An Introduction to Using REXX with Language Environment

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Trademarks

Agenda

- Why Language Environment
- What can you do?
- Decisions, decisions
- Initialization (& Termination)
- Structures
- Passing and Returning Arguments
- Sharing Variables
- Miscellany

Why Language Environment?

- Really *any* language which produces program modules…
  - Register parms also in parm lists
  - Special (short) alternate entry point names for Fortran
- but…

Why Language Environment? …

- If you’re a REXX programmer
  - There is a lot you can do in an HLL that you cannot in REXX
    - Deal with registers, SVCs
    - Add functions and function packages
    - Preload execs
    - Replace or extend some REXX native functionality such as I/O
    - With LE applications you can always bind in LE-conforming or LE-enabled High Level assembler!

Why Language Environment? …

- If you’re a C/C++ or COBOL or PL/I or assembler programmer
  - HLLs have run-times
    - REXX functions can be a powerful and easily extensible addition
      - *Could be useful even just for prototyping*

Why Language Environment? …

- A bunch of assembler macros (many to be covered later) in **‘SYS1.MACLIB’:**

IRXARGTB	– Argument Table
IRXCMPTB	– Compiler Programming Table
IRXDSIB	– Data Set Information Block
IRXEFPL	– External Function Parameter List
IRXENVB	– Environment Block
IRXEVALB	– Evaluation Block
IRXEXECB	– Exec Block
IRXEXTE	– Vector of External Entry Points
IRXFPDIR	– Function Package Directory
IRXINSTB	– In-Storage Block
IRXMODNT	– Module Name Table
IRXPACKT	– Function Package Table
IRXPARMB	– Parameter Table
IRXSHVB	– Shared Variable Request Block
IRXSUBCT	– Subcommand Table
IRXWORKB	– Work Block Extension

- All primarily mappings

Why Language Environment? …

- For C/C++ the DSECT conversion utility – EDCDSECT
  - SYSADATA override required for multiple steps in one batch job

```
//     SET       REL=ZOS1D0
//     SET     INLIB=SYS1.MACLIB
//     SET    OUTLIB=BARRYL.BINDER.MACLIB
//*-----------------------------------------------------
//IRXARGTB  EXEC PROC=EDCDSECT,
//               INFILE=DUMMY,
//              OUTFILE=&OUTLIB.(IRXARGTB),
//                DPARM='EQU(DEF),LOC(En_US.IBM-1047),PP',
//              LIBPRFX=&REL..CEE,
//              LNGPRFX=&REL..CBC
//ASSEMBLE.SYSADATA DD DSN=&&IRXARGTB
//ASSEMBLE.SYSLIB DD DSN=&INLIB.(IRXARGTB),DISP=SHR
//ASSEMBLE.SYSIN  DD *
         CSECT
         IRXARGTB
         END
/*
```

Why Language Environment? …

- Some editing is required for some DSECT utility created headers…
  - Because REXX defines with alignments

```
ARGTABLE_ENTRY DSECT                          REXX Argument Table Entry
         DS   0D                              Align on doubleword boundary
ARGTABLE_ARGSTRING_PTR    DS   A              Address of the argument string
ARGTABLE_ARGSTRING_LENGTH DS   F              Length of the argument string
ARGTABLE_NEXT             DS   0D             Next ARGTABLE entry
```

  - C/C++ doesn't have a comparable capability
    - It uses "natural alignments so requires a member of that size…
    - OK if extra last field, not OK for this array of arguments!

```
struct argtable_entry {
void          *argtable_argstring_ptr;      /* Address of the argument string */
  int            argtable_argstring_length; /* Length of the argument string  */
/*double         argtable_next;*/           /* Next ARGTABLE entry            */
  };
```

Why Language Environment? …

- z/OS (and z/VM) only
  - Only z/OS described here!
  - Not in ooRexx© etc.
    - ooRexx has C extensible APIs
      - *Some similar capabilities*
        - *Like building external native libraries (usually DLLs)*

What can you do?
REXX to Language Environment

- Easy, just call as a “host” program!
  - Like *Address LINKMVS* …
- A little harder…
  - Write LE as a REXX function or subroutine
    - Return data, not just a return code
- A little harder still…
  - Use REXX programming services
    - For example to share variables

What can you do? …
Language Environment to REXX

- Not too hard, CALL like any other program…
  - REXXC (REXX compiler) can create program modules
    - Need optional product “IBM Compiler and Library for REXX”
    - Not just base element “Alternate Library for REXX” (no compiler)
  - IRXJCL – invoke REXX exec from batch or program
    - Single MVS style parameter string
- Harder, call as a REXX function or subroutine
  - IRXEXEC – invoke REXX exec from batch or program
    - Pass multiple arguments
    - Preload execs
    - Return data, not just a return code
      - *A “command” can only return a signed fullword number*

What you can do? …

- Services (like IRXEXEC, IRXEXCOM)…

- Parameter lists
  - Standard OS linkage
    - R1 points to a list of pointers to parameters
    - Last parameter is identified by the Hob
      - *On most calls, some parameters are optional*
    - standard R13, R14, R15
  - Language Environment HLLs support OS linkage
    - C use linkage(…,OS)
    - …

- Structures ("Blocks")

What you can do? …

- Return Codes
  - R15, also return code parameter
  - *Not* returned to the REXX program!
    - REXX variables are (RC, RESULT)
  - **IRX0040I Error running exec_name, line nn: Incorrect call to routine**

    The language processor encountered an incorrectly used call to a built-in or external routine.

    You may have passed invalid data (arguments) to the routine. This is the most common possible cause and is dependent on the actual routine.

    If a routine returns a non-zero return code, the language processor issues this message and passes back its return code of 20040.

Decisions, decisions

- Tradeoffs
  - Time, complexity, isolation
  - KISS !
- No need for REXX services ?
- Infrequently called ?

  and / or

- Heavy-weight

Decisions, decisions …

- Using Language Environment requires run-time initialization
  - Normally happens upon first program call from host (C main)
- LE Linkage Conventions
  - LE-conforming programs require LE and can use all services
  - LE-enabled applications follow similar OS-linkage conventions but not use all services

Decisions, decisions …
REXX to Language Environment

- Host program call using LE application
  - Each call to Language Environment requires full LE initialization
  - Most isolated
    - No access to REXX services
  - Slowest!

Decisions, decisions …
REXX to Language Environment

- REXX function or subroutine using LE application
  - Still requires full LE initialization
  - Less isolated
    - Access to REXX services
  - Faster…

Decisions, decisions …
REXX to Language Environment

- REXX function or subroutine using LE function
  - Something must still initialize the library!
    - Unless you use METAL C
  - Limited function C library support
    - System Programming C (SPC)
  - Full LE support
    - Preinitialization Services (PIPI)

Decisions, decisions …
REXX to Language Environment

- System Programming C – SPC
  - Regular C compiles
  - No C++
  - No XPLINK, LP64, DLL (that all needs LE!)
  - Freestanding
    - @@XSTRT/@@XSTRL/@@XSTRX
      - *used by UNIX support of REXX syscalls*
  - persistent
    - @@XHOTC/@@XHOTL

Decisions, decisions …
REXX to Language Environment

- PIPI comparison
  - REXX calling REXX subroutine implemented in LE
  - Simple HLL program written in C, writing a line of output
    - Assembler subroutine for PIPI INIT_SUB
    - Assembler subroutine for PIPI CALL_SUB to HLL subroutine

versus

    - HLL application as subroutine

versus

    - HLL application as host command

Decisions, decisions …
REXX to Language Environment

- PIPI comparison …
  - Called 1000 times
    - About a 3 to 1 ratio of time between PIPI vs. directly called subroutine!
    - HLL application about 1000x worse !
  - Caveats
    - Ignored time spent for PIPI INIT_SUB
    - Measurements simply with REXX elapsed timer
    - Host command was in UNIX so spawn using /bin/sh

Decisions, decisions …
REXX to Language Environment

- PIPI comparison …
  - With PIPI the environment is “resumed”
    - Careful of “Stop Semantics” which terminate enclave
      - *C exit(), COBOL STOP RUN, etc.*
  - So true subroutine can have static data
    - maintain a counter etc.
  - The subroutines must be known a priori in table
    - Loaded by the INIT call
    - Added by an ADD_ENTRY call

Example 1 – ASMPIPI / ASMPIPC

```
/* REXX */

Call ASMPIPI

Say 'PIPIADDR='C2X(PIPIADDR)
Say 'PIPITOKN='C2X(PIPITOKN)

Call TIME 'Reset'
Do pp=1 To cnt
  Call ASMPIPC PIPIADDR,PIPITOKN
End pp
Say TIME('Elapsed')
```

Decisions, decisions …
Language Environment to REXX

- Call directly as REXX function or subroutine
  - Access to REXX control blocks needed to call REXX services
    - Access arguments
    - Create shared variables
    - etc.
  - Use PLIST(OS)
    - LE run-time option or C/C++ compiler option
    - Must be able to get R1 (__osplist macro in C/C++), the EFPL pointer

Example 2 – HLLPIPIM2

```
/* REXX */
Call TIME 'Reset'
Do pp=1 To cnt
  Call HLLPIPM2 "hi there","you all"
End pp
Say TIME('Elapsed')

Say "LEREXX = <"LEREXX">"
```

```
LEREXX before = <LEREXX>
C main beginning 1 args: <1=BPXWREXC>,
<__osplist=217a949c>
arg[000]=<hi there>
arg[001]=<you all>
. . .
0.043548
LEREXX after  = <perfect together>
```

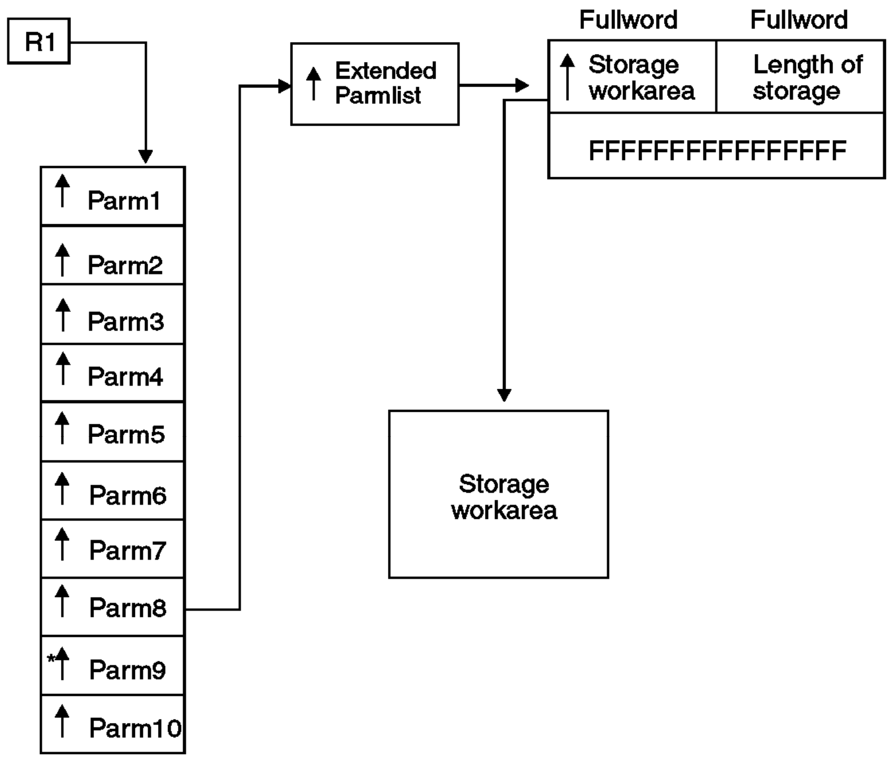
Initialization (& Termination)

- IRXINIT (IRXTERM) - Initialize (Terminate) a language processor environment.
- IRXINIT R1 parm list (of addresses of)…

1.	Function	8 characters
2.	Parameters module and/or	8 characters
3.	In-storage parameter list	address
4.	User field	address
5.	Reserved	address, parameter must be 0
6.	Environment block	address, output
	• Also in R0	
7.	Reason code	fullword, output
8.	Extended parameter list	address, optional
	• Storage workarea; by default system obtained	
	• Generally 3 pages (12K) of storage is needed for the storage workarea for normal exec processing, for each level of exec nesting.	
9.	Return code	fullword, output, optional
10.	TSO/E ECT	address of address of, optional
	• Only for initializing TSO/E integrated environment	

Initialization …

- IRXINIT…



* high order bit on

Initialization …

- Precedence for initializing environment (parameters)

  - Each type can exist but have (some) null parameters
    - blanks or zeroes depending on type

1. In-storage parameter list
2. Parameters module
3. Previous environment
4. IRXPARMS default parameters module

Initialization …

- Provided parameter module tables

IRXPARMS	– non-TSO/E
IRXTSPRM	– TSO/E
IRXISPRM	– ISPF

Initialization …

- IRXINIT… Function
  - INITENVB - initialize an environment
  - FINDENVB - find the current environment
  - CHECKENVB - validate a given address is an environment
    - R0 must point to an existing environment block (optional for other calls)

Initialization …

- Initialization normally not required
  - MVS, TSO/E, ISPF, z/OS UNIX automatically initialize for you
- Will initialize based on previous environment
  - Environments are chained
  - This allows you to create your own environment with select updates
    - Cannot be “integrated into TSO/E”
      - *Cannot use TSO/E commands, service routines such as IKJPARS and DAIR, or ISPF services or CLISTs*

Initialization Parameters

- The format of the in-storage list is identical to the format of the parameters module.

1.	ID	8 characters
2.	Version	4 characters, “0200”
3.	Language	3 characters, “ENU”
4.	Reserved	1 byte
5.	MODNAMET	address of Module Name Table
6.	SUBCOMTB	address of Subcommand Table
7.	PACKTB	address of Function Package Table
8.	PARSETOK	8 bytes, Parse Source token
9.	FLAGS	fullword, environment flags
10.	MASKS	fullword, FLAGS mask bits
11.	SUBPOOL	fullword, Storage Allocation Subpool Number
12.	ADDRSPN	fullword, Address Space Name
13.	End of Block	doubleword of X‘FF’

Initialization Parameters …

- MODNAMET (IRXMODNT) -- module name table
  - The DDs for reading and writing data
    - *SYSTSIN / SYSTSPRT*
  - The DD from which to load REXX execs
    - *SYSEXEC*
  - Replaceable routines
    - *Replace I/O (Say, EXECIO, etc), Stack, USERID()*
  - Several exit routines
    - *EXECINIT/EXECTERM – before/after language processing of exec*

Initialization Parameters …

- SUBCOMTB (IRXSUBCT) – subcommand table
  - “host” command environments
    - “address” subcommand names
      - *the environment to which the language processor passes commands for execution*
    - An “address” name
    - A corresponding processing routine

Termination

- Pass environment pointer
- Same task
- LIFO

- Closes all data sets opened under that environment
- Deletes any data stacks (NEWSTACK)

Updating the Subcommand Table

- IRXSUBCM
  - ADD
    - Add an entry to the subcommand table (ignoring duplicates)
  - DELETE
    - Delete the last occurrence from the table
  - UPDATE
    - Update the values for the last occurrence of an entry (Routine, Token)
  - QUERY
    - Query the values of the last occurrence of an entry

Structures

- Environment Block (IRXENVB, ENVBLOCK)
  - Address in R0 when external function or subroutine gets control
  - Required for all services (still optional, current will be found if not provided)
    - Unless it’s reentrant
  - Contains…
    - Parameter Block (IRXPARMB, PARMBLOCK)
    - Vector of External Entry Points (IRXETE)
      - *REXX routines*
      - *System / User replaceable routines*
      - *You might like IRXSAY, IRXLOAD, etc.*
  - You can initialize more than one and run (REXX) in any particular one
    - by passing that environment block address

Structures …

- Example SUBCOM Table in UNIX

```
  1 name=MVS      routine=IRXSTAM  token=                .
  2 name=LINK     routine=IRXSTAM  token=                .
  3 name=ATTACH   routine=IRXSTAM  token=                .
  4 name=CPICOMM  routine=IRXAPPC  token=                .
  5 name=LU62     routine=IRXAPPC  token=                .
  6 name=LINKMVS  routine=IRXSTAMP token=                .
  7 name=LINKPGM  routine=IRXSTAMP token=                .
  8 name=ATTCHMVS routine=IRXSTAMP token=                .
  9 name=ATTCHPGM routine=IRXSTAMP token=                .
 10 name=APPCMVS  routine=IRXAPPC  token=                .
 11 name=SYSCALL  routine=BPXWREXX token=                .
 12 name=MVS      routine=IRXSTAM  token=                .
 13 name=LINK     routine=IRXSTAM  token=                .
 14 name=ATTACH   routine=IRXSTAM  token=                .
 15 name=CPICOMM  routine=IRXAPPC  token=                .
 16 name=LU62     routine=IRXAPPC  token=                .
 17 name=LINKMVS  routine=IRXSTAMP token=                .
 18 name=LINKPGM  routine=IRXSTAMP token=                .
 19 name=ATTCHMVS routine=IRXSTAMP token=                .
 20 name=ATTCHPGM routine=IRXSTAMP token=                .
 21 name=APPCMVS  routine=IRXAPPC  token=                .
 22 name=SYSCALL  routine=BPXWREXX token=                .
 23 name=SYSCALL  routine=BPXWREXX token=                .
 24 name=SH       routine=BPXWRKSH token=                .
 25 name=TSO      routine=BPXWRADT token=                .
```

Structures …

- Subcommand Table Block (IRXSUBCT)
  - Previous output from small assembler program called as function from REXX program
    - REXX passed ENVBLOCK address in R0 when external function or subroutine gets control
    - Parameter block contains SUBCOMTB address
    - Assembler subroutine passes SUBCOMTB header back to REXX program
      - *<u>REXX factoid:</u> The only difference between functions and subroutines is that functions <u>must</u> return data, while subroutines <u>may</u> return data*

Structures …

- Subcommand Table Block (IRXSUBCT) …

  - Table header

ADDRESS	fullword address of first entry (row) in table
TOTAL	fullword # of entries in table (used & unused)
USED	fullword # of used entries
LENGTH	fullword length of each entry (always 32)
INITIAL	fullword address of name of host command environment (only if not passed on IRXEXEC)
reserved	doubleword
End of Table	doubleword of X'FF'

  - Array of entries (rows)

NAME	8 characters
ROUTINE	8 characters
TOKEN	16 characters, passed to ROUTINE when called
. . .	

Structures …

- External Function Parameter List (IRXEFPL)
  - REXX passes EFPL address in R1 when external function or subroutine gets control
  - 5th word points to the Argument Table
    - Parsed arguments
  - 6th word points to the Evaluation Block
    - For returning data
    - Preset size

Passing and Returning Arguments

- Argument Table (IRXARGTB)
  - Argument lists can be passed on IRXEXEC call
  - Same arguments/format received by any function/subroutine
- An array of fullword pairs
  - Argument address
  - Argument length
- Terminated with a doubleword of X'FF'.

Example 3 – ASMPIPC (see Example 1)

```
* Get REXX arguments
         L     R1,efplarg
         USING argtable_entry,R1
*
         LHI   R3,0                 1st arg index
         L     R2,argtable_argstring_ptr(R3)  1st arg ptr
         L     R2,0(R2)             1st arg (we know len is 4)
         ST    R2,PPRTNPTR          Save the addr of CEEPIPI routine
*
         AHI   R3,argtelen          2nd arg index
         L     R2,argtable_argstring_ptr(R3)  2nd arg ptr
         L     R2,0(R2)             2nd arg (we know len is 4)
         ST    R2,TOKEN             Save the TOKEN
. . .
* call the subroutine which was loaded by LE PIPI INIT call
CSUB     EQU   *
         L     R15,PPRTNPTR         Get address of CEEPIPI routine
         CALL  (15),(CALLSUB,PTBINDEX,TOKEN,PARMPTR,                  X
               SUBRETC,SUBRSNC,SUBFBC)    Invoke CEEPIPI routine
         LTR   R2,R15                 Is R15 = zero?
         BZ    DONE                   Yes (success).. go to next section
```

Passing and Returning Arguments …

- Evaluation Block (IRXEVALB, EVALBLOCK)
  - When REXX calls a function / subroutine
    - It is allocated for you with a fixed size
      - *TSO/E provides 250 bytes for your returned data*
  - If you have coded HLL/assembler function / subroutine
    - You must create a larger block if necessary (using IRXRLT)
  - Same format used by IRXEXEC
    - For returning from a REXX function / subroutine

Example 3 – SUBR1

Return Subcommand Table block in the Evaluation Block

```
SUBR1    CSECT
. . .
*
         LR    r3,r0                Save ENVblock
         USING ENVBLOCK,r3
         LR    r4,r1                Save EFPL
         USING EFPL,r4
*
         L     r5,EFPLEVAL          ptr to addr of...
         L     r5,0(r5)             .. evalblock
         USING EVALBLOCK,r5
*
         L     r6,ENVBLOCK_PARMBLOCK
         USING PARMBLOCK,r6
         L     r6,PARMBLOCK_SUBCOMTB
         USING SUBCOMTB_HEADER,r6
*
         MVC   EVALBLOCK_EVLEN,=F'24'
         MVC   EVALBLOCK_EVDATA(4),EVALBLOCK_EVSIZE
         MVC   EVALBLOCK_EVDATA+4(20),SUBCOMTB_HEADER
*
. . .
RET      LHI   r15,0
. . .
         BR    r14                  RETURN TO CALLER
```

```
...

**
         YREGS
**
efpl0    IRXENVB
efpl1    IRXEFPL
evalb    IRXEVALB
parmb    IRXPARMB
subcomt  IRXSUBCT
**
         END
```

Loading An Exec

- IRXEXEC runs the exec which is …
  - Preloaded with IRXLOAD or user replaceable routine
  - In-Storage Control Block (IRXINSTB, INSTBLK)
    - header
    - array of REXX record/length pairs

-- or --

  - Loaded by building an Exec Block (IRXEXECB, EXECBLK)
    - Member
    - DDNAME (default is SYSEXEC from module name table)
    - DSNptr
      - *for Parse Source*
    - Initial SUBCOM environment
    - Extended execname
      - *Not used by IRXLOAD; could be a UNIX pathname*

- UNIX users take note!
  - Executable external functions or subroutines that are written in a language other than interpreted REXX and located in the z/OS UNIX file system are not supported.

Sharing Variables

- IRXEXCOM – REXX exec communication
  - 4th parameter points to …
  - SHVBLOCK (IRXSHVB) – shared variable request block
    - SHVBLOCKs can be chained
    - HLL/assembler coded function / subroutine can get and set REXX variables

Sharing Variables …

- SHVBLOCK (IRXSHVB) – shared variable request block

  - SHVNEXT fullword chain pointer (0 if last block)
  - SHVUSER fullword user value
               except for "Next"
  - SHVCODE byte function code
  - SHVRET   byte return code
  - reserved halfword, set to zero

  - SHVBUFL fullword length of "Fetch" value buffer

  - SHVNAMA fullword address of variable name
  - SHVNAML fullword length of variable name (250 max)

  - SHVVALA fullword address of value buffer
  - SHVVALL fullword length of value
               set for "Fetch"

Sharing Variables …

- IRXEXCOM – REXX exec communication …
  - SHVRET – Return Code Flags

```
SHVCLEAN  X'00' Execution was OK
SHVNEWV   X'01' Variable did not exist
SHVLVAR   X'02' Last variable transferred (for "N")
SHVTRUNC  X'04' Truncation occurred during "Fetch“
SHVBADN   X'08' Invalid variable name
SHVBADV   X'10' Value too long
SHVBADF   X'80' Invalid function code (SHVCODE)
```

Sharing Variables …

- IRXEXCOM – REXX exec communication …
  - Return Codes

-1	Insufficient storage
-2	Entry conditions not valid (like REXX exec not currently running)
0	SUCCESS
28	No environment found
32	Invalid parameter list
nn	Composite OR of SHVRETs (except SHVNEWV and SHVLVAR)

Sharing Variables …

- IRXEXCOM – REXX exec communication …
  - Function code convention:
    - Direct interface (Uppercase):
      - *WYSIWYG*
      - *If b=‘Barry’ then A.b is A.B*
    - Symbolic interface (Lowercase):
      - *Just like REXX does it*
      - *If b=‘Barry’ then A.b is A.Barry*

Sharing Variables …

- IRXEXCOM – REXX exec communication …
  - Function codes:

• S/s	– Set/Store (create)
• F/f	– Fetch
• D/d	– Drop
• N	– Fetch Next (exposed variables in generation)
• P	– fetch Private information (Arg, Source, Version)

Example 4 – SUBR3

Returning variables from assembler to REXX

```
...
         LR    r3,r0           Save ENVblock
         USING ENVBLOCK,r3
***
         LA    r6,shvb2
shvr2    USING SHVBLOCK,r6
         MVC   shvr2.SHVNEXT,=F'0'
         MVC   shvr2.SHVUSER,=F'0'
         MVI   shvr2.SHVCODE,SHVSTORE
         MVC   shvr2.SHVNAMA,=A(var2)
         MVC   shvr2.SHVNAML,=A(evar2-var2)
         MVC   shvr2.SHVVALA,=A(vvar2)
         MVC   shvr2.SHVVALL,=A(evvar2-vvar2)
***
         LR    r0,r6
         LA    r6,shvb1
shvr1    USING SHVBLOCK,r6
         ST    r0,shvr1.SHVNEXT
         MVC   shvr1.SHVUSER,=F'0'
         MVI   shvr1.SHVCODE,SHVSTORE
         MVC   shvr1.SHVNAMA,=A(var1)
         MVC   shvr1.SHVNAML,=A(evar1-var1)
         MVC   shvr1.SHVVALA,=A(vvar1)
         MVC   shvr1.SHVVALL,=A(evvar1-vvar1)
***
```

```
         LA    r5,=CL8'IRXEXCOM'
         ST    r5,parm1
*
         LHI   r5,0
         ST    r5,parm2
         ST    r5,parm3
*
         ST    r6,parm4
*
         OI    parm4,X'80'

**
         LR    r0,r3   restore ENVBLOCK 4 call!
         LA    r1,plist
*
         LINK  EP=IRXEXCOM
         ST    r15,myret
...
         BR    r14     RETURN TO CALLER
```

Example 4 – SUBR3 …

Returning variables from assembler to REXX …

```
**
var1     DC     C'BARRY.Assembler'
evar1    EQU    *
*
vvar1    DC     C'doth he'
         DC     C' rexx codeth'
evvar1   EQU    *
*
var2     DC     C'RC'
evar2    EQU    *
*
vvar2    DC     C'1958'
evvar2   EQU    *
```

```
**
         YREGS
**
envb0    IRXENVB
evalb    IRXEVALB
parmb    IRXPARMB
shrvar   IRXSHVB
**
MYAREA   DSECT
*
myret    DS     F
mysize   DS     F
**
plist    DS     0D
parm1    DS     F
parm2    DS     F
parm3    DS     F
parm4    DS     F
**
shvb1    ORG  *+SHVBLEN
shvb2    ORG  *+SHVBLEN
*
MYAREASZ EQU   *-MYAREA
```

Example 5 – HLLPIPIM2 (see Example 2)

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>

#include <irxefpl.h>
#include <irxargtb.h>
#include <irxshvb.h>
#include <irxenvb.h>

typedef int (IRXEXCOM)(char func[8], void,
     *zero2, void *zero3, struct shvblock,
     shvbp, int envbp0, int retcode);

#pragma linkage(IRXEXCOM, OS)

int cnt = 0, envbp0=0;
```

Example 5 – HLLPIPIM2 …
(see Example 2)

```
main (int argc, char **argv)
{

 struct efpl * EFPLP = (struct irxefpl *) __osplist;
 struct argtable_entry * ARGTEP = EFPLP->efplarg;

 char varname1[] = "LEREXX";
 char varvalue1[] = "perfect together";

 IRXEXCOM* excomfunc;
 int retcode;
```

Example 5 – HLLPIPIM2 …
(see Example 2)

```
struct shvblock SHVAR1 = { 0 };

SHVAR1.shvcodes._shvcode = shvstore;

SHVAR1.shvnama = &varname1;
SHVAR1.shvnaml = sizeof(varname1)-1;

SHVAR1.shvvala = &varvalue1;
SHVAR1.shvvall = sizeof(varvalue1)-1;
```

Example 5 – HLLPIPIM2 …
(see Example 2 & DSECT utility argtable_entry)

```
excomfunc = fetch("IRXEXCOM");
if (excomfunc==NULL) { perror("fetch IRXEXCOM failed:"); exit(1); }

fprintf (stderr,
         "C main beginning %d args: <1=%s>, <__osplist=%x>\n",
         argc, argv[0], __osplist);

cnt=0;
while (ARGTEP[cnt].argtable_argstring_ptr != (void *) -1)
{
  fprintf (stderr, "arg[%03d]=<%.*s>\n",
           cnt,
           ARGTEP[cnt].argtable_argstring_length,
           ARGTEP[cnt].argtable_argstring_ptr);
  cnt++;
}

excomfunc("IRXEXCOM", NULL, NULL, SHVAR1, envbp0, retcode);

return(0);
```

Miscellany

- Using z/OS UNIX System Services
  - Environment created automatically when REXX program (**/*REXX*/** “magic number) is *exec*’d.
    - BPXWRXEV parameters module
      - *Source in SYS1.SAMPLIB(BPXWRX01)*
    - Inherits default MVS REXX environment
    - I/O etc. overridden in MODNAMET table
    - Subcommand environments added in SUBCOMTB
      - *as we saw from example 1 earlier …*
    - There is also a function package ..
      - *for most of the UNIX REXX functions such as getpass()*

Miscellany …

- Using z/OS UNIX System Services …
  - BPXWRBLD
    - Create your own z/OS UNIX REXX environment
    - Sample C program in z/OS Using REXX and z/OS UNIX System Services

Miscellany …

- Using z/OS UNIX System Services …
  - Other services available for HLL/assembler programmers
    - BPXWDYN – dynamic allocation (SVC 99) text string interface
    - bpxwunix() – run z/OS UNIX shell (/bin/sh)
      - *Run a shell script and/or other UNIX commands*

Miscellany …

- New & Improved PD!
  - IRX0900E REXX INITIALIZATION FAILED WITH RETURN CODE 20 AND REASON CODE 1.
    - OA07204 - NEW FUNCTION - MSGISPI025 TSO/E ROUTINE IRXINIT SEVERE ERROR RAS ENHANCEMENT
      - *Opened 2004, Closed 2010/07/22*
      - *PTFs available 2010/10/18 for z/OS V1.9 & later*

Miscellany …

- z/OS TSO/E REXX Reference – SA22-7790
- z/OS Using REXX and z/OS UNIX System Services – SA22-7806

- z/OS Language Environment Programming Guide – SA22-7561

- z/OS XL C/C++ User's Guide – SC09-4767
- z/OS XL C/C++ Programming Guide – SC09-4765