE 24 routines
  - This option does not implicitly alter storage, in particular storage managed by the STACK and HEAP runtime options
  - However, you must be aware of your application's requirements for stack and heap storage, because such storage can potentially be allocated above the line while running in AMODE 24
  - It is recommended that ALL31 have the same setting for all ***enclaves*** in a ***process***
    - LE does not support the invocation of a nested ***enclave*** requiring ALL31(OFF) from an ***enclave*** running with ALL31(ON) in non-CICS environments.

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LE Runtime Options for Performance

- Favor 31-Bit Application Enhancement
  - IMS applications compiled with C/370 and linked with the pre-LE CTDLI stub and run with ALL31(OFF) may abend because LWS (Library Work Space) storage is not allocated
    - This is fixed with APAR PQ56143
    - Or you can relink with LE version of CTDLI
  - The Reserve Stack needs to be a minimum of 32K
    - STORAGE(,,,nK)
    - Used by LE to process out-of-storage conditions

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Setting LE Runtime Options

- There are MANY ways to set LE runtime options
  - CEEDOPT
  - CEEROPT
  - CEEUOPT
  - Application Load Module
  - IMS V8 Dynamic LE runtime options
  - LRR Storage Tuning User Exit

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Setting LE Runtime Options

- CEEDOPT
  - Installation-wide LE default options
- CEEROPT
  - Region-wide LE options (if IMS with LRR)
  - CEEROPT can only be used in IMS (with LRR) and CICS environments

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Setting LE Runtime Options

- CEEUOPT
  - Application specific LE options
  - Must be linked with the application

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Setting LE Runtime Options

- Load module
  - PL/I main
    - PLIXOPT
  - C main
    - #pragma runopts()
- LRR Storage Tuning User Exit
  - This was previously discussed

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - IMS users asked for the ability to dynamically change LE runtime options for an IMS transaction
  - The solution should not require that CEEROPT or CEEUOPT or the application to be recompiled or relinked
  - This requirement was met in IMS V8

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - New IMSplex commands allow a user to dynamically update, delete, and query LE runtime options
    - There are no equivalent “/” commands
  - Requires new IMS V8 Operations Manager (OM)
  - Uses DFSBXITA, an IMS specific version of CEEBXITA
    - DFSBXITA uses an enhanced DL/I INQY call to retrieve the dynamic options

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - Filters are used to decide when to set the dynamic LE runtime options
    - Transaction Code
    - LTERM
    - Userid
    - Program

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - Users can specify whether or not IMS should allow dynamic runtime option overrides
    - LEOPT= Y or N in the DFSCGxxx IMS Proclib member
    - UPD LE SET(LEOPT(YES or NO)) IMSplex command
  - QUERY MEMBER TYPE(IMS) displays “LEOPT” if overrides are enabled
  - JMP/JBP regions must also have JLEOPT=Y specified in the Environment Proclib member
    - These regions require APAR PQ54375 to use Dynamic LE Runtime Options

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - The dynamic LE options are specified and displayed with IMSplex commands
    - UPDATE LE
    - DELETE LE
    - QUERY LE
  - Standard OM (Operations Manager) security is used

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - The UPD LE command is used to set dynamic LE runtime options based on a filter of transaction code and/or LTERM and/or USERID and/or program
    - At least one filter must be specified
  - The UPD LE command can be issued while dynamic LE options are disabled
    - The options and filters will be saved and go into effect when dynamic LE options are enabled

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - The DELETE LE command is used to delete dynamic LE runtime options based on a filter of transaction code and/or LTERM and/or USERID and/or program
    - At least one filter must be specified
    - All matches found will be deleted
    - Wildcard support is available for the filters
  - The DELETE LE command can be issued while dynamic LE options are disabled
    - The options table will be updated and go into effect when dynamic LE options are enabled

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Setting LE Runtime Options

- IMS V8 Dynamic LE Runtime Options
  - The QUERY LE command is used to display dynamic LE runtime options based on a filter of transaction code and/or LTERM and/or USERID and/or program
    - At least one filter must be specified
    - The first entry in the list with the most exact filter matches is displayed
    - Wildcard support is available for the filters

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Debugging With LE

- ABEND codes are different with LE
  - Why be consistent?!?!?
  - Most LE abends are U4038/U4039
    - About as useful as IMS U4095
- Debug using error messages – not abend codes
  - e.g. Abend0C4 becomes message CEE3204S
- The MSGFILE runtime option species the DDNAME for all runtime diagnostics and reports generated by RPTOPTS and RPTSTG
  - The default is SYSOUT

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Debugging With LE – Dump Files

- CEEDUMP
  - Formatted dump of LE storage/data
  - Content depends on TERMTHDACT() suboption
- CEESNAP
  - Application generated dump information
- SYSUDUMP
  - If TRMTHDACT(UADUMP) and SYSUDUMP DD card
  - Formatted dump but no formatting of LE information
- SYSMDUMP
  - If TRMTHDACT(UADUMP) and SYSMDUMP DD card
  - Use when reporting problems to IBM
  - IPCS verbexit LEDATA/CEEERRIP formats LE data

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Debugging With LE – Control Blocks

- Common Anchor Point (CAA)
  - Pointed to by Register 12
- Stack Frame/Dynamic Save Area (DSA)
  - Pointed to by Register 13
  - DSA's are backchained at DSA+4
- Condition Information Block
  - CEECAA+x'2D8' points to current CIB
- Machine State Information Block (ZMCH)
  - Pointed to by CIB+x'24'

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Debugging with IMS and LE

- IMS & LE do coordinate condition handling!
  - If an error occurs in an IMS environment LE will send the condition to IMS
- There are a number of APAR's dealing with IMS and LE
  - Some have been documented in this presentation
  - Others can be found be searching IBMLINK
    - This is HIGHLY recommended

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Uninitialized Variables

- Prior to LE uninitialized variables had a “high probability” of being binary zero
  - Many programs relied on this
- With LE many uninitialized variables contain “garbage”
  - LE gets the storage and uses it for initialization and then uses it for the application
- This was the source of MANY (MANY MANY) abends and unexpected conditions and logic errors

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Conclusion

- Implementing and upgrading LE in an IMS environment requires hard work
- Plan by reading the Migration manuals
- Review runtime options before migration
- Consider LRR for performance
- Check for uninitialized variables
- Do extensive testing
  - Including error scenarios

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Questions?

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