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An Introduction to Using REXX with Language Environment

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March 2014

Session 15229

SHARE in Anaheim

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Agenda

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

Why me?

EXEC1 EXEC:

```
&CONTROL CMS
&FNAME = Barry
&LNAME = Lichtenstein
&TYPE My name is:  &FNAME &LNAME
&EXIT 0

Ready; T=0.01/0.01 12:31:36
exec1
My name is: Barry Lichtens
```

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 language
    - 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? …

- 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

- Starting in REXX
  - Calling Language Environment
- Starting in LE
  - Calling REXX
- Further Nesting ?
  - LE -> REXX -> LE ???

What can you do? …
REXX to Language Environment

- Easy, just call as a “host” program!
  - Like *Address LINKMVS* …
- A little more work…
  - Write LE as a REXX function or subroutine
    - Return data, not just a return code
  - 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; In storage execs
    - Return data, not just a return code
      - *A “command” can only return a signed fullword number*

What you can do? … Language Environment to REXX

- 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? …
REXX to Language Environment

- Return Codes
  - R15 (also return code parameter on REXX services)
  - *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
- 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
    - COBOL main program, C main, etc.
- LE Linkage Conventions
  - LE-conforming programs require LE and can use all services
  - LE-enabled applications follow similar OS-linkage conventions but cannot use all services

Decisions, decisions …
REXX to Language Environment

- Host program call using LE application
  - Like TSO or SH, so…
    - Host subcommand environment handles the call
  - Each call to Language Environment requires full LE initialization
  - Most isolated
    - No access to REXX services
  - Potentially slowest!

Decisions, decisions …
REXX to Language Environment

- REXX function or subroutine using LE application
  - C main(), COBOL main program, etc. so…
    - Still requires full LE initialization
  - Less isolated
    - Access to REXX services
  - Potentially faster…

Example 1 – HLLPIPM2

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

```
As a REXX function, calling COBOL main program IGZPIPM2:
Before: LEREXX = <LEREXX>
REXX RC IS 000000000, IRXEXCOM RC IS 000000000, SHVRET IS
000000001.
REXX RC IS 000000000, IRXEXCOM RC IS 000000000, SHVRET IS
000000000.
. . .
0.165410
After: LEREXX and COBOL all together!
```

Decisions, decisions …
REXX to Language Environment

- REXX function or subroutine using HLL sub-function
  - C function, COBOL subprogram, etc. so…
    - Something must still initialize the library!
  - Unless you're only interested in C…
    - METAL C
      - *Subset of C library functions*
    - System Programming C (SPC)
      - *Limited function C library support*

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

- Preinitialization Services (PIPI)
  - Full LE support
  - Can call into main programs or subprograms
  - Requires some setup which has to be done in assembler
    - Or Metal C …

Decisions, decisions …
REXX to Language Environment

- Preinitialization Services (PIPI) …
  - 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 or provided on the INIT call
    - Added by an ADD_ENTRY call

Example 2 – ASMPIPI / ASMPIPC

```
/* REXX */

Call ASMPIPI

Say 'PIPIADDR (after)  ='C2X(PIPIADDR)'.'
Say 'PIPITOKN (after)  ='C2X(PIPITOKN)'.'
Say 'As a REXX function, calling an HLL sub' ,
    'using PIPI CALL_SUB:'
Call TIME 'Reset'
Do pp=1 To cnt
  Call ASMPIPC PIPIADDR,PIPITOKN, ,
       "ASMPIPC ", ,
       "As a REXX function via PIPI! call#" ,
        pp "of" cnt
End pp
Say TIME('Elapsed')
```

Example 2 – ASMPIPI / ASMPIPC …

```
PIPIADDR (after)  =8000B000.
PIPITOKN (after)  =210E0DB8.

As a REXX function, calling an HLL sub using PIPI CALL_SUB: ..........

HLLPIPI COBOL subprogram, first call, using LE PIPI Call Sub interface
HLLPIPI COBOL subprogram returning.
HLLPIPI COBOL subprogram called 000000002 times.
. . .
HLLPIPI COBOL subprogram called 000000010 times.
HLLPIPI COBOL subprogram returning.

ELAPSED: 0.006767
```

Decisions, decisions …
REXX to Language Environment

- Simple timing 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

- Simple timing comparison …
  - Called 1000 times
    - About a 3 to 1 ratio of time between PIPI vs. directly called subroutine!
    - HLL application about 1000 X 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

- Call directly as REXX external 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
      - *Arguments*
      - *Eval Block*

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

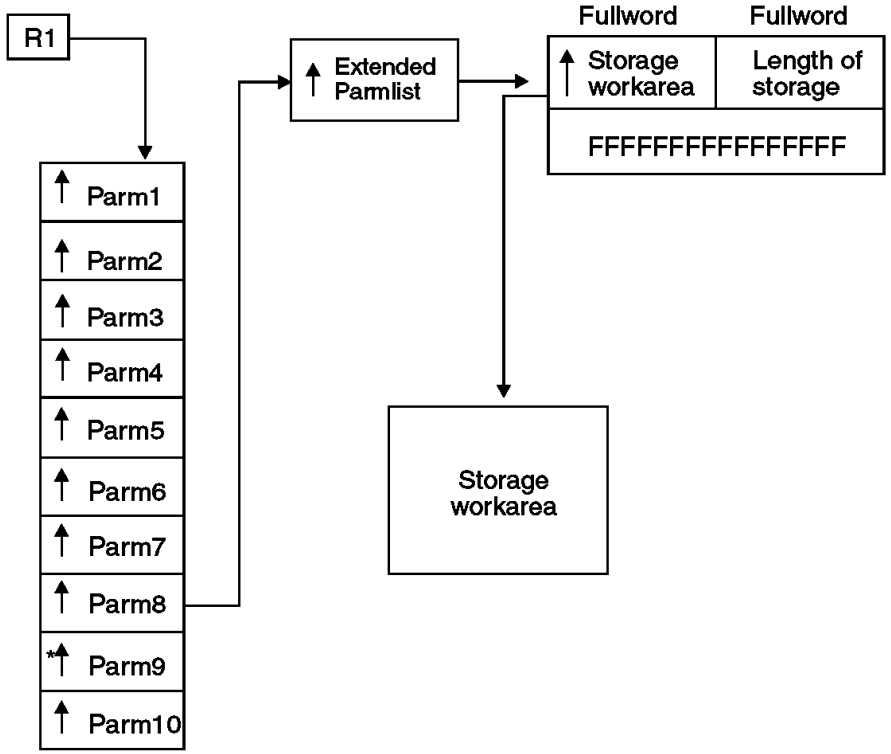
  - Storage workarea; by default system obtained
  - Generally 3 pages (12K) of storage is needed for the storage workarea for normal exec processing, for each level of exec nesting.

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” unless a TSO/E address space
      - *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)

Dynamic Update of 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)
      - *Initialization parameters*
    - 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 …

- Subcommand Table Block (IRXSUBCT)
  - Output (to follow) 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
      - *REXX factoid: The only difference between functions and subroutines is that functions must return data, while subroutines may 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'.

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

Putting it all togther

- Previous ASMPIPI / ASMPIPC (Example 2)
  - ASMPIPC takes arguments
- subr1.rexx / SUBR1.s (Example 3)
  - Assembler gets eval block from EFPL
    - Returns Subcommand Table header
      - *REXX does the rest!*

Putting it all togther ...

- SUBCOM Table in UNIX (Example 3)

```
 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=                .
```

Language Environment to REXX

- REXX into a module (compiled)

  or

- IRXJCL, IRXEXEC
  - Inherits environment

    or

  - Initializes environment / runs / Terminates environment

Example 4
Language Environment to REXX …

- IRXJCL – from z/OS TSO/E REXX Reference

```
JCLXMP1 : Procedure Options (Main);
/* Function: Call a REXX exec from a PL/I program using IRXJCL      */
DCL IRXJCL EXTERNAL OPTIONS(RETCODE, ASSEMBLER);
DCL 1 PARM_STRUCT,                  /* Parm to be passed to IRXJCL     */
      5 PARM_LNG BIN FIXED (15), /* Length of the parameter          */
      5 PARM_STR CHAR (30);      /* String passed to IRXJCL          */
DCL PLIRETV BUILTIN;              /* Defines the return code built-in*/
PARM_LNG = LENGTH(PARM_STR);      /* Set the length of string         */
/*                                                                   */
PARM_STR = 'JCLXMP2 This is an arg to exec'; /* Set string value
                                    In this case, call the exec named
                                    JCLXMP2 and pass argument:
                                    'This is an arg to exec'         */
FETCH IRXJCL;                     /* Load the address of entry point */
CALL IRXJCL (PARM_STRUCT);        /* Call IRXJCL to execute the REXX
                                    exec and pass the argument       */
PUT SKIP EDIT ('Return code from IRXJCL was:', PLIRETV) (a, f(4));
                                  /* Print out the return code from
                                    exec JCLXMP2.                    */
END ;                             /* End of program                  */
```

Example 4 …
Language Environment to REXX …

- JCLXMP2 is in SYSEXEC

```
Say 'LE has called JCLXMP2'
/* Note we didn't need the REXX "magic number" since we
pointed the interpreter right at it! */

Say 'ARGS:' ARG(1)
Say 'now exiting with RC=22'

Exit 22
```

```
LE has called JCLXMP2
ARGS: This is an arg to exec
now exiting with RC=22

Return code from IRXJCL was:  22
```

Language Environment to REXX …

- 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.

Example 5
Language Environment to REXX …

- IRXEXEC home-grown C using DSECT utility headers

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

#include <irxevalb.h>
#include <irxargtb.h>
#include <irxinstb.h>

typedef struct irxexec_flags_s {
  unsigned int
    command : 1,
    function : 1,
    subroutine : 1 ,
    extended_retcodes : 1 ,
    _reserved : 4;
  char _reseved_flags[3];
} IRXEXEC_FLAGS;
```

Example 5 …
Language Environment to REXX …

- badly prototyped!

```
typedef int (IRXEXEC)(void** execblk, void** argtable, IRXEXEC_FLAGS
flags,
                      void** instor, void** cppl, void** evalb,
                      void** work, void** user,
                      void** envb, void* retcd );
#pragma linkage(IRXEXEC, OS)

int aa = 0;
void *envbp0=0, *null=NULL, *userfld1=0;

IRXEXEC_FLAGS execflags = {0, 0, 1, 1, 0};
```

Example 5 …
Language Environment to REXX …

```
#define EVDATA_SIZE 240
struct eval1 {
 struct evalblock EVB1;
 char restofevdata[EVDATA_SIZE];
} EVAL1 = { 0, ((EVDATA_SIZE/8)+2), 0};  /* 250?, has to be 240 or 248 ? */
unsigned char *EVAL1data_ptr = &EVAL1.EVB1.evalblock_evdata;

#define ARG1 "hello"
#define ARG2 " REXX "
#define ARG3 "from LE"
#define ARGEND "\xff\xff\xff\xff\xff\xff\xff\xff"

struct argtable1 {
  struct argtable_entry args1[3];
  struct argstring args1end;
} ARGTABLE1 =
{ARG1, sizeof(ARG1)-1,
 ARG2, sizeof(ARG2)-1,
 ARG3, sizeof(ARG3)-1,
 ARGEND};
```

Example 5 …
Language Environment to REXX …

```
char *REXX1[] = {
  "Say; Say COPIES('=',72)"
 ,"Parse Arg arg1, arg2, arg3"
 ,"Say \"Args to REXX are:\" arg1\",\" arg2\",\" arg3\".\""
 ,"Parse Source src"
 ,"Say \"REXX source is '\"src\"'\""
 ,"Say COPIES('=',72); Say"
 ,"Exit 72"
};

#define REXXIN1_CNT (sizeof(REXX1)/sizeof(char*))
struct instblk_entry REXXIN1[REXXIN1_CNT];

struct instblk_header INSTBLK1 =
{"IRXINSTB", sizeof(INSTBLK1),
 0, 0, /* address of INSTOR exec */
 sizeof(struct instblk_entry)*REXXIN1_CNT,
 "inSideMe", "-ddNone-", "SH      ",
 0, 8, "NoDSname", 0};
```

Example 5 …
Language Environment to REXX …

```
IRXEXEC* execfunc;

int retcode, RC, rr;

struct argtable1      *ARGTABLE1_ptr = &ARGTABLE1;
struct eval1          *EVAL1_ptr     = &EVAL1;
struct instblk_header *INSTBLK1_ptr  = &INSTBLK1;

INSTBLK1._instblk_address = &REXXIN1[0];

for (rr=0; rr<REXXIN1_CNT; rr++) {
  REXXIN1[rr].instblk_stmt_ = REXX1[rr];
  REXXIN1[rr].instblk_stmtlen = strlen(REXX1[rr]);
}

execfunc = (IRXEXEC*) fetch("IRXEXEC");
if (execfunc==NULL) { perror("fetch IRXEXEC failed:"); exit(1); }
```

Example 5 …
Language Environment to REXX …

```
ARGTABLE1.args1[0].argtable_argstring_ptr = argv[1];
ARGTABLE1.args1[0].argtable_argstring_length = strlen(argv[1]);

RC=execfunc(&null,
            (void**) &ARGTABLE1_ptr,
            execflags,
            (void**)&INSTBLK1_ptr,
            &null,
            (void**)&EVAL1_ptr,
            &null,
            &userfld1,
            &envbp0,
            &retcode);

printf("retcode is: %d\n", retcode);
printf("EVAL_data is: %.8s\n", EVAL1data_ptr);

if (RC==0) RC=strtoul((char *)EVAL1data_ptr,NULL,0);

exit(RC);
```

Example 5 …
Language Environment to REXX …

```
EXECXMP1 “ here’s some arguments: the PID is 66193”

================================================================================
Args to REXX are:  here's some arguments: the PID is 66193,  REXX , from
LE.
REXX source is 'TSO SUBROUTINE inSideMe -ddNone- NoDSname ? SH MVS ?'
================================================================================

retcode is: 0
EVAL_data is: 72
```

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 6 – HLLPIPIM2 COBOL (see Example 1)

```
CBL LIB,QUOTE
      *
       IDENTIFICATION DIVISION.
       PROGRAM-ID. COBPIPM2.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
           COPY IRXSHVB.              <<  had to manually create COBOL mapping
      *
       77 REXXRTN        PIC X(8) VALUE "IRXEXCOM".
       77 REXXRC         PIC S9(9) BINARY.
       77 REXXRTNRC      PIC S9(9) BINARY.
       77 SHVRETB        PIC S9(9) BINARY.
      *
       77 NULADDR        PIC 9(9) USAGE BINARY VALUE 0.
      *
```

Example 6 – HLLPIPIM2 COBOL … (see Example 1)

```
 01 VarName1  VALUE "006LEREXX".
    02 VarName1L    PIC 999.
    02 VarName1V    PIC X
       Occurs 1 To 250 Times Depending on VarName1L.
*
 01 VarValue1 VALUE "023and COBOL all together!".
    02 VarValue1L   PIC 999.
    02 VarValue1V   PIC X
       Occurs 1 To 250 Times Depending on VarValue1L.
```

Example 6 – HLLPIPIM2 COBOL … (see Example 1)

```
PROCEDURE DIVISION.
      PARA-REXXVAR.
          Initialize SHVBLOCK Replacing AlphaNumeric By X'00'.
      * STORE (direct not symbolic) the variable
          Move SHVSTORE To SHVCODE Of SHVBLOCK.
      * The variable name
          Set SHVNAMA Of SHVBLOCK To Address Of VARNAME1V(1).
          Move VARNAME1L To SHVNAML Of SHVBLOCK.
      * The variable value
          Set SHVVALA Of SHVBLOCK To Address Of VARVALUE1V(1).
          Move VARVALUE1L To SHVVALL Of SHVBLOCK.
```

Example 6 – HLLPIPIM2 COBOL … (see Example 1)

```
* Call the REXX service as a subprogram to set the
* shared variable
     CALL REXXRTN USING REXXRTN ,
          OMITTED , OMITTED ,
          SHVBLOCK ,
          NULADDR , REXXRC
      Returning REXXRTNRC.
*
     MOVE SHVRET To SHVRETB.
     DISPLAY "REXX RC IS " REXXRC ","
            " IRXEXCOM RC IS " REXXRTNRC ","
            " SHVRET IS " SHVRETB "." .
*
     GOBACK.
```

If you code in C/C++

- 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
```

If you code in C/C++ …

- 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            */
  };
```

If you code in C/C++ …

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

```
INSTBLK_ENTRY DSECT                    REXX In-Storage Block Entry.
                  DS  0F               Allign on a fullword boundary
INSTBLK_STMT@     DS  A                Address of REXX statement
INSTBLK_STMTLEN   DS  F                Length of the REXX statement
INSTBLK_NEXT      DS  0CL8             Next INSTBLK_ENTRY
```

```
struct instblk_entry {
  void          *instblk_stmt_;   /* Address of REXX statement    */
  int            instblk_stmtlen; /* Length of the REXX statement */
/*unsigned char  instblk_next[8]; ** Next INSTBLK_ENTRY           */
  };
```

  - Similar issues necessitated removing nesting structure from **instblk_header**
    - and #ifdef'd out "helpful" #defines that were because of inner structure

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 – SA32-0972
- z/OS Using REXX and z/OS UNIX System Services – SA23-2283

- z/OS Language Environment Programming Guide – SA38-0682

- z/OS XL C/C++ User's Guide – SC14-7307
- z/OS XL C/C++ Programming Guide –SC14-7315

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An Introduction to Using REXX with Language Environment

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March 2014

Session 15229

SHARE in Anaheim