Things to Do with Rexx
When You’re on Z

René Vincent Jansen
Previously

❖ There was EXEC2 on VM
❖ There was CLIST on TSO
❖ But the console typewriter ran out of &&&&&ampersands
1979, REX is born

- Yes, it is 35 years old today
- A second X was bought for one million $
- Introduced publicly in 1981, Houston, TX
- IBM Product 1982 due to customer demand
It is a high-level language

- Scripts
- Applications
- Scientific and Commercial Programming
- Without resorting to an assembler language
The most useful command ever: Rexx’ read-evaluate-print

Command line scripting

In this case, the Julian date
ISPF Edit Macro Language

- ISREDIT enables quick writing of edit macros

- An example isredit macro in Rexx

- Note the “address isredit” to set the environment
Write an ISPF application in Rexx

- ISPF shares its variable pool with Rexx: A Rexx ISPF application has “nothing to declare”
- Define your panels using GML or just the old fashioned way
- Implement the logic in Rexx
DB2

- Can execute SQL and make complete applications
- Stored procedures
- DB2 command procedures
- Formatting traces
Supported DB2 statements

- CALL
- CLOSE
- CONNECT
- DECLARE CURSOR
- DESCRIBE prepared statement or table
- DESCRIBE CURSOR
- DESCRIBE INPUT
- DESCRIBE PROCEDURE
- EXECUTE
- EXECUTE IMMEDIATE
- FETCH
- OPEN
- PREPARE
- RELEASE connection
- SET CONNECTION
- SET CURRENT PACKAGE PATH
- SET CURRENT PACKAGESET
- SET host-variable = CURRENT DATE
- SET host-variable = CURRENT DEGREE
- SET host-variable = CURRENT MEMBER
- SET host-variable = CURRENT PACKAGESET
- SET host-variable = CURRENT PATH
- SET host-variable = CURRENT SERVER
- SET host-variable = CURRENT SQLID
- SET host-variable = CURRENT TIME
- SET host-variable = CURRENT TIMESTAMP
- SET host-variable = CURRENT TIMEZONE

```
123  SIGNAL ON ERROR
124
125  SELECT_STMT = 'SELECT EMPLOYEE.PROJNO, PROJNAME, COUNT(*),                
126                  ' SUM(DAYS(EMPENDATE) - DAYS(EMPSTARTDATE) * EMPTIME *     
127                  '  DECIMAL(SALARY / ?, 8, 2) )                    
128                  ' FROM CORPDATA/EMPLOYEE, CORPDATA/PROJECT, CORPDATA/EMPLOYEE,  
129                  ' WHERE EMPLOYEE.PROJNO = PROJECT.PROJNO AND                 
130                  ' EMPLOYEE.EMPNO = EMPLOYEE.EMPNO AND ',
131                  ' PRENDATE > ?                                  ',
132                  ' GROUP BY EMPLOYEE.PROJNO, PROJNAME ',
133                  ' ORDER BY 1 '                                 
134     EXECSQL,
135     'PREPARE S1 FROM :SELECT_STMT'
136     EXECSQL,
137     'DECLARE C1 CURSOR FOR S1'
138     EXECSQL,
139     'OPEN C1 USING :WORK_DAYS, :RAISE_DATE'
140
141     /* Handle the FETCH errors and warnings inline */
142     SIGNAL OFF ERROR
143
144     /* Fetch all of the rows */
145     DO UNTIL (SQLCODE <> 0)
146       EXECSQL,
147       'FETCH C1 INTO :RPT1.PROJNO, :RPT1.PROJNAME,    
148       '              :RPT1.EMPCOUNT, :RPT1.TOTAL_COST ' 
149
150     /* Process any errors that may have occurred. Continue so that   
151     /* we close the cursor for any warnings.                         */
152     IF SQLCODE < 0 THEN
153       SIGNAL ERROR
154
155     /* Stop the loop when we hit the EOF. Don't try to print out the */
156     /* fetched values.                                               */
157     IF SQLCODE = 100 THEN
158       LEAVE
159
160     /* Print out the fetched row */
161     SAY RPT1.PROJNO '   ' RPT1.PROJNAME '  ' ,
162     RPT1.EMPCOUNT '        ' RPT1.TOTAL_COST ;
163     END;
164
165     EXECSQL,
166     'CLOSE C1'
167```
Format DB2 Traces

- Start a monitor trace
- Dest OPX
- format an IFCA block
Format DB2 traces (continued)

use linkpgm to call the db2 attachment facility
Make complete applications in Rexx
"CICS XCTL PROGRAM('PGMA') COMMAREA(COMA)"
/ * REXX */
ascb = C2D(Storage(224,4))
assb = C2D(Storage(D2X(ascb+336),4))
jsab = C2D(Storage(D2X(assb+168),4))
jbnm = Storage(D2X(jsab+28),8)
jbid = Storage(D2X(jsab+20),8)
usid = Storage(D2X(jsab+44),8)
Say 'JOBNAME='jbnm' JOBID='jbid' USERID='usid
System Rexx

- Since z/OS 1.09
- Automate all console commands
- See the 2010 symposium materials
NetView Rexx

- This is here for a long time already
- Take care of monitoring and network automation
The Rexx Compiler

- Delivers performance benefits
- Provides CEXEC modules for the Rexx environment
- Provides native z/OS load modules to be linked with other programs
Fred Brooks called JCL the worst language ever designed and has stated he is sorry it happened on his watch.

True JCL opponents could rewrite most of the jobs in Rexx; this is very seldom seen.

ADDRESS LINKMVS is your main tool here.
Calling DFSORT

❖ As an example, call a sort from a Rexx exec without using JCL

❖ "FREE FI(SYSOUT SORTIN SORTOUT SYSIN)"
❖ "ALLOC FI(SYSOUT) DA("
❖ "ALLOC FI(SORTIN) DA('Y897797.INS1') REUSE"
❖ "ALLOC FI(SORTOUT) DA('Y897797.OUTS1') REUSE"
❖ "ALLOC FI(SYSIN) DA('Y897797.SORT.STMTS') SHR REUSE"
❖ ADDRESS LINKMVS ICEMAN
❖ Here are the DFSORT control statements that might appear in the Y897797.SORT.STMTS data set:

❖ SORT FIELDS=(5,4,CH,A)
❖ INCLUDE COND=(21,3,SS,EQ,C'L92,J82,M72')

❖ the DFSort Manual calls this a “Rexx CLIST”
Calling ICETOOL

❖ "FREE FI(TOOLMSG DFSMSG VLR LENDIST TOOLIN)"
❖ "ALLOC FI(TOOLMSG) DA(*)"
❖ "ALLOC FI(DFSMSG) DUMMY"
❖ "ALLOC FI(VLR) DA('Y897797.VARIN') REUSE"
❖ "ALLOC FI(LENDIST) DA(*)"
❖ "ALLOC FI(TOOLIN) DA('Y897797.TOOLIN.STMTS') SHR REUSE"
❖ ADDRESS LINKMVS ICETOOL

Here are the ICETOOL statements that might appear in the Y897797.TOOLIN.STMTS data set:

❖ OCCURS FROM(VLR) LIST(LENDIST) -
❖ TITLE('LENGTH DISTRIBUTION REPORT') BLANK -
❖ HEADER('LENGTH') HEADER('NUMBER OF RECORDS') -
❖ ON(VLEN) ON(VALCNT)
In order to make your application scriptable, you define Rexx function packages that execute code in your application.

This interface is highly standardized and exhaustively documented.

It is usual to define these in Assembler but C can also be used.
procedure division.
000-do-main-logic.
  display "PROGRAM COBPRG - Beginning".
  display "Return code before call is " RETURN-CODE.
  *
  * Pass the procedure parm HELLO to IRXJCL.
  * Pass 3 to REXX procedure 'HELLO'.
  * Set the size of the argument.
  *
  move "HELLO  3" to ARG-CHAR.
  move 8 to arg-size.
  * Call "IRXJCL" in order to execute the REXX procedure
  move "IRXJCL" to PGM-NAME.
  CALL PGM-NAME USING ARGUMENT.
  * Display the return code.
  display "Return code after call is " RETURN-CODE.
  display "PROGRAM COBPRG - Normal end".
  stop run.
Calling Rexx from PL/1

- FETCH IRXEXEC;
- CALL IRXEXEC(EXECBLK_PTR,
  ARGTABLE_PTR,
  flags,
  INSTBLK_PTR,
  reserved_parm5,
  EVALBLK_PTR,
  reserved_workarea_ptr,
  reserved_userfield_ptr,
  reserved_envblock_ptr,
  REXX_return_code_ptr);
- /* Handle the return code. */
  RETURN_CODE = PLIRETV;
- PUT SKIP EDIT ('RETURN CODE: ', RETURN_CODE) (A, F(4));
- PUT SKIP EDIT ('REXX RETURN CODE: ', REXX_RETURN_CODE) (A, F(4));
- PUT SKIP EDIT ('REXX RESULT IS: ' ||
  SUBSTR(EVALBLK_EVDATA,1,EVALBLK_EVLEN)) (A);
- PUT SKIP EDIT ('End of PLIPROG') (A);
- RETURN;
- END PLIPROG;

This is an impression of the main call; there is some DCL overhead needed
ZOC and its Rexx interface

- Zap-o-com is a 3270 (+5250+Unix) emulator and as such is on-topic for this talk.
- It has a well maintained Rexx interface that enables use of ooRexx and Regina.
- It is highly recommended (I have no stake in it, it is from a German company).
- All emulator actions can be scripted.
Ever tried to make an exec sleep for 10 seconds?

This is how it is done the easy way:

ADDRESS SYSCALL

"sleep" 10
Of course, z/OS is UNIX

...and has been a looong time ...

- Young persons: read right to left
Wait, does it have Stream-IO?

❖ Of course, it has them, the UNIX way
❖ It is ironic that this environment has these calls, years after they did not made the source-freeze when Rexx went to Endicott
❖ Let us look a bit deeper into this very modern way to write Rexx on z/OS
z/OS Unix adds three environments to ADDRESS

SYSCALL - for, erm, System Calls

SH - The Unix Shell

TSO - The (very non-optional) Time Sharing Option
File System Considerations

- A Rexx program that is invoked from a z/OS shell or from a program must be a text file or a compiled Rexx program that resides in the z/OS Unix file system.
- It must be readable and writeable.
- CEXEC output can be executed in the z/OS shell environment. The catalogued procedure REXXOEC can be used to compile and OCOPY the program to the Unix filesystem in one go.
SYSCALL
SYSCALL can be run from TSO/E or Unix Shell

- start program with `syscall('on')`
- ensures that `ADDRESS syscall` is enabled
- ensures that the address space is a process (this is called ‘dubbing’)
- initializes the Rexx variables in the initial variable pool
- sets the process signal mask to block all blockable signals
- clears the `argc` and `argv` variables
The SH environment

For a REXX program with syscall commands that will be run from a z/OS shell or from a program, SH is the initial host environment. The SYSCALL environment is automatically initialized as well, so you do not need to begin the REXX program with a `syscalls('ON')` call.

Syscall commands within the REXX program (for example, `chmod`) are interpreted as z/OS shell commands, not as syscall commands.
Using external functions and subroutines

- The search path for subroutines and external functions is similar to that for a Rexx program that is used from a z/OS shell or a program.
- The PATH variable is used to locate programs that are called by only using the file name.
- For executable programs, LPA, link list and STEPLIB are searched.
- If the name contains special or lowercase characters, quotes must be used.
  - `ans='myfunc'(p1,p2)`
- Otherwise, the name is folded to uppercase.
- Only interpreted Rexx programs are found in the z/OS Unix filesystem, other languages and compiled Rexx is not found in the filesystem (but is found in STEPLIB or LPA, link list).
A REXX program can run TSO/E commands, but you cannot use TSO commands to affect your REXX environment, or have REXX statements or other host command environments affect your TSO process.

Commands that are addressed to TSO will be run in a TMP running in a separate address space and process from your REXX program.

The TSO process is started when the first TSO command is run, and persists until your REXX program terminates or you run the TSO LOGOFF command.
The TSO command environment can be used from a z/OS Unix Rexx environment, and is initialized with:

- `address tso [command]`

where `[command]` may be any TSO command, clist, exec that can run in a TSO batch tmp

- the started program can be observed with `ps` as process `bpwwrtso`
TSO Input

- Most TSO programs use TGET for input and will fail
- For commands that are able to read input, first data is what is on the stack, and then any data that is in your Rexx exec’s standard input stream
- The standard input stream may also be queued as part of the input stream

For example, if you have a file redirected as input and you run a TSO command before processing that file, some or all of the file may be queued to the TSO command. If input is the terminal, queued input may be queued to the TSO command. This characteristic can be used to interact with some TSO commands.
The standard output stream of the Rexx exec will be used

The `outtrap()` function can be used to store output in a variable
To run the TSO/E TIME command:

address tso 'time'

To trap command output and print it:

call outtrap out.
   address tso 'listc'
   do i=1 to out.0
   say out.i end

To run a REXX exec in TSO/E:

address tso
   "alloc fi(sysexec) da('schoen.rexx') shr"
   "myexec"
More examples
Variable Scope

When the REXX program is initialized and the SYSCALL environment is established, the predefined variables are set up. If you call an internal subroutine that uses the PROCEDURE instruction to protect existing variables by making them unknown to that subroutine (or function), the predefined variables also become unknown. If some of the predefined variables are needed, you can either list them on the PROCEDURE EXPOSE instruction or issue another `syscalls('ON')` to reestablish the predefined variables. The predefined variables are automatically set up for external functions and subroutines. For example:

subroutine: procedure
junk = syscalls('ON')
parse arg dir
 ’readdir (dir) dir. stem.’
Running Rexx in z/OS Unix from a C program

```c
#pragma strings(readonly)
#include <stdlib.h>
#include <string.h>
#include <stdio.h>
typedef int EXTF();
#pragma linkage(EXTF,OS)
int main(int argc, char **argv) {
    extern char **environ;
    EXTF *irxjcl;
    EXTF *bpxwrbld;
    /* access environ variables */
    /* pointer to IRXJCL routine */
    /* pointer to BPXWRBLD routine */
    /* addid of REXX environment */
    /* temps */
    /* return code */
    /* ptr to env length pointers */
    /* ptr to env lengths */
    /* OE MVS env work area */
    /* name of exec up to 8 chars */
    char *penvb;
    int i,j;
    long rcinit;
    int **environlp;
    int *environl;
    char rxwork[16000];
    char *execname="execname";
    char *execparm="exec parameter string"; /* parm to exec */
    struct s_rxparm {
        short len;
        char name[8];
        char space;
        char text[253];
    } *rxparm;
    /* set IRXJCL */
    /* halfword length of parm */
    /* area to hold exec name */
    /* one space */
    /* big area for exec parm */
    /* if stdin or stdout are not open you might want to open file */
    /* descriptors 0 and 1 here */
    /* if no environ, probably iso or batch - make one */
    if (environ==NULL) {
        environ=(char **)malloc(8);
        environ[0]="PATH=.",
        environ[1]=NULL;
    }
    /* create one */
    /* set PATH to cwd */
    /* env terminator */
    /* need to build the environment in the same format as expected by */
    /* the exec() callable service. See */
    /* Assembler Callable Services for UNIX System Services. */
    /* the environ array must always end with a NULL element */
    /* temps */
    /* count vars */
    /* get array for len ptrs */
    /* get words for len vals */
    /* point to len */
    /* set len word */
    /* null entry at end */
    environlp=(int **)malloc(i*4+4);
    environl=(int *)malloc(i*4+4);
    for (j=0;j<i;j++) {
        environlp[j]=&environl[j];
        environl[j]=strlen(environ[j])+1;
    }
    /* name of exec up to 8 chars */
    for (i=0;environ[i]=NULL;i++);
    environlp=malloc(strlen(execname)+strlen(execparm)+sizeof(struct s_rxparm));
    memset(rxparm->name,' ',sizeof(rxparm->name));
    memcpy(rxparm->name,execname,strlen(execname));
    rxparm->space=' ';
    memcpy(rxparm->text,execparm,i=strlen(execparm));
    rxparm->len=sizeof(rxparm->name)+sizeof(rxparm->space)+i;
    return irxjcl(rxparm);
}
```

For example, to define your external functions for an application support package

Chapter 2. z/OS UNIX REXX programming services 17

```
    irxjcl=(EXTF *)fetch("IRXJCL");
    bpxwrbld=(EXTF *)fetch("BPXWRBLD");
    build the REXX environment
    environ=irxjcl(rxwork,
    argc,argv,
    ienvirnlp,environ, &penvb);
    if (rcinit!=0) {
        printf("environment create failed rc=%d\n",rcinit);
        return 255;
    }
    /* if you need to add subcommands or functions to the environment, */
    /* or create a new environment inheriting the current one, this is */
    /* the place to do it. The user field in the environment is used */
    /* by the z/OS UNIX REXX support and must be preserved. */
    /* run exec */
    rxparm=(struct s_rxparm *)malloc(strlen(execname)+
    strlen(execparm)+
    sizeof(struct s_rxparm));
    memset(rxparm->name,".",sizeof(rxparm->name));
    memcpy(rxparm->name,execname,strlen(execname));
    rxparm->space=" ";
    memcpy(rxparm->text,execparm,i(strlen(execparm));
    rxparm->len=sizeof(rxparm->name)+sizeof(rxparm->space)+i;
    return irxjcl(rxparm);
    }
assume that *pathname* was assigned a value earlier in the exec. This example changes the mode of the file to read-write-execute for the owner, and read-execute for all others:
"chmod (pathname) 755"
Rexx I/O Functions

- `lineout()` and `charout()`
- `linein()` and `charin()`
- `stream()`
- Streams can be opened implicitly and explicitly
Example Rexx I/O Functions

This example opens a stream for the file mydata.txt:
file=stream('mydata.txt','c','open write')

This example opens a stream for the file mydata.txt, but replaces the file if it exists:
file=stream('mydata.txt','c','open write replace')

To read the next 256 characters:
say charin(file,,256)

To set the read location to the sixth 80-byte record:
call charin file,5*80+1,0
Submit a Job to JES2

do i=1 by 1 while lines(fn)>0
    fn.i=linein(fn)
end
fn.0=i-1
say submit('fn.')
BPXWDYN, interface to dynamic allocation

This example allocates SYS1.MACLIB to SYSLIB and directs messages to z/OS UNIX standard error (stderr):

```r
CALL BPXWDYN "ALLOC FI(SYSLIB) DA(SYS1.MACLIB) SHR MSG(2)"
```

This example requests that the name of the data set allocated to ddname SYSLIB be returned in the REXX variable `dsnvar`.

```r
CALL BPXWDYN "INFO FI(SYSLIB) INRTDSN(DSNVAR)"
```

This example frees SYSLIB and traps messages in stem S99MSG:

```r
CALL BPXWDYN "FREE FI(SYSLIB)"
```

This example concatenates SYS1.SBPXEXEC to SYSPROC:

```r
IF BPXWDYN("ALLOC FI(tmp) DA(SYS1.SBPXEXEC) SHR MSG(2)")=0 THEN CALL BPXWDYN "CONCAT DDLIST(SYSPROC,tmp) MSG(2)"
```
Rexx for the 21st Century

- Pervasive on z/OS
- Support for USS
- Reuse these interfaces for ooRexx on z/OS