21st-Century CL

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Today we'll discuss . . .

1. Scope
2. Data
3. Structured programming
4. Subroutines
5. Built-in functions
6. Files and database
7. Miscellaneous enhancements
8. Final thoughts

Scope

Scope

Q: If you were designing a new computer language, would you include support for arithmetic?

A: It depends. First you have to tell me the purpose of the language.

Scope

- CL falls into the category of job control languages.
- (It is fair to say that CL is more than a JCL, since CL not only controls jobs, but all the operations on the system.)
- Job control languages do not need many of the capabilities of RPG and other high-level application languages.
- CL was introduced in 1980 with the first shipment of the System/38 and remained largely unchanged until 2002 (V5R3).
- Somebody with clout persuaded IBM that CL was not robust enough.

Data

New Data Types

- Signed integer (*INT)
- Unsigned integer (*UINT)
- Pointer (*PTR)

- First new data types since 1980.
- Signed integer type is more straightforward than the %BINARY (%BIN) function (but the %BIN function is not obsolete).
- Signed integer type is used by many APIs.

```
dcl &BytesAvail *int  4
dcl &BytesRtn   *int  4

Chgvar   &BytesAvail   %size(&RcvVar)
```

Defined-on variables

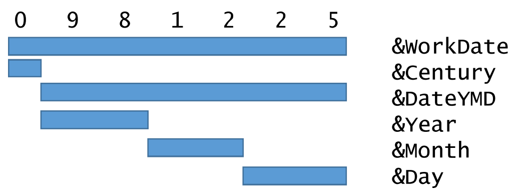
- Allow one variable to overlay another in memory
- Similar in function (but not in syntax) to data structures in RPG
- Syntax:

```
STG(DEFINED) DEFVAR(defined-on-variable   beginning-position)
```

- Default beginning position is 1

Defined-on variable example

```
dcl  &WorkDate    *char    7
dcl  &Century     *char    1  stg(*defined) defvar(&WorkDate 1)
dcl  &DateYMD     *char    6  stg(*defined) defvar(&WorkDate 2)
dcl  &Year        *char    2  stg(*defined) defvar(&DateYMD  1)
dcl  &Month       *char    2  stg(*defined) defvar(&DateYMD  3)
dcl  &Day         *char    2  stg(*defined) defvar(&DateYMD  5)
```



Pointers

- Store memory addresses
- The %ADDRESS (or %ADDR) function lets you set a pointer.
- The %OFFSET (or %OFS) function lets you do pointer arithmetic.

Structured programming

Looping – DOWHILE

- Top-tested loop
- Body of loop may not be executed at all
- Terminated by ENDDO

DOWHILE example

```
dcl  &Libs     *char   80
dcl  &Lib      *char   10

dowhile (&Libs *ne ' ')
   /* process the first library in the list */
   chgvar   &Lib   &Libs

   . . . do something with &Lib

   /* remove the library that was just processed */
   chgvar   &Libs     %sst(&Libs 11 70)
enddo
```

Not executed if &LIBS is blank!

1. &LIBS is a list of library names, such as:

```
MYLIB     YOURLIB   HISLIB    HERLIB    BIGLIBNAME
```

2. &LIB is one library name.

3. The first CHGVAR command copies the first 10 bytes of &LIBS to &LIB. (We don't need %SST (substring) because CHGVAR truncates, but we could use %SST if we wanted to clarify our intentions.)

```
MYLIB
```

4. After the system has done something with that library name, the second CHGVAR removes the first library name from the list. After the first iteration, &LIBS looks like this:

```
YOURLIB   HISLIB    HERLIB    BIGLIBNAME
```

5. The loop continues until all libraries have been processed.

Looping – DOUNTIL

- Bottom-tested loop
- Body is always executed at least once
- Terminated by ENDDO

DOUNTIL example

Executed at least once.

```
dountil (&Status *eq '0')
   call qrcvdtaq (&DtaQ &DtaQLib &DtaLen &Dta &Wait)
   select
      when (%sst(&Dta 1 1) *lt '1') then( chgvar &Status '0')
      when (%sst(&Dta 1 1) *eq '1') then( call Pgm1)
      when (%sst(&Dta 1 1) *eq ‘2') then( call Pgm2)
      when (%sst(&Dta 1 1) *eq ‘3') then( call Pgm3)
   endselect
enddo
```

Looping – DOFOR

- Top-tested loop
- Counted loop
- Terminating condition evaluated on each iteration (a “moving target”)
- Terminated by ENDDO
- Control variable must be an integer
- Loop increment can be positive or negative

DOFOR example

```
dcl  &inOptions     *char   80    /* list of options */
dcl  &Ndx           *uint    2
dcl  &Option        *char    8
dcl  &OptOffset     *uint    2    /* offset into the list */
dcl  &ToReport      *lgl

chgvar       &OptOffset         3

dofor        var(&Ndx) from(1) to(%bin(&inOptions 1 2))
   chgvar    &Option            %sst(&inOptions &OptOffset 8)
   select
      when (&Option *eq REPORT)   then(chgvar &ToReport '1')
      when (&Option *eq NOREPORT) then(chgvar &ToReport '0')
   endselect
   chgvar    &OptOffset         (&OptOffset + 8)
 enddo
```

(See https://www.itjungle.com/2014/07/09/fhg070914-story02/ for the complete example.)

LEAVE and ITERATE

- LEAVE jumps to the statement immediately following the end of the loop
- ITERATE jumps to the loop-control test
- Optional CMDLBL parameter allows you to specify which loop you wish to LEAVE or ITERATE

Looping – Middle-tested loops

- Implemented with DOWHILE

```
DOWHILE ‘1’
   . . . code that must run at least once
   IF COND(. . .) THEN(LEAVE)
   . . . code that might not run at all
ENDDO
```

- Must include a conditioned LEAVE to stop the loop

Middle-tested loop example

```
dclf  Schedule  opnid(s)

dowhile '1'
   rcvf opnid(s)
   monmsg cpf0864 exec(leave)
   if (&s_active *ne A) then(iterate)
   . . . do something to active record
enddo
```

Must be done at least once.

Test to leave loop or not

May not be done at all.

Case construct

- Implemented with SELECT/WHEN/OTHER/ENDSELECT keywords
- THEN may be null to ignore a case
- May be nested up to 25 levels deep

SELECT example (with keywords)

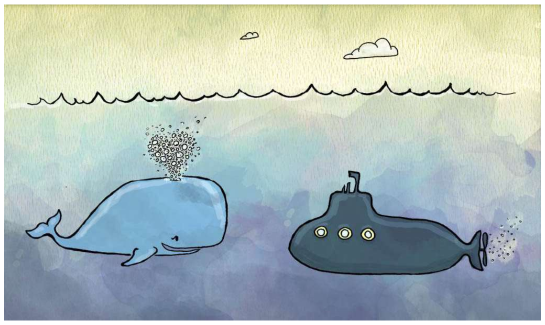
```
select

   when (&Option *eq O) +
      then(chgvar  &DevOption ('OUTQ(' *cat &OptValue *tcat ')'))

   when (&Option *eq D) +
      then(chgvar  &DevOption ('DEV(' *cat &OptValue *tcat ')'))

   otherwise +
      cmd(chgvar  &DevOption ('OUTQ(*DEV)'))

endselect
```

SELECT example (without keywords)

```
select

   when (&Option *eq O) +
      chgvar  &DevOption ('OUTQ(' *cat &OptValue *tcat ')')

   when (&Option *eq D) +
      chgvar  &DevOption ('DEV(' *cat &OptValue *tcat ')')

   otherwise +
      chgvar  &DevOption ('OUTQ(*DEV)')

endselect
```

Limitations

- Maximum of 25 levels of DOxxx commands
- Maximum of 25 levels of SELECT commands



Subroutines

Subroutines

- Follow the main routine and precede ENDPGM
- Bounded by SUBR and ENDSUBR commands
- Invoked by CALLSUBR command
- RTNSUBR and ENDSUBR leave a subroutine
- RTNSUBR and ENDSUBR may return a signed integer value
- Labels are local
- Recursive subroutine calls are permitted
- GOTO is not allowed into or out of subroutines
- Stack size is 99 levels, and may be changed to 20 thru 9999 in the SUBRSTACK parameter of the DCLPRCOPT command
- DMPCLPGM includes the subroutine stack

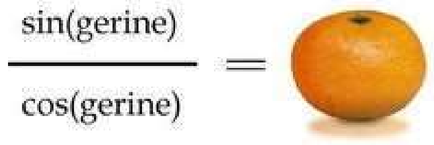
Subroutine with RTNVAL

```
dcl  &SubrStatus      *int     4
dcl  &RecCount        *dec    10

callsubr  Prepare  rtnval(&SubrStatus)
select
if (&SubrStatus *eq 2) do
   sndpgmmsg msgid(usr1001) msgf(myusrmsgf) +
      msgdta('Prepare routine requires file POST40.') +
      msgtype(*escape)

subr Prepare   /* Return code                         */
               /* 0 = all OK                          */
               /* 1 = completed with warnings         */
               /* 2 = not completed due to a fatal error */

   chgvar  &SubrStatus  0

   chkobj  post40  *file aut(*objexist)
   monmsg  cpf9801 exec(rtnsubr rtnval(2))

   rtvmbrd file(post40) nbrcurrcd(&RecCount)
   if (&RecCount *eq 0) chgvar &SubrStatus '1'

   . . . do something else

endsubr rtnval(&SubrStatus)
```

A more realistic example

Use subroutines to divide a program into logically-related pieces.

```
callsubr  PrcParms    /* process parameters */
callsubr  CrtWorkF    /* create the work files */
callsubr  Updt        /* update the database */
return


subr PrcParms
   . . . code to process the parameters
endsubr


subr  CrtWrkF
   . . . code to create work files
endsubr


subr  Updt
   . . . code to update the database
endsubr
```



Built-in Functions

Trim Functions

- %TRIM, %TRIML, %TRIMR
- First parameter is the character value to trim
- Second parameter is the group of characters to trim
- If no second parameter, these functions trim blanks

%TRIM example

```
dcl  &File           *char    10
dcl  &Lib            *char    10
dcl  &Stmf           *char   128

chgvar var(&Stmf) +
    value('/QSYS.LIB/'  *cat +
           %trim(&Lib)  *cat '.LIB/'  *cat +
           %trim(&File) *cat '.FILE/' *cat +
           %trim(&File) *cat '.MBR')
```

&Stmf has a value like this:

```
/QSYS.LIB/QTEMP.LIB/TEMP01.FILE/TEMP01.MBR
```

Case-conversion Functions

- %UPPER, %LOWER
- First parameter is the character value to convert
- Second parameter is the CCSID in which the data is stored. The default is zero, which means the job’s CCSID.

Case-conversion example

Allow the user to enter a value in uppercase, lowercase, or mixed case.

```
dcl    &Response    *char    8

chgvar var(&Response) value(%upper(&Reponse))
if (&Response *eq RETRY) do
```

Scan Functions

• %SCAN	find the position of one string within another one
• %CHECK	search a string for a character that is not part of a set
• %CHECKR	like %CHECK but search backwards from the end

• You may specify *LDA as the string to be searched/checked.

Example

Does the list of options contain the value *REPORT?

```
dcl  &Options       *char       82
dcl  &CrtRpt        *lgl

chgvar  &CrtRpt  (%scan('*REPORT ' &Options) *gt 0)
```

Type-conversion functions

- %CHAR
- %DEC
- %INT
- %UINT

Example

```
dcl   &DeleteCt       *dec   7
SndPgmMsg  ('Deleted' *bcat %char(&DeleteCt) *bcat 'orders.')
```

Sample output:

```
Deleted 105 orders.
```

%CHAR discards leading zeros

Memory-allocation functions

- %SIZE returns the number of bytes occupied by a variable
- %LEN returns the number of digits (if numeric) or characters in a variable

Example

```
dcl   &Cmd           *char    96
dcl   &CmdLen        *dec    (15 5)

chgvar    &Cmd          . . . whatever . . .
chgvar    &CmdLen        %size(&Cmd)

Call      qcmdexc        (&Cmd &CmdLen)
```

If the size of &Cmd changes, no mod is required here.

Files and database

File support - Multiple Files

- Up to five declared files in one CL procedure
- OPNID parameter assigns an identifier to each open file
- One file may have an OPNID of *NONE
- CL variables are prefixed with the OPNID value and an underscore
- OPNID is used for all file-related commands:
  DCLF, CLOSE, RCVF, SNDF, SNDRCVF, WAIT, ENDRCV

Example

```
dclf  QAFDMBRL opnid(MbrList)

dspfd file(&srclib/&srcfile) type(*mbrlist) +
         output(*outfile) outfile(qtemp/fdmbrl)

ovrdbf  qafdmbrl   tofile(qtemp/fdmbrl)

dowhile '1'
   rcvf opnid(MbrList)
   monmsg cpf0864 exec(leave)

   . . . do something with one or more &MBRLIST_ fields. . .

enddo
```

File Support – CLOSE

- Allows you to close a file so it can be re-read
- A RCVF against a closed file opens the file

File Support – RUNSQL

- Allows you to execute a single SQL statement in a CL procedure
- Work on those concatenation skills!

```
dcl  &FromDate *dec      7
dcl  &ThruDate *dec      7
dcl  &Comma    *char     1   value(',')
dcl  &SQL      *char   256

chgvar &SQL ('declare global temporary table SltData +
              (FromDate dec(7), ThruDate dec(7)) +
              with replace')
runsql sql(&Sql) commit(*none)

chgvar &SQL ('insert into session.SltData +
              values (' *cat %char(&FromDate) *cat +
              &Comma *cat %char(&FromDate) *cat ')')
runsql sql(&Sql) commit(*none)
```

Miscellaneous enhancements

INCLUDE

- Tells the compiler to copy in source code
- Like /COPY and /INCLUDE in RPG
- SRCMBR is the source member to copy
- SRCFILE is the file containing the copy member
- SRCFILE(*INCFILE) refers to the INCFILE parameter in CRTBNDCL, CRTCLPGM, CRTCLMOD

INCLUDE

```
pgm

include srcmbr(ErrorDcl) srcfile(qclsrc)

. . . more code

include srcmbr(ErrorRtn) srcfile(qclsrc)

endpgm
```

Pass Parameters by Value

- Allowed on CALLPRC (specify *BYREF or *BYVAL)
- Useful for binding to C and MI routines
- Also works for calling RPG routines!

RPG module

```
ctl-opt  nomain;

dcl-s   gOption    packed(3);

dcl-proc  SetOption    export;
   dcl-pi *n;
      inOption    packed(3)    value;
   end-pi;

   gOption = inOption;

end-proc;
```

CL module

```
dcl  &Option    *dec     3

callprc   prc(SetOption)  parm((&Option *byval))
```

Increased maximums

- Maximum number of parameters on PGM command increased from 40 to 255
- Maximum number of parameters on CALL and TFRCTL commands increased to 255
- Maximum number of PARM commands in command source increased from 75 to 99
- Maximum size of *CHAR variables increased from 9999 to 32,767

Final thoughts

Final thoughts

- CL is probably more or less what it will be when it comes to end of life, so you may as well master what’s there.
- We could already do what these many of these enhancements do by calling HLL programs.
- Don’t try to replace RPG.

ENDPGM