Rexx/370 Compiler and Library 1995

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IBM Rexx/370 Compiler and Library

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IBM Rexx/370 Compiler and Library
Service and Development

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Disclaimer

Products

- Compiler:
  - IBM Compiler for SAA Rexx/370, Release 3
    - Program number 5695-013
    - CompID 569501301 FMID HWK0130 (MVS)
    - CompID 569501302 FESN 0463773 (VM)
- Library:
  - IBM Library for SAA Rexx/370, Release 3
    - Program number 5695-014
    - CompID 569501401 FMID HWJ9130 (MVS)
    - CompID 569501402 FESN 0463776 (VM)
  - Rexx/VSE Library, Release 2
    in Rexx/VSE, Version 1 Release 1
    - Program number 5686-058
    - CompID 568605802
  - Rexx/VSE Library, Release 2
    in VSE Central Functions, Version 6 Release 1
    in VSE/ESA, Version 2 Release 1
    - Program number 5686-066
    - CompID 568606612

Operating Systems

- MVS
  - TSO/E V2R3M1 or later on MVS/ESA SP V4R1 or later
  - TSO/E V2R4 or later on MVS/ESA SP V3R1
  - NetView V2R2 or later with above
- VM/CMS
  - VM/ESA V1R1 or later
  - VM/XA SP R2 or later
  - VM/SP R5 or later
  - VM/HPO R5 or later
- VSE (Library only)
  - Rexx/VSE V1R1 or later on VSE/ESA V1R3 or later
  - VSE/ESA V2R1 or later
    (Rexx/VSE integrated into base)

Language Levels

The Rexx language level accepted is:

- 4.00 on VM/ESA V1R2.1 and later including stream I/O^{R3}
- 3.48 everywhere else including Trace^{R3} and Interpret^{R2}

With Release 3, the Rexx Compiler and Library now supports the entire classic Rexx language

Compiler and Library Publications

IBM Compiler and Library for SAA Rexx/370, Release 3:

- Licensed Program Specifications (GH19-8161-02)
- Introducing the Next Step in Rexx Programming (G511-1430-02)
- User's Guide and Reference (SH19-8160-03)
- User's Guide and Reference (Japanese) (SH88-7187-03)
- Diagnosis Guide (SH19-8179-01)
- User's Guide and Reference and Diagnosis Guide (SK2T-1410-00)
  included in IBM Online Library Omnibus Editions:
  - MVS Collection (SK2T-0710-10)
  - VM Collection (SK2T-2067-06)
  - VSE Collection (SK2T-0060-05)

Program Directories

- MVS Compiler: PRGDDIR820P, October 1994
- MVS Library: PRGDDIR817P, October 1994
- VM Compiler: PRGDDIR83F2, March 1995
  (replaces PRGDIR822P, October 1994)
- VM Library: PRGDDIR82F2, March 1995
  (replaces PRGDIR818P, October 1994)

Other Pubs About Using The Compiler

- TSO Extensions Version 2
  - Rexx/MVS Reference (SC28-1883-06)
  - Rexx/MVS User's Guide (SC28-1882-04)
  - Customization (SC28-1872-07)
- VSE/ESA V2R1
  - Rexx/VSE Reference (SC33-6642-00)
  - Rexx/VSE User's Guide (SC33-6641-00)
  - Rexx/VSE Diagnosis Reference (LY33-9189-00) (available August 1995)
- Rexx/VSE V1R1
  - Reference (SC33-6529-00)
  - User's Guide (SC33-6528-00)
  - Diagnosis Reference (LY33-9144-00)
  - Getting Started (GG24-4192-00)
- Book
  - The Rexx Handbook
    Gabriel Goldberg, Philip H. Smith III
    1992, McGraw Hill (SB20-0020-00)

Communicating

- Service: USREXX,182 or WTREXX,182
  - 569501301 R130 MVS Compiler
  - 569501302 R130 VM Compiler
  - 569501401 R130 MVS Library
  - 569501402 R130 VM Library
- Electronic
  - IBM TalkLink: RexxComp CForum
  - VMSHARE: Memo RexxComp
  - VMSHARE: Prob RexxComp
  - VMSHARE: Note RexxComp
  - ListServ: RexxComp@bitnic.cren.net
  - EMail: RexxComp@vnet.ibm.com
- Readers' Comment Form
  - Internet: pubrcf@vnet.ibm.com
  - IBMLink: GDLVME(PubRCF)
  - IBM Mail: USIB2L8Z@IBMMail
  - Fax: USA 607-752-2327

Release History

Short Name	Program Number	Rel	First Avail.	End of Service
CMS Comp & Libr	5664-390	1	89Jun30	95Sep22
CMS Library	5684-124	1	89Nov17	95Sep22
Rexx/370 Compiler	5695-013	1	91Aug30	93Nov28
Rexx/370 Library	5695-014	1	91Aug30	93Nov28
Rexx/370 Compiler	5695-013	2	93May28	95May07
Rexx/370 Library	5695-014	2	93May28	95May07
Rexx/VSE V1R1 Libr	5686-058	2	93Sep17	
Rexx/370 Compiler + Alternate Library	5695-013 + PN48006(MVS)	2	93Nov04 PN48015(VM)	95May07
Rexx/370 Compiler	5695-013	3	94Nov07	
Rexx/370 Library	5695-014	3	94Nov07	
Rexx/VSE V2R1 Libr	5686-066	2	95Apr21	
Rexx/VSE V2R1 Libr	5686-066 +	3	95Oct27	

Determining Levels

- Compiler
  - From program listing: Release, PTF
- Library

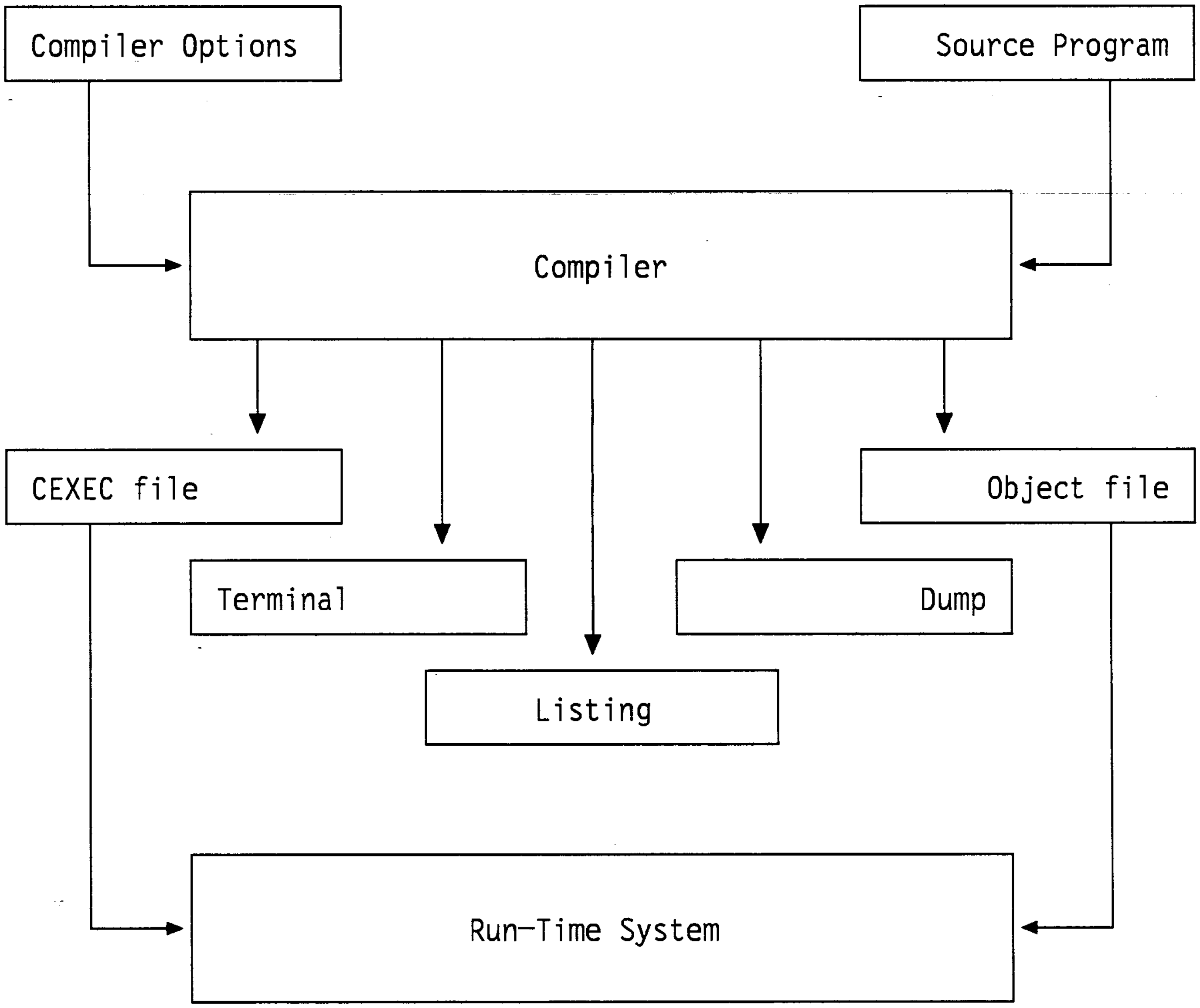
  Offset from beginning of first EAGRTLIB in file

Release	+9..+13
PTF	+19..+25
Date	+37..+44
Time	+46..+50

- Compiled program

Field	CExec file	Object file
Release	rec 1 cols 36..40	rec 2 cols 52..56
Compilation Date	rec 1 cols 43..54	rec 2 cols 60..70
Compilation Time	rec 1 cols 56..63	rec 2 cols 72+
		rec 3 cols 17..23
Compilation System	rec 1 cols 65..67	rec 3 cols 25..27
Language Level	rec 1 cols 78..81	rec 3 cols 38..41
Compiler Date	rec 1 cols 83..93	rec 3 cols 43..53
Compiler PTF	rec 1 cols 99..105	rec 3 cols 59..65

Compilation



Note: No compiler work files, everything kept in virtual storage

Compiled Rexx Files

- CExec and Object files contain the same information, except for one bit indicating what kind of file it is, but are formatted differently
  - CExecs are used the same way Execs are used
  - Object files are used the same way other high-level language compiler outputs are used (link-edit)
- Contain
  - Executable S/370 instructions
  - Invocations of Library routines
  - Symbol tree, with names and descriptors
  - Control blocks
- Are reentrant, relocatable, and XA (31-bit) capable
- Are execution operating system independent
- Can use any Library at a release level at least as great as the Compiler
- Don't contain the program source
  (unless compiled with SLine option)

Rexx Is Hard To Compile

- Dynamic program structure
  - No conventional block structure
  - Start a procedure by executing Procedure instruction
  - End a procedure by executing Return instruction
- Signal can transfer control most anywhere
- No data types but some operations content dependent
- Variables
  - Are not declared
  - Can change attributes dynamically
  - Come and go dynamically
  - Can be shared with external programs
  - Names can be computed
  - Size limited only by storage
  - Arithmetic precision can be set dynamically
- Program text can be created dynamically

Assumptions That Make Compiling Worthwhile

- Assignments appear often
- Simple arithmetic appears often
- Control constructs appear often
- Do loops appear often
- Interpret not used often
- Storage management is expensive

Performance

Compiled programs that include many	Run this much faster
Arithmetic operations	6 to 10 times
String and word processing	6 to 10 times
Constants and variables	4 to 6 times
References to procedures and built-in functions	4 to 6 times
Changes to values of variables	4 to 6 times
Assignments	2 to 4 times
Reused compound variables	2 to 4 times
Host commands	Minimal improvement

Optimizations

- No tokenizing/parsing at run-time
- Address simple variables and stems directly
- Compiler optimizations
  - Common subexpressions
  - Constant folding
  - Value propagation
  - Less general code generation with knowledge about state of variables, Numeric Digits setting, and types of operands
  - Not load addresses already in register
- Fast linkage to library routines
- Optimized storage management for several kinds of use
- Binary arithmetic
- String arithmetic optimized for large numbers
- Avoid string movements, reuse string storage
- Lookup for compound variable access not always from top
- Cache compound variable addresses
- Optimized for compound variable integer tails

Optimization stoppers

- Interpret instruction
- Trace compiler option
- Numeric Digits < 9 suppresses binary arithmetic
- Numeric Digits unknown suppresses binary arithmetic
- Integers coded in exponential notation, with decimal points, or in strings with non-digit characters suppress binary arithmetic (1e0, 1., '1 ', ' 1' vs '1', 1)
- Labels stop compound variable access optimizations
- Referenced labels may stop other optimizations
- Labels within loops require run-time checks for jumps into loop
- More than three numeric tails suppresses numeric tail optimizations

Note: A program compiled with the Trace[R3] option is fully interpreted by the run-time Library and will perform better than when interpreted by the system interpreters

Optimizing programs

- Quoted strings perform better than variable names
- Assignment of quoted strings perform best
- TestHalt slows down loops (especially on MVS)
- Compiled assignment is faster than Parse
- Assignment preserves binary value
- Simple variables are faster than compound variables
- Exposing stem is faster than exposing compound variable
- Binary representation can be forced (a+0)
- Preallocating strings faster than extending strings
- DLinked modules perform best
- Object compiler output can be used in function packages (which can be DLinked)

Extensive Error Reporting

- 232 compile-time message numbers
  - Detailed static syntax analysis of entire program
  - Marks probable cause of error in listing
  - Cross-reference can be used to
    - find misspelled and similarly spelled names
    - find variables never assigned a value
  - Can flag non-SAA language elements
- 182 run-time message numbers
  - Issues standard Rexx error messages
  - Plus more detailed messages for each error
- Messages can be translated to other national languages (Japanese available)
- Both compiler and library have internal diagnostic facilities to help isolate internal errors

Program Listing

- On every page
  - program identifier
  - compiler release and PTF level
  - compilation date and time
- Compilation summary
  - Compilations status
    (number of messages, severity code)^{R2}
  - Each compilation option with specified or default value
  - If ETMode in effect^{R2}
- Source listing (optional)
  - Nesting levels for If, Do, Select
  - Program line numbers and record and file numbers^{R3}
  - Messages interspersed with markers to probable cause on line

- Cross-references (optional)
  - Grouped by
    - Labels, built-in functions, external routines
    - Constants (optional)
    - Simple variables
    - Stems and compound variables
  - Include
    - The item
    - Attributes
    - Line references
    - Where set and for labels: valid definition, reference to undefined, duplicate
  - Host commands in source[R3] (optional)
- Compilation statistics[R2]
  - Number of source lines
  - Size of compiled program
  - Message statistics
  - Flagged source line numbers
  - Included files names[R3]

Alternate Library (R2+PTF)

- Run compiled execs without the Library product
- Can be distributed freely, without charge
- Can be packaged with compiled Rexx applications

- Uses interpreter so no performance advantage
- Alternate and SLine compiler options required
- Condense option may be used
- Can be used for either CExec or Object files
- Compiled execs can use actual Library if available

Condense (R1)

- Compiled programs larger than source
- Condensed programs usually smaller than source, even when source lines included
- Expansion occurs when program invoked
- Advantages
  - Less disk space
  - Less I/O when read into storage
  - After expansion at start-up, no performance degradation
  - Source scrambled, including host commands and constants, even when source lines included
- Disadvantages
  - More storage when running (both condensed and expanded versions remain in storage)
  - More processor time to expand when invoked
  - Can't use DLink option

- Use Condense when
  - I/O is the bottleneck and storage isn't
  - Program resides on disk or non-shared storage
  - Program is large
  - Program is long-running
  - Program is seldomly invoked
  - Source or constants need protection
  - DLink not required

Copyright (R2+PTF)

- Control directive — /*%Copyright ... */
- Inserts notice as visible text in compiled file
- Inserted notice is the concatenation of all Copyright directives in a program
- Treated as a comment by Rexx interpreters

Margins (R3)

- Can specify left and right text bounds of source files
- Only text within margins is compiled
  Compiler listing contains complete record
- SLine and IExec output contain only text within margins
- On MVS, file sequence numbers detected and removed before margins applied

Include Files (R3)

- No longer necessary to have entire program in 1 source file
- Control directive — /*%Include file_id */
  - Inserts included file immediately following the */
  - Includes may be nested
  - Included files may be members of libraries
  - Treated as a comment by Rexx interpreters — but ...
- IExec compiler option
  - Generates a single file with all program source, %Included or otherwise
  - Contains only text within specified margins
  - Can be used to interpret programs composed of include files or with non-Rexx text outside of margins

Object

- Use Rexx program as would other high-level language programs
  - Build modules
  - Command or program search order
  - Use various MVS/VSE parameter passing conventions
    - TSO/E command
    - Rexx external routine
    - Either TSO/E or Rexx external routine
    - MVS program
    - VSE program
    - TSO/E Called command
- Build function packages
- Combine with routines written in other languages
- Same file content as CExec, just different format
- Get external symbol and relocation information with DLink option

DLink (R1)

- Combine external functions and subroutines into 1 executable module
- Direct linking instead of searching
  - Can be very significant performance improvement
- Can create self-contained modules
- No name clashes with user's environment
- No behavioral changes due to changes to external routines
- Select which routines are included — doesn't have to be all routines (generates weak external references)

Possibilities?

- Object Rexx
- More, better optimizations
- Better error reporting by recognizing bifs and operand types at compile time
- ANSI flag option — flag non-ANSI syntax
- NoExecComm option — assume no ExecComm interface, means better optimization possible
- WDB/WDBLang debugger support — generate needed side files
- AutoSLine option — include source only if SourceLine bif used
- SLine option ranges — include only selected source
- Scramble imbedded source — improve security
- Compiler dump range option — reduce dump volume
- Page width option — support wider lines
- Indicate minimum runtime level required on listing and via utility and function

Possibilities?

- Error number cross reference option
- Add column numbers to messages and list of flagged lines
- Print DCB parameters in options list
- Support alternate DD names
- Include invalid hex and binary strings in cross reference listing
- Print hex and binary strings as they appear in source
- Spilt source lines at more sensible places in listing
- More dump data — unsorted symbol table, environment interface, lister
- User specified placement of TestHalt hooks
- Ability to build single executable that doesn't require runtime library
- OS/2 syntax checker, lister
- Source reformatter — indent by nesting level, etc.

- Classic Rexx compiler and library for
  - OS/2, WARP
    - Intel
    - PowerPC
  - AIX, UNIX
  - WindowsNT, Windows95
  - AS/400
  - CICS/MVS (library only, both)
  - VSE (compiler)
  - PC DOS
  - Other

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