

OS/390



C/C++ Compiler and Run-Time Migration Guide

OS/390



C/C++ Compiler and Run-Time Migration Guide

Note!

Before using this information and the product it supports be sure to read the general information under "Notices" on page vii.

Fourth Edition, September 1998

This edition applies to Version 2 Release 6 of OS/390 C/C++ (5647-A01) and to all subsequent releases and modifications until otherwise indicated in new editions or other updated documentation. Make sure that you use the correct edition for the level of the program listed above. Also, ensure that you apply all necessary PTFs for the program.

Technical changes in the text since the last release of this book are indicated by a vertical line (|) to the left of the change.

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Part 1. Introduction

This part provides answers to some common migration questions.

Chapter 1. Locating your Migration Path

This book discusses the implications of migrating applications from each of the compilers and libraries listed in Table 2 on page 4 to the OS/390 Version 2 Release 6 C/C++ product. To find the section of the book that applies to your migration, see “How This Book Is Organized” on page 4.

Use this book to help determine what must be done to continue to use existing source code, object code, and load modules, and to be aware of differences in behavior between products that may affect your migration. In most situations, existing well-written applications can continue to work without modification.

This book does not discuss all of the enhancements that have been made to the OS/390 Version 2 Release 6 C/C++ compiler and OS/390 Version 2 Release 6 Language Environment. This book does not show how to change an existing C program so that it can use C++. For a list of books that provide information about the OS/390 Version 2 Release 6 C/C++ compiler and its class libraries, debugger, and utilities, refer to “Bibliography” on page 83. For a description of some of the differences between C and C++, see *OS/390 C/C++ Language Reference*.

In this book, references to the products listed in the first column of Table 1 also apply to the products in the second column.

Table 1. Product References

References To These Products	Also Apply To These Products
LE/370 Release 3	MVS/ESA SP Version 5 Release 1 OpenEdition, AD/Cycle C/370 Language Support Feature
Language Environment Release 4	MVS/ESA SP Version 5 Release 2 Modification 0 C/C++ Language Support Feature
Language Environment Release 5	MVS/ESA SP Version 5 Release 2 Modification 2 C/C++ Language Support Feature
C/MVS Version 3 Release 2 compiler	C component of the C/C++ for MVS/ESA Version 3 Release 2 compiler
C++/MVS Version 3 Release 2 compiler	C++ component of the C/C++ for MVS/ESA Version 3 Release 2 compiler
OS/390 Release 1	C/C++ for MVS/ESA Version 3 Release 2, IBM Language Environment for MVS & VM Release 5
OS/390 Release 2 C compiler	C component of the OS/390 Release 2 C/C++ compiler
OS/390 Release 2 C++ compiler	C++ component of the OS/390 Release 2 C/C++ compiler
OS/390 Release 3 C compiler	C component of the OS/390 Release 3 C/C++ compiler
OS/390 Release 3 C++ compiler	C++ component of the OS/390 Release 3 C/C++ compiler

Introduction

Table 1. Product References (continued)

References To These Products	Also Apply To These Products
OS/390 Version 2 Release 4 C compiler	C component of the OS/390 Version 2 Release 4 C/C++ compiler
OS/390 Version 2 Release 4 C++ compiler	C++ component of the OS/390 Version 2 Release 4 C/C++ compiler
OS/390 Version 2 Release 5 C compiler	C component of the OS/390 Version 2 Release 5 C/C++ compiler
OS/390 Version 2 Release 5 C++ compiler	C++ component of the OS/390 Version 2 Release 5 C/C++ compiler
OS/390 Version 2 Release 6 C compiler	C component of the OS/390 Version 2 Release 6 C/C++ compiler
OS/390 Version 2 Release 6 C++ compiler	C++ component of the OS/390 Version 2 Release 6 C/C++ compiler

How This Book Is Organized

- Part 1 contains some general answers to common migration questions.
- Part 2 describes the considerations for migrating from one of the following:
 - The IBM C/370 Version 1 or Version 2 Release 1 compiler and the IBM C/370 Version 1 or Version 2 Release 1 library
 - The IBM SAA AD/Cycle C/370 Version 1 Release 2 compiler and the IBM C/370 Version 2 Release 2 library
- Part 3 describes the considerations for migrating from one of the following:
 - The AD/Cycle C/370 compilers
 - The MVS C/C++ Version 3 compilers
 - The OS/390 V1R1 C/C++ compilerand any release of Language Environment
- Part 4 describes the considerations for migrating from one of the following:
 - OS/390 Release 2 C/C++
 - OS/390 Release 3 C/C++
 - OS/390 Version 2 Release 4 C/C++
 - OS/390 Version 2 Release 5 C/C++

A History of Compilers and Libraries

Table 2 lists the versions of the C and C++ compilers and run-time libraries in the order in which they were first released. Use this table to help determine which changes described in this book apply to your migration.

Table 2. A History of Compilers and Libraries

Short Name	Product Number	GA Date	Description	Service Status
C/370 V1R1	5688-040	1988	C/370 V1R1 Compiler	end of service
	5688-039	1988	C/370 V1R1 Library	
C/370 V1R2	5688-040	1989	C/370 V1R2 Compiler	end of service
	5688-039	1989	C/370 V1R2 Library	

Table 2. A History of Compilers and Libraries (continued)

Short Name	Product Number	GA Date	Description	Service Status
C/370 V2R1	5688-187	1991	C/370 V2R1 Compiler	
	5688-188	1991	C/370 V2R1 Library	
AD V1R1	5688-216	1991	AD/Cycle C/370 V1R1 Compiler, follow-on to C/370 V2R1 Compiler.	end of service
LE V1R1	5688-198	1991	LE/370 V1R1 Library, first release of Language Environment /370; follow-on to C/370 V2R1 Library.	end of service
LE V1R2	5688-198	1992	LE/370 V1R2 Library	end of service
AD V1R2	5688-216	1994	AD/Cycle C/370 V1R2 Compiler: <ul style="list-style-type: none"> • Runs on either LE V1R3 or C/370 V2R2 • Generates code for either LE V1R3 or C/370 V2R2 	
LE V1R3	5688-198	1994	LE/370 V1R3 Library, also shipped as part of MVS/ESA SP 5.1 OpenEdition AD/Cycle C/370 Language Support Feature.	end of service as of March 1997
C/370 V2R2	5688-188	1994	C/370 V2R2 Library. Follow-on to the C/370 V2R1 Library, intended to help customers migrate to LE/370.	
C/C++MVS V3R1	5655-121	1995	C/C++ for MVS/ESA V3R1 Compilers, follow-on to AD V1R2 Compiler. First release of C++ on MVS.	end of service as of December 1996
LE V1R4	5688-198	1995	LE V1R4 Library for MVS & VM, also shipped as the MVS/ESA SP 5.2.0 C/C++ Language Support Feature.	end of service Sept 1997
C/C++/MVS V3R2	5655-121	1995	C/C++ for MVS/ESA V3R2 Compilers	
LE V1R5	5688-198	1995	LE V1R5 Library for MVS & VM, also shipped as part of MVS/ESA SP 5.2.2 C/C++ Language Support Feature.	
OS/390 R1	5645-001	March 1996	OS/390 R1 includes the C/C++ for MVS/ESA V3R2 Compilers and the LE V1R5 Library.	
OS/390 R2	5645-001	Sept 1996	OS/390 R2 C/C++ is the follow-on to OS/390 R1 C/C++, and includes new optimization options to improve the execution-time performance of C code.	
OS/390 R3	5645-001	March 1997	OS/390 R3 C/C++ is the follow-on to OS/390 R2 C/C++, and includes new optimization options to improve the execution-time performance of C++ code.	

Introduction

Table 2. A History of Compilers and Libraries (continued)

Short Name	Product Number	GA Date	Description	Service Status
OS/390 V2R4	5647-A01	Sept 1997	OS/390 V2R4 C/C++ is the follow-on to OS/390 R3 C/C++, and includes performance improvements for DLLs, conversion of character string literals, and support for the Program Management Binder.	
OS/390 V2R5	5647-A01	March 1998	OS/390 V2R5 C/C++ is functionally equivalent to OS/390 V2R4 C/C++.	
OS/390 V2R6	5647-A01	Sept 1998	OS/390 V2R6 C/C++ is the follow-on to OS/390 V2R5 C/C++, and includes support for the IEEE binary floating-point and the long long integer data types, and improvements to the handling and format of packed decimal numbers in C++.	

Chapter 2. Common Questions about Migration

This chapter describes the kind of migration impacts that you may encounter, and the possible solutions.

Will Existing LE Applications Run with OS/390 V2R6?

Yes, in nearly all situations, an existing, well-behaved Language Environment application can be run with OS/390 Language Environment without any modifications. A well-behaved application is one that relies on documented interfaces only.

For example, the *OS/390 C/C++ Run-Time Library Reference* states that the `remove()` function returns a nonzero return code when a failure occurs. The following code fragments show the correct and incorrect ways to call the `remove()` function and to check the return code:

Incorrect method

```
if (remove("my.file") == -1) {  
    call_err();  
}  
  
.  
.  
.
```

Correct method

```
if (remove("my2.file") != 0) {  
    call_err();  
}  
  
.  
.  
.
```

The value of the return code from the `remove()` function changed in LE/370 Release 3. If an LE/370 Release 2 program was coded incorrectly, and checked for a specific value, as in the first code fragment, a source change is required when the code is migrated. This situation is common when an application relies upon undocumented interfaces. However, if the program was coded correctly, and it did not check for a specific nonzero return code, as in the second fragment, no source changes are required.

Will Existing C/370 Applications Work with OS/390 V2R6?

A C/370 application is created using the IBM C/370 Version 1 or Version 2 compiler and library, or the AD/Cycle C/370 Version 1 Release 2 compiler with the `TARGET (COMPAT)` option and the C/370 Version 2 Release 2 library. A well-coded C/370 application, in most situations, works with OS/390 Language Environment without any modifications.

Two common migration problems that you may encounter relate to interlanguage calls:

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- You must relink applications that contain interlanguage calls between C/370 and Fortran before running them with OS/390 Language Environment
- You can only run them with OS/390 Language Environment after they are relinked. You cannot continue to run them with the C/370 library.

The same rules apply to applications that contain interlanguage calls between C/370 and COBOL, unless you relink them with the C/370 Version 2 Release 1 or Release 2 library with the PTF for APAR PN74931 applied. This PTF replaces the C/370 Version 2 link-edit stubs so that they tolerate Language Environment. After your application is relinked using the modified C/370 Version 2 stubs, you can run the application with either the C/370 Version 2 run-time library or with Language Environment. Refer to “Executable Programs with Interlanguage Calls” on page 14 for more information about COBOL and Fortran interlanguage calls.

Though there are other migration items (described in the following chapters) that may affect your application, these are the most serious ones.

My Application Does Not Run — Now What?

If your application does not run, it may be either a migration problem, or an error in your program that surfaces as a result of a new design feature in the run-time library. Do the following:

1. Verify the concatenation order of your libraries.

If you have a load module built with both C/370 library parts and OS/390 Language Environment parts, ensure that you are not accidentally initializing your environment using the C-PL/I Common Library rather than OS/390 Language Environment. The PDS with the low level qualifier SCEERUN (which belongs to OS/390 Language Environment), must be concatenated ahead of the PDS with the low level qualifier SIBMLINK (which belongs to the C-PL/I Common Library).

Refer to the section “Initialization Compatibility” on page 15 for more information.

2. Use environment variables to obtain the “Old Behavior”.

Under OS/390 Language Environment, you can use the ENVAR run-time option to specify the values of environment variables at execution time. With some environment variables, you can specify the “old behavior” for particular items. The following setting provides you with “old behavior” for the greatest number of items:

```
ENVAR("_EDC_COMPAT=32767")
```

The value assigned to `_EDC_COMPAT` is used as a bit mask. If you assign a value of 32767, the library uses “old behavior” for all of the general compatibility items currently defined by `_EDC_COMPAT`. For more information about `_EDC_COMPAT` and its possible values, refer to the *OS/390 C/C++ Programming Guide*.

If `_EDC_COMPAT` solves your migration problem, you can use it with the ENVAR run-time option, as shown above, or in a call to `setenv()` either in the CEEBINT High-Level Language exit or in your `main()` program. Using CEEBINT only requires you to relink your application, but adding a call to `setenv()` in the `main()` function requires a recompile and obviously a relink. See the *OS/390 C/C++ Run-Time Library Reference*, and the *OS/390 C/C++ Programming Guide* for more details about the `setenv()` function.

3. Relink your application.

Relinking your application with OS/390 Language Environment ensures that you did not link in any non-OS/390 Language Environment interfaces. You must relink your C/370 application before running it with OS/390 Language Environment, if your application:

- Contains ILCs between C and Fortran, or between C and COBOL.

Refer to “Executable Programs with Interlanguage Calls” on page 14 for more information.

- Is an SP C application that uses the library
- Contains calls to `c_test()`

4. Review the migration items documented in this book.

If you find a migration item in this manual that you think may affect your application, use the workaround described in this book. If a relink or a setting of an environment variable is not suggested, you must change your source, and then recompile and relink your application.

5. Look for uninitialized storage.

In some cases, applications will run with uninitialized storage, because the run-time library may inadvertently clear storage, or because the storage location referenced is set to zero.

Use the `STORAGE` and `HEAP` run-time options to find uninitialized storage. We recommend `STORAGE(FE,DE,BE)` and `HEAP(16,16,ANY,FREE)` to determine if your application is coded correctly. Any uninitialized pointers will fail at first reference instead of accidentally referencing storage locations at random.

Note: Your program will run slower with these options specified. Do not use them for production, only development.

6. Look for undocumented interfaces.

It is possible that your application has dependencies on undocumented interfaces. For example, you may have dependencies on library control blocks, specific `errno` values, or specific return values. Alter your code to use only documented interfaces, and then recompile and relink.

7. Contact your service representative.

If you followed steps 1 to 6, but cannot run your existing load module under OS/390 Language Environment, contact your System Programmer to verify whether or not all service has been applied to your system. Often, the problem you encounter has already been reported to IBM, and a fix is available. If this is not the case, ask your Service Representative to open a Problem Management Record (PMR) against the applicable IBM product. See the APAR member in data set `CBC.SCBCDOC` (available on the compiler product tape) for information on how to open a PMR.

I Attempt to Recompile My Application and It Fails — Why?

Changes were made between versions and releases of compilers. Several changes were made between C/370 Version 1 and C/370 Version 2. In some cases, these changes were made to ensure compliance with C Language standards such as ANSI/ISO. This book describes these changes, and the alterations you may need to make to your code.

Part 2. From C/370 to OS/390 Version 2 Release 6 Language Environment

This part discusses the implications of migrating applications that were created with one of the following compilers:

- The IBM C/370 Version 1 compiler, 5688-040
- The IBM C/370 Version 2 compiler, 5688-187
- The AD/Cycle C/370 Version 1 Release 2 compiler with the TARGET (COMPAT) compiler option, 5688-216

and with one of the following libraries:

- The IBM C/370 Version 1 library, 5688-039, and C-PL/1 Common Library, 5688-082
- The IBM C/370 Version 2 library, 5688-188, and C-PL/1 Common Library, 5688-082

to the OS/390 Version 2 Release 6 C/C++ product.

In this part, OS/390 Version 2 Release 6 Language Environment may also be referred to as OS/390 Language Environment, or Language Environment.

Chapter 3. Application Executable Program Compatibility

An application executable program is the output of the bind process. The output is a load module when stored in a PDS and a program object when stored in a PDSE or HFS. C/370 executable programs can usually be run with OS/390 Version 2 Release 6 Language Environment without modification. This chapter describes the exceptions and shows how to solve specific compatibility problems.

For purposes of this chapter, C/370 or old executable programs are executable programs that were built with one of the compilers and one of the libraries listed in “Part 2. From C/370 to OS/390 Version 2 Release 6 Language Environment” on page 11. New executable programs are those that were built with the OS/390 Version 2 Release 6 C/C++ or Language Environment products.

Executable program compatibility problems requiring source changes are discussed in “Chapter 4. Source Program Compatibility” on page 21.

Note: The terms in this section having to do with linking (bind, binding, link, link-edit) refer to the process of creating an executable program from object modules.

Input and Output Operations

Programs that ran with the C/370 Version 1 or Version 2 Release 1 library may have to be changed to run with OS/390 Language Environment if they have dependencies on any of the input and output behaviors listed in “Chapter 7. Input and Output Operations Compatibility” on page 41.

Differences Between the C/370 V1 and V2 Compilers

If you have programs that were created with C/370 Version 1, you should be aware of some changes made in C/370 Version 2 that may affect them. These differences also exist in the OS/390 Version 2 Release 6 C compiler. See “Chapter 5. C/370 Version 1 to Version 2 Compiler Changes” on page 27 for more information.

Executable Programs That Invoke Debug Tool

When migrating your application from C/370 to OS/390 Version 2 Release 6 Language Environment, you must relink modules that contain calls to `ctest()`. The old library object, `@@CTEST`, must be replaced as described in “Converting Old Executable Programs to New Executable Programs” on page 16 and in “Considerations for Interlanguage Call (ILC) Applications” on page 17. After you replace the old objects, the new modules are executable under OS/390 Language Environment.

System Programming C Facility (SP C) Executable Programs

There are two types of SP C programs: the ones that still require the run-time library, and the ones that do not. With OS/390 Language Environment, only the SP C executable programs that use the OS/390 C/C++ run-time library need to be relinked. You can relink applications from executable programs or from text decks using the OS/390 Language Environment text libraries. If you relink from text decks, you can use the JCL that originally built the application. However, you must modify it to point to the OS/390 Language Environment static or resident library (SCEELKED). If you relink from executable programs, you will need to do a CSECT replacement for the appropriate part, such as EDCXSTRL, EDCXENVL, and EDCXHOTL.

If your SP C module has been built with exception handling, automatic library call is not enabled when you relink, so you must explicitly include the new routine @@SMASK.

Executable Programs with Interlanguage Calls

You must relink C/370 executable programs that contain interlanguage calls (ILCs) to or from COBOL to execute them under OS/390 Language Environment. Old executable programs that contain ILCs to and from assembler or PL/I language modules do not need to be relinked.

To relink your C/370-COBOL ILC application under the C/370 V2R2 library so that it can run under either the C/370 Version 2 Release 2 library or Language Environment, obtain and apply PTF for APAR PN74931 for the Version 2 Release 1 or Release 2 link-edit stubs. This PTF replaces the link-edit stubs so that they tolerate Language Environment. After your application is relinked using the modified Version 2, you can run the application with either the Version 2 Release 1 or Release 2 run-time library, or with Language Environment.

To relink your C/370-COBOL ILC application so that it will only run under OS/390 Language Environment, replace the old library objects @@C2CBL and @@CBL2C, as described in “Converting Old Executable Programs to New Executable Programs” on page 16 and “Considerations for Interlanguage Call (ILC) Applications” on page 17. After you replace the old objects, the new modules will be executable only under OS/390 Language Environment.

Fortran-C ILC was not supported prior to Language Environment Release 5 and C/MVS Version 3.1, for Language Environment conforming applications. To use Fortran and C ILC routines, you must relink all Fortran-C ILC applications containing pre-Language Environment C or Fortran library routines.

The following table outlines when a relink of ILC applications is required, based on languages found in the executable program:

Table 3. Migrations requiring relinking

Language	Relink required
Assembler	No
PL/I	No
Fortran	YES
COBOL	YES *

Notes:

1. * If the C/370 ILC application is built (relinked) after the PTF for APAR PN74931 is applied, no relink is required to run under OS/390 Version 2 Release 6 C/C++. Otherwise a relink is required.
2. If you have multiple languages in the executable program, then the sum of the restrictions applies. For example: if you have C, PL/I and Fortran in the executable program, then it should be relinked because Fortran needs to be relinked.

Refer to *OS/390 Language Environment Writing Interlanguage Applications* for more information.

Initialization Compatibility

Both OS/390 Version 2 Release 6 Language Environment and C/370 modules use static code and dynamic code. Static code sections are emitted or bound with the main program object. Dynamic code sections are loaded and executed by the static component.

The sequence of events during initialization for C/370 modules differs from that for OS/390 Version 2 Release 6 Language Environment modules. The key static code for both C/370 and OS/390 Language Environment modules is an object named CEESTART, which controls initialization at execution. Its contents differ between the products, thus there is an old and a new version of CEESTART. The key dynamic code for OS/390 Language Environment is CEEBINIT, which is a OS/390 Language Environment service stored in SCEERUN. The key dynamic code for IBM C/370 Version 1 and Version 2 is IBMBLIIA, which is a Common Library part stored in SIBMLINK. The Common Library is used by the C/370 Version 1 and Version 2 libraries.

The following lists describe the initialization schemes:

IBM C/370 Version 1 and Version 2 Initialization

1. Old CEESTART loads IBMBLIIA.
2. IBMBLIIA initializes the Common Library.
3. The Common Library runs C/370-specific initialization.
4. The main program is called.

OS/390 Language Environment Initialization

1. The new CEESTART loads CEEBINIT.
2. CEEBINIT initializes OS/390 Language Environment.
3. OS/390 Language Environment C-specific initialization is run.
4. The main program is called.

OS/390 LE Initialization of C/370 Executable Programs

1. Old CEESTART loads CEEBLIIA (as IBMBLIIA).
2. CEEBLIIA (IBMBLIIA) initializes OS/390 Language Environment.
3. OS/390 Language Environment C-specific initialization is run.
4. The main program is called.

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In the third situation listed above, compatibility with old executable programs depends upon the program's ability to intercept the initialization sequence at the start of the dynamic code and to perform the OS/390 Language Environment initialization at that point. This interception is done by providing a OS/390 Language Environment part named CEEBLIIA, assigned the alias of IBMBLIIA. This provides "initialization compatibility".

Special Considerations: CEEBLIIA and IBMBLIIA

The only way to control which environment is initialized for a given old executable program (when CEEBLIIA is assigned the alias of IBMBLIIA) is to correctly arrange the concatenation of libraries.

To initialize the Common Library environment, ensure that SIBMLINK is concatenated before SCEERUN. To initialize the OS/390 Language Environment environment, ensure that SCEERUN is concatenated before SIBMLINK. The version of IBMBLIIA that is found first determines the environment (Language Environment or Common Library) that is initialized.

Converting Old Executable Programs to New Executable Programs

Many sites will have some old executable programs that will require the C/370 Common Library environment unless they have been converted to use OS/390 Language Environment. These are incompatible modules that, for example, contain ILCs to COBOL or that use the library function `cctest()` to invoke the Debug tool.

There are three different methods of converting old modules to new modules, so that they will run under OS/390 Language Environment:

- Link from original objects using OS/390 Language Environment. EDCSTART and CEEROOTB must be explicitly included.
- Relink the old executable program with OS/390 Language Environment using CSECT replacement. EDCSTART and CEEROOTB must be explicitly included.

Figure 1 on page 17 shows an example of a job that uses this method. The job converts an old executable program to a new executable program by relinking it and explicitly including the OS/390 Language Environment CEESTART to replace the old C/370 CEESTART.

This is a general-purpose job. The comments show the other include statements that are necessary if certain calls are present in the code. Refer to "Considerations for Interlanguage Call (ILC) Applications" on page 17 for the specific control statements that are necessary for different kinds of ILCs with COBOL.

```

//Jobcard information
//*
//*****
//*RELINK C/370 Version 1 or 2 USER MODULE FOR OS/390 Language Environment */
//*****
//*
//*
//LINK      EXEC PGM=HEWL,PARM='RMODE=ANY,AMODE=31,MAP,LIST'
//SYSPRINT DD SYSOUT=*
//SYSLIB    DD DSN=CEE.SCEELKED,DISP=SHR
//SYSLMOD   DD DSN=TSUSER1.A.LOAD,DISP=SHR
//SYSUT1    DD UNIT=VIO,SPACE=(CYL,(10,10))
//SYSLIN    DD *
            INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
            INCLUDE SYSLIB(CEER00TB)     ALWAYS NEEDED
            INCLUDE SYSLIB(@@CTEST)      NEEDED ONLY IF CTEST  CALLS ARE PRESENT
            INCLUDE SYSLIB(@@C2CBL)      NEEDED ONLY IF CALLS ARE MADE TO COBOL
            INCLUDE SYSLIB(@@CBL2C)      NEEDED ONLY IF CALLS ARE MADE FROM COBOL
            INCLUDE SYSLMOD(HELLO)
            ENTRY  CEESTART
            NAME   HELLO(R)
/*

```

Figure 1. Link Job for Converting Executable Programs

- For those modules that have a C main(), replace the old executable program by recompiling the source (if available). Recompile the source containing the main() function with the OS/390 Version 2 Release 6 C/C++ compiler, and then relink the objects with OS/390 Language Environment. By recompiling, you get a OS/390 Language Environment version of CEESTART. This is an alternative to explicitly including EDCSTART when linking from objects.

Considerations for Interlanguage Call (ILC) Applications

This section lists the linkage editor control statements required to relink modules that contain ILCs between C and COBOL, and C and Fortran. The object modules are compatible with the OS/390 Language Environment; however, the ILC linkage between the applications and the library has changed. You must relink these applications using the JCL shown in Figure 1 and the control statements that fit your requirements from the following list. The INCLUDE SYSLIB(@@CTDLI) is only necessary if your program will invoke IMS facilities using the OS/390 C library function ctdli() and if the OS/390 C function was called from a COBOL main program.

Control statements for various combinations of ILCs and compiler options are as follows. The modules referenced by SYSLMOD contain the routines to be relinked.

1. C main() statically calling COBOL routine B1 or dynamically calling the COBOL routine through the use of fetch(), where B1 was compiled with the RES option. Relink the C module:

```

MODE      AMODE(31),RMODE(ANY)
INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
INCLUDE SYSLIB(CEER00TB)     ALWAYS NEEDED
INCLUDE SYSLIB(@@C2CBL)      REQUIRED FOR C CALLING COB OL
INCLUDE SYSLIB(@@CTDLI)      REQUIRED FOR ILC & IMS
INCLUDE SYSLMOD(SAMP1)
ENTRY  CEESTART              MAIN ENTRY POINT
NAME   SAMP1(R)

```

2. C main() statically calling COBOL routine B2 or dynamically calling the COBOL routine through the use of fetch(), where B2 was compiled with the NORES option. Relink the C module:

```

MODE      AMODE(24),RMODE(24)
INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
INCLUDE SYSLIB(CEEROOTB)      ALWAYS NEEDED
INCLUDE SYSLIB(@@C2CBL)       REQUIRED FOR C CALLING COBOL
INCLUDE SYSLIB(@@CTDLI)       REQUIRED FOR ILC & IMS
INCLUDE SYSLIB(IGZENRI)       REQUIRED FOR COBOL with NORES
INCLUDE SYSLMOD(SAMP2)
ENTRY     CEESTART             MAIN ENTRY POINT
NAME      SAMP2(R)

```

3. C main() fetches a C1 function that statically calls a COBOL routine B1 compiled with the RES option. Relink the C module:

```

MODE      AMODE(31),RMODE(ANY)
INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
INCLUDE SYSLIB(CEEROOTB)      ALWAYS NEEDED
INCLUDE SYSLIB(@@C2CBL)       REQUIRED FOR C CALLING COBOL
INCLUDE SYSLIB(@@CTDLI)       REQUIRED FOR ILC & IMS
INCLUDE SYSLMOD(SAMP3)
ENTRY     C1                   ENTRY POINT TO FETCHED ROUTINE
NAME      SAMP3(R)

```

4. C main() fetches a C1 function that statically calls a COBOL routine B1 that is compiled with the NORES option. Relink the C module:

```

MODE      AMODE(24),RMODE(24)
INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
INCLUDE SYSLIB(CEEROOTB)      ALWAYS NEEDED
INCLUDE SYSLIB(@@C2CBL)       REQUIRED FOR C CALLING COBOL
INCLUDE SYSLIB(@@CTDLI)       REQUIRED FOR ILC & IMS
INCLUDE SYSLIB(IGZENRI)       REQUIRED FOR COBOL with NORES
INCLUDE SYSLMOD(SAMP4)
ENTRY     C1                   ENTRY POINT TO FETCHED ROUTINE
NAME      SAMP4(R)

```

5. A COBOL main CBLMAIN compiled with the RES option statically or dynamically calls a C1 function. Relink the COBOL module:

```

MODE      AMODE(31),RMODE(ANY)
INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
INCLUDE SYSLIB(CEEROOTB)      ALWAYS NEEDED
INCLUDE SYSLIB(IGZEBST)
INCLUDE SYSLIB(@@CBL2C)       REQUIRED FOR COBOL CALLING C
INCLUDE SYSLIB(@@CTDLI)       REQUIRED FOR ILC & IMS
INCLUDE SYSLMOD(SAMP5)
ENTRY     CBLRTN              COBOL ENTRY POINT
NAME      SAMP5(R)

```

6. A COBOL main CBLMAIN compiled with the NORES option statically or dynamically calls a C1 function. Relink the COBOL module:

```

MODE      AMODE(24),RMODE(24)
INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
INCLUDE SYSLIB(CEEROOTB)      ALWAYS NEEDED
INCLUDE SYSLIB(IGZENRI)
INCLUDE SYSLIB(@@CBL2C)       REQUIRED FOR COBOL CALLING C
INCLUDE SYSLIB(@@CTDLI)       REQUIRED FOR ILC & IMS
INCLUDE SYSLMOD(SAMP6)
ENTRY     CBLRTN              COBOL ENTRY POINT
NAME      SAMP6(R)

```

7. C main() calls a Fortran routine. Relink the C module:

```

INCLUDE SYSLIB(EDCSTART)      ALWAYS NEEDED
INCLUDE SYSLIB(CEEROOTB)      ALWAYS NEEDED
INCLUDE SYSLIB(@@CTOF)        REQUIRED FOR C CALLING Fortran

```

```

INCLUDE SYSLIB(@@CTDLI)    REQUIRED FOR ILC & IMS
INCLUDE SYSLMOD(SAMP7)
ENTRY   CEESTART           MAIN ENTRY POINT
NAME    SAMP7(R)

```

8. A Fortran main() calls a C function. Relink the C module:

```

INCLUDE SYSLIB(EDCSTART)   ALWAYS NEEDED
INCLUDE SYSLIB(CEEROOTB)   ALWAYS NEEDED
INCLUDE SYSLIB(@@FTOC)     REQUIRED FOR Fortran CALLING C
INCLUDE SYSLIB(@@CTDLI)    REQUIRED FOR ILC & IMS
INCLUDE SYSLMOD(SAMP8)
ENTRY   CEESTART           MAIN ENTRY POINT
NAME    SAMP8(R)

```

For other related Fortran considerations, refer to the *OS/390 Language Environment Programming Guide*.

Chapter 4. Source Program Compatibility

This chapter describes the changes that you may have to make to your source code when moving applications to the OS/390 Version 2 Release 6 C/C++ product.

It considers programs created with one of the following compilers:

- The IBM C/370 Version 1 compiler, 5688-040
- The IBM C/370 Version 2 compiler, 5688-187
- The AD/Cycle C/370 Version 1 Release 2 compiler with the TARGET (COMPAT) compiler option, 5688-216

and with one of the following libraries:

- The IBM C/370 Version 1 library, 5688-039, and C-PL/1 Common Library, 5688-082
- The IBM C/370 Version 2 library, 5688-188, and C-PL/1 Common Library, 5688-082

C/370 Version 1 modules were created with the C/370 Version 1 library. C/370 Version 2 modules were created with the C/370 Version 2 library.

“Chapter 6. Other Migration Considerations” on page 31 has information on run-time options, which may also affect source code compatibility.

Input and Output Operations

You may have to change programs running with the C/370 Version 1 or Version 2 Release 1 library if they have dependencies on any of the input and output behaviors listed in “Chapter 11. Input and Output Operations Compatibility” on page 63.

Differences Between the C/370 V1 and V2 Compilers

If you have programs that were created with the C/370 Version 1 compiler, you should be aware of some changes made in C/370 Version 2 that may affect your programs. These differences are also in the OS/390 Version 2 Release 6 C compiler. See “Chapter 5. C/370 Version 1 to Version 2 Compiler Changes” on page 27 for more information.

SIGFPE Exceptions

Decimal overflow conditions were masked in the C/370 library before Version 2 Release 2. The conditions were enabled when the packed decimal data type was introduced in the AD/Cycle C/370 Version 1 Release 2 compiler, and continue to be enabled with OS/390 Version 2 Release 6 Language Environment. If you have old load modules (created with the C/370 Version 1 or Version 2 Release 1 library) that accidentally generated decimal overflow conditions, they may behave

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differently with OS/390 Language Environment, by raising unexpected SIGFPE exceptions. You cannot migrate such modules to the new library without altering the source, and they are unsupported.

It is unlikely that such modules are present in a C-only environment. These unexpected exceptions may occur in mixed language modules, particularly those using C and assembler code where the assembler code explicitly manipulates the program mask.

Program Mask Manipulations

Programs created with the C/370 Version 1 or Version 2 Release 1 compiler and library that explicitly manipulated the program mask may require source alteration to execute correctly under OS/390 Language Environment. Changes are required if you have one of the following types of programs:

- A C program containing assembler interlanguage calls (ILCs), where the invoked code uses the S/370 decimal instructions that might generate an unmasked decimal overflow condition, requires modification for migration. There are two methods for migrating the code. The first one is preferred:
 - Modify the assembler code to save the existing mask, set the new value, and when finished, restore the saved mask.
 - Change the C code so that the produced SIGFPE signal is ignored in the called code. In the following example, the SIGNAL calls surround the overflow-producing code. The SIGFPE exception signal is ignored, and then reenabled:

```
signal(SIGFPE, SIG_IGN); /* ignore exceptions */
...
callit():                /* in called routine */
...
signal(SIGFPE, SIG_DFL); /* restore default handling */
```

- A C program containing assembler ILCs that explicitly alter the program mask, and do not explicitly save and restore it, also requires modification for migration.

If user code explicitly alters the state of the program mask, the value before modification must be saved, and the value restored to its former value after the modification. You must ensure that the decimal overflow program mask bit is enabled during the execution of C code. Failure to preserve the mask may result in unpredictable behavior.

These changes also apply in a System Programming C environment, and to Customer Information Control System (CICS) programs in the handling and management of the PSW mask.

The release() Function

With the OS/390 C compiler and OS/390 Language Environment, you can no longer issue a `release()` call against a fetched COBOL, Fortran, or PL/I module. If you do, `release()` returns a nonzero return code. You can still use `release()` with C modules and non-OS/390 Language Environment enabled assembler modules.

If your application fetches and releases PL/I, Fortran, or COBOL modules, you must change your source code, then recompile and link it with OS/390 Language Environment, if you are dependent on the `release()` return code.

Although `release()` could be issued against any assembler routines with IBM C/370 Version 1 and Version 2, it cannot be issued against OS/390 Language Environment-enabled assembler routines. These routines, known as ASM15 routines, are assembled with OS/390 Language Environment assembler prologs. ASM15 routines are coded with the CEEENTRY macro. If any assembler routines are rewritten as ASM15 routines, ensure that the calling code does not issue a `release()` call against them.

The realloc() Function

When the `realloc()` function is used with OS/390 Language Environment, a new area is always obtained and the data is copied. This is different from IBM C/370 Version 1 and Version 2, where, if the new size was equal to or less than the original size, the same area was used.

Programmers may want to ensure that their source code has no dependencies on the behavior of the old version of the `realloc()` function, so that their code is compatible with OS/390 Language Environment.

Fetch Main Programs

C/370 Version 1 and Version 2 programs that are fetched must now be recompiled without a main entry point. Under OS/390 Language Environment, if you attempt to fetch a main program it will fail.

User Exits

If both CEEBXITA and IBMBXITA are present in a relinked IBM C/370 Version 1 or Version 2 module, CEEBXITA will have precedence over IBMBXITA.

#line Directive

The AD/Cycle C/370 Version 1 Release 2 compiler ignored the `#line` directive when either the `EVENTS` or the `TEST` compiler option was in effect. The OS/390 C compiler, however, provides the correct information for the Debug Tool, and the compiler does not ignore the `#line` directive.

sizeof Operator

The behavior of `sizeof` when applied to a function return type was changed in the C/C++ MVS Version 3 Release 2 compiler. For example:

```
char foo();
..
s = sizeof foo();
```

If the example is compiled with a compiler prior to C/C++ MVS Version 3 Release 2, `char` is widened to `int` in the return type, so `sizeof` returns `s = 4`.

If the example is compiled with C/C++ MVS Version 3 Release 2, or with any OS/390 C/C++ compiler, the size of the original `char` type is retained. In the above example, `sizeof` returns `s = 1`. The size of the original type of other data types such as `short`, and `float` is also retained.

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With the OS/390 Version 2 Release 4 C/C++ and subsequent compilers, you can use `#pragma wsizeof` or the `WSIZEOF` compiler option to get `sizeof` to return the widened size for function return types if your code has a dependency on this behavior. For more information on `#pragma wsizeof`, see *OS/390 C/C++ Language Reference*. For more information on the `WSIZEOF` compiler option, see *OS/390 C/C++ User's Guide*.

System Programming C Applications Built with EDCXSTRX

If you have SP C applications that are built with EDCXSTRX and that use dynamic C library functions, note that the name of the C library function module has changed from EDCXV in C/370 Version 2 to CEEEV003 in OS/390 Language Environment. Change the name from EDCXV to CEEEV003 in the assembler source of your program that loads the library, and reassemble.

The `__librel()` Function

The `__librel()` function is a System/370 extension to SAA C. It returns the release level of the library that your program is using, in a 32-bit integer. Under OS/390 Language Environment, it has a field containing a number that represents the library product. IBM C/370 Version 1 and Version 2 libraries are product 0, Language Environment is Product 1, and OS/390 Language Environment is product 2.

In IBM C/370 Version 1 and Version 2, the high-order 8 bits were used to return the version number. Now these 8 bits are divided into 2 fields. The first 4 bits contain the product number and the second 4 bits contain the version number.

You must modify programs that use the information returned from `__librel()`. For more information on `__librel()`, see the *OS/390 C/C++ Run-Time Library Reference*.

Library Messages

There are differences in messages between C/370 and OS/390 Language Environment. Some run-time messages have been added and some have been deleted; the contents of others have been changed. Any application that is affected by the format or contents of these messages must be updated accordingly. **Do not build dependencies on message contents or message numbers.**

Refer to the *OS/390 Language Environment Debugging Guide and Run-Time Messages* for details on run-time messages and return codes.

Prefix of `perror()` and `strerror()` Messages

All `perror()` and `strerror()` messages under OS/390 Language Environment contain a prefix (in IBM C/370 Version 1 and Version 2 there were no prefixes to these messages). The prefix is `EDCxxxxa`, where `xxxx` is a number and the `a` is either `I`, `E`, or `S`. See *OS/390 Language Environment Debugging Guide and Run-Time Messages* for a list of these messages.

Compiler Messages and Return Codes

There are differences in messages and return codes between the C/370 compilers and the OS/390 C compiler. Message contents have changed, and return codes for some messages have changed (errors have become warnings, and the other way around). Any application that is affected by message content or return codes must be updated accordingly. **Do not build dependencies on message content, message numbers, or return codes.** See *OS/390 C/C++ User's Guide* for a list of messages.

_Packed Structures and Unions

With the OS/390 C compiler, you can no longer do the following:

- Assign `_Packed` and `non-_Packed` structures to each other
- Assign `_Packed` and `non-_Packed` unions to each other
- Pass a `_Packed` union or `_Packed` structure as a function parameter if a `non-_Packed` version is expected (or the other way around)

If you attempt to do so, the compiler issues an error message.

Alternate Code Points

The following alternate code points are not supported by the OS/390 C compiler:

- `X'8B'` as alternate code point for `X'C0'` (the left brace)
- `X'9B'` as alternate code point for `X'D0'` (the right brace)

These alternate code points were supported by the C/370 and AD/Cycle C/370 compilers (the `NOLocale` option was required if you were using the AD/Cycle C/370 Version 1 Release 2 compiler).

Chapter 5. C/370 Version 1 to Version 2 Compiler Changes

This chapter describes some of the changes made between the C/370 Version 1 and Version 2 compilers. These changes also appear in the OS/390 C compiler. Read this section if you are migrating programs from C/370 Version 1.

Source Code Incompatibilities

This section describes the changes you may have to make to your source code when moving from C/370 Version 1.

Characters

You can no longer assign a char the value `' '`. A character must be between the single quotation marks. Under C/370 Version 1, `' '` was the same as `'\0'`.

A warning is now issued when the `CHECKOUT` compile-time option is specified, and more than 4 bytes are assigned to a char or more than 2 bytes are assigned to a `wchar_t` constant. These restrictions did not apply under C/370 Version 1.

Sign extension now occurs when the `#pragma chars(signed)` directive is used. Thus the value of `'\xff'` is -1 when chars are signed. When a signed char literal is converted to int, the sign extension will occur on the most significant specified byte that is not shifted out. These are changes from C/370 Version 1. See Table 4 for examples.

Table 4. Sign Extensions

Value of signed char literal	Value of int
<code>'\x80\x00'</code>	<code>(int)0xffff8000</code>
<code>'\x80\x00\x00'</code>	<code>(int)0xff800000</code>
<code>'\x80\x00\x00\x00'</code>	<code>(int)0x80000000</code>
<code>'\x80\x00\x00\x00\x80'</code>	<code>0x00000080</code>

Note: A hexadecimal escape sequence represents one char of data, so `'\x123456789'` is equivalent to `'\x89'`.

The #pragma comment Directive

If you are using the `#pragma comment` directive, you must now enclose the characters specified in double quotation marks. In C/370 Version 1, the double quotation marks were not required.

Structure Declarations

With the OS/390 C compiler, you must declare a struct type before any function calls that contain the struct as one of its parameters. Otherwise, the struct in the function call will be incomplete and the parameter passed must be a pointer to void.

For example, the following program will not compile as desired because struct `st` in `func_call` is an incomplete struct. The call of `func_call` with a pointer to a struct will be an incompatible parameter type with the expected pointer to void.

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```
int func_call (struct st *s); /* incomplete struct */

struct st { int x, y, z; };

int main(void)
{
    struct st *t;
    func_call(t);           /* pointer to struct st but func_call */
                             /* can only accept pointer to void */
    printf("%\n", t->y);
}
```

To solve this problem, add a declaration before the function declaration:

```
struct st;

int func_call (struct st *s);

struct st { int x, y, z; };
```

Note: If you have the following declaration,

```
extern struct S my_struct;
```

the type must be completed before the `->` or `.` operators can be performed on `my_struct`. In C/370 Version 1, the struct S had to be a complete type at the time this declaration was reached.

Function Argument Compatibility

If you compile the following example under C/370 Version 1, the compiler fails to notice that the argument `func1` is incompatible with the prototype for `func2`. The `func2()` function requires a pointer to a void function with an argument of type `void *`, but an argument of type pointer to void function with an argument of type `int *` is passed instead. The OS/390 C compiler will generate an error message in this situation.

```
void func2( void (*)(void *) );

void func1(int *);

main() {
    func2( func1 );
}
```

Pointer Considerations

According to the *ANSI C Standard*, pointers to void types and pointers to functions are incompatible types. The C/370 Version 2, AD/Cycle C/370, C/MVS Version 3, and OS/390 C compilers perform some type checking, such as in assignments, argument passing on function calls, and function return codes.

If you are not conforming to ANSI rules for the use of pointer types, your run-time results may not be as expected, especially when you are using the compile-time option `OPTIMIZE`.

With the C/370 Version 2, the AD/Cycle C/370, and the C/MVS Version 3.1, you could not assign `NULL` to an integer value. For example, the following was not allowed:

```
int i = NULL;
```

With the C/MVS V3R2 and OS/390 C compilers, you can assign NULL pointers to void types if you specify `LANGVLV(LCOMMONC)` when you compile your program.

Macro Changes

In `stdio.h`, the `#define` macro `__VSAM_OPEN_AIX_PATH` (a value for the `__amrc` struct `__last_op` field), was replaced in C/370 Version 2 by `__VSAM_OPEN_ESDS_PATH` and `__VSAM_OPEN_KSDS_PATH`.

Modules compiled with C/370 Version 1 work with OS/390 Language Environment. However, if you plan to compile your source with the OS/390 C compiler, you must first change it to use `__VSAM_OPEN_ESDS_PATH` and `__VSAM_OPEN_KSDS_PATH`.

Chapter 6. Other Migration Considerations

This chapter provides additional considerations on migrating applications that were created with one of the following compilers:

- The IBM C/370 Version 1 compiler, 5688-040
- The IBM C/370 Version 2 compiler, 5688-187
- The AD/Cycle C/370 Version 1 Release 2 compiler with the TARGET (COMPAT) compiler option, 5688-216

and with one of the following libraries:

- The IBM C/370 Version 1 library, 5688-039, and C-PL/1 Common Library, 5688-082
- The IBM C/370 Version 2 library, 5688-188, and C-PL/1 Common Library, 5688-082

to OS/390 Version 2 Release 6 C/C++.

Changes That Affect User JCL, CLISTS, and EXECs

This section describes changes that may affect your JCL, CLISTS and EXECs.

Return Codes and Messages

Library return codes and messages have been changed, and JCL, CLISTS and EXECs that are affected by them must be changed accordingly (or else the CEEBXITA exit must be customized to emulate the old return codes). IBM C/370 Version 1 and Version 2 return codes were from 0 to 999. However, the OS/390 Language Environment return codes have a different range. These return codes are documented in *OS/390 Language Environment Debugging Guide and Run-Time Messages*.

Return codes greater than 4095 are returned as modulo 4095 return codes. The return code for an abort is now 2000; it was 1000. The return code for an unhandled SIGFPE, SIGILL, or SIGSEGV condition is now 3000; it was 2000.

Compiler message contents and return codes have changed. You must change JCL, CLISTS, and EXECs that are affected by them. Refer to "Compiler Messages and Return Codes" on page 25 for more information.

Changes in Data Set Names

The names of IBM-supplied data sets may change from one release to another. See the OS/390 Program Directory for more information on data set names.

Differences in Standard Streams

Under OS/390 Language Environment there is no longer an automatic association of ddnames SYSTERM, SYSERR, SYSPRINT with stderr. Command line redirection of the type 1>&2 is necessary in batch to cause stderr and stdout to share a device.

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In IBM C/370 Version 1 and Version 2, you could override the destination of error messages by redirecting `stderr`. OS/390 Language Environment determines the destination of all messages from the MSGFILE run-time option. See the section on the MSGFILE run-time option in the *OS/390 Language Environment Programming Guide* for more information.

Passing Command-Line Parameters to a Program

In IBM C/370 Version 1 or Version 2, if an error was detected with the parameters being passed to the main program, the program terminated with a return code of 8 and a message indicating the reason why the program was not run. For example, if there was an error in the redirection parameters, the message would indicate that the program had terminated because of a redirection error.

Under OS/390 Language Environment, the same message will be displayed, but the program will also terminate with a 4093 abend, reason code 52 (hexadecimal 34). For more information about the abend codes and messages see *OS/390 Language Environment Debugging Guide and Run-Time Messages*.

SYSMSGGS ddname

The method of specifying the language for compiler messages has changed. Instead of specifying a messages data set for the SYSMSGGS ddname, you must now use the NATLANG run-time option. If you specify a data set for the SYSMSGGS ddname, it will be ignored.

Run-Time Options

This section describes changes that may affect your run-time options.

Ending the Run-Time Options List

In C/370 Version 1 and Version 2, when passing only run-time options to a C/370 program, you did not have to end the arguments with a slash (/). With OS/390 Language Environment, you must end the arguments with a slash.

With OS/390 Language Environment, if you have no run-time options and the input arguments passed to `main()` contains a slash, you must prefix the arguments with a slash. JCL, CLISTs, and EXECs that are affected by the slash must be changed accordingly.

ISASIZE, ISAINC, STAE/SPIE, LANGUAGE, and REPORT options

Use the OS/390 Language Environment equivalent for the IBM C/370 Version 1 and Version 2 run-time options on the command line and in `#pragma runopts`.

ISASIZE/ISAINC	becomes	STACK
LANGUAGE	becomes	NATLANG
REPORT	becomes	RPTSTG
SPIE/STAE	becomes	TRAP

The C/370 run-time options are mapped to OS/390 Language Environment equivalents. However, if you do not use the OS/390 Language Environment

options, during execution you will get a warning message which cannot be suppressed. JCL, CLISTs and EXECs that are affected by these differences must be changed accordingly.

STACK Default Size

The default size and increment for the STACK run-time option have changed. If you have not indicated the size and increment, STACK will be allocated differently when your program is running under OS/390 Language Environment. The defaults in IBM C/370 Version 1 and Version 2 were 0K size and 0K increment. The defaults under OS/390 Language Environment without CICS are 128K size and 128K increment and with CICS are 4K size and 4K increment. The default location has not changed, and remains BELOW.

To summarize, in OS/390 Language Environment, the IBM-supplied defaults are STACK(128K,128K,BELOW,KEEP) without CICS and STACK(4K,4K,BELOW,KEEP) with CICS.

STACK parameters

The parameters for the STACK run-time option are all positional in OS/390 Language Environment; in IBM C/370 Version 1 and Version 2, only the first two were. The keyword parameter could be specified if the first two were omitted. Now, to specify only ANYWHERE you must enter: STACK(, ,ANYWHERE).

HEAP Default Size

The default size and increment for the HEAP run-time option have changed. If you have not indicated the size and increment, HEAP will be allocated differently when running under OS/390 Language Environment. The defaults in IBM C/370 Version 1 and Version 2 were 4K size and 4K increment. The defaults under OS/390 Language Environment without CICS are 32K size and 32K increment and with CICS are 4K size and 4K increment.

Two new parameters have been added, `initsz24` and `incrsz24`. They determine how much of the heap is allocated and incremented below the 16M line.

For information about these parameters, see the *OS/390 Language Environment Programming Reference*.

To summarize, under OS/390 Language Environment, the IBM-supplied defaults are HEAP(32K,32K,ANYWHERE,KEEP,8K,4K) without CICS and HEAP(4K,4K,ANYWHERE,KEEP,4K,4K) with CICS.

Note: If you have installed the C component of OS/390 Language Environment below the line (that is, if your applications run in RMODE 24 AMODE 24) you must either:

- Change the HEAP setting to HEAP(, ,BELOW, , ,) or
- Specify HEAP(, ,BELOW, , ,) at run time (either through `#pragma runopts` or on the command line).

HEAP Parameters

In IBM C/370 Version 1 and Version 2, the first two of the four parameters for the HEAP option were positional. The keyword parameters could be specified if the first two were omitted. Under OS/390 Language Environment, all parameters are positional. To specify only KEEP, you must enter HEAP(,,,KEEP).

Compile-Time Options

This section describes changes that may affect your compile-time options.

DECK Compile-Time Option

In IBM C/370 Version 1, the DECK compiler option directed the object module to the data set associated with SYSLIN. With the OS/390 C compiler, as with the AD/Cycle C/370 and IBM C/370 Version 2 compilers, the object module is directed to the data set associated with SYSPUNCH.

INLINE Compile-Time Option

The defaults for the INLINE compiler option have changed. In the past, the default for the threshold suboption was 250 ACUs (Abstract Code Units). With the C/MVS Version 3 and OS/390 C compilers, the default is 100 ACUs.

OPTIMIZE Compile-Time Option

In the C/370 Version 2 Release 1 and subsequent compilers, OPTIMIZE mapped to OPT(1).

Starting with OS/390 Version 2 Release 6, the C compiler maps both OPTIMIZE and OPT(1) to OPT(2).

SEARCH and LSEARCH Compile-Time Option

The include file search process has changed. Prior to the C/MVS V3R2 compiler, if you used the LSEARCH option more than once, the compiler would only search the libraries specified for the last LSEARCH option. Now the OS/390 C compiler searches all of the libraries specified for all of the LSEARCH options, from the point of the last NOLSEARCH option.

Similarly, if you specify the SEARCH option more than once, the OS/390 C compiler searches all of the libraries specified for all of the SEARCH options, from the point of the last NOSEARCH option. Previously, only the libraries specified for the last SEARCH option were searched.

TEST Compile-Time Option

Starting with the OS/390 C/C++ compilers, the default for the PATH suboption of the TEST option has changed from NOPATH to PATH. Also, the INLINE option is ignored when the TEST option is in effect at OPT(0), but the INLINE option is no longer ignored if OPT(1) or OPT(2) is in effect.

Starting with C/C++ MVS Version 3 Release 2, a restriction applies to the TEST compiler option if you are using the OS/390 C/C++ compiler. Now, the maximum number of lines in a single source file cannot exceed 131,072. If you exceed this limit, the results from the Debug Tool and LE/370 Dump Services are undefined.

Language Environment Run-Time Options

If you have `#pragma runopts` in your source code, the OS/390 Language Environment STORAGE option will be set to (NONE,NONE,NONE,8K) at run time. If you run your C/370 module with the `RPTOPTS(ON)` run-time option to get a report, your report will show that the STORAGE option has been set by the programmer and that the program did not use the installation default. If you do not use `#pragma runopts` in your source, the program will use the installation default.

If occurrences of `ISASIZE/ISAINC`, `STAE/SPIE`, `LANGUAGE`, and `REPORT` runopts are specified by `#pragma runopts` in your source code, you may want to change them to the OS/390 Language Environment equivalent before recompiling. These options are mapped to the OS/390 Language Environment equivalent, but if you do not change them, you will get a warning or informational message during compilation.

Precedence of Language Environment over C/370 for `#pragma runopts`

If you have `#pragma runopts` in both a C/370 and a OS/390 Language Environment object module, and you link the two together, the `#pragma runopts` settings in the Language Environment object module will take precedence.

System Programming C Facility Applications with `#pragma runopts`

If you code a program for use in the SP C environment and you use `#pragma runopts` to specify the heap or stack directives, the OS/390 Version 2 Release 6 C compiler will expand these directives according to the OS/390 Language Environment defaults and rules. Thus, the program may behave differently under OS/390 Language Environment.

Decimal Exceptions

OS/390 Language Environment provides support for the packed decimal overflow exception using native System/370 hardware enablement (as did the C/370 Version 2 Release 2 library).

The value of the program mask in the program status word (PSW) is 4 (decimal overflow enabled).

Migration and Coexistence Considerations

The following points identify migration and coexistence considerations for user applications:

- CICS programs running under OS/390 Language Environment are enabled for decimal exceptions.
- The C packed decimal support routines are not supported in an environment that exploits asynchronous events.

SIGTERM, SIGINT, SIGUSR1, and SIGUSR2 Exceptions

There are changes to application/program behavior for SIGTERM, SIGINT, SIGUSR1, and SIGUSR2 exceptions from C/370 Version 1 and Version 2.

The differences or incompatibilities are:

- The defaults for the SIGINT, SIGTERM, SIGUSR1, and SIGUSR2 signals changed in LE/370 Release 3, from what they were in C/370 Version 1 and 2 and LE/370 Release 1 and 2. These changes were carried into OS/390 Version 2 Release 6 Language Environment. In the C/370 library and LE/370 Release 1 and Release 2, the defaults for SIGINT, SIGUSR1, and SIGUSR2 were to ignore the signals. As of LE/370 Release 3, the defaults are to terminate the program and return a return code of 3000. For SIGTERM, the default has always been to terminate the program, but the return code is now 3000 whereas before it was 0.
- Applications that terminate abnormally will **not** drive the atexit list.

Running Different Versions of the Libraries under CICS

You cannot run two different versions of the C/370 run-time libraries within one CICS region.

Sometimes a C/370 Version 2 CICS interface (EDCCICS) and the OS/390 Language Environment CICS interface can be present in a CICS system through CEDA/PPT definitions and inclusion of modules in the APF STEPLIB. Even if both versions are present, the OS/390 Language Environment version will be initialized by CICS when the region is initialized.

CICS Abend Codes and Messages

Abend codes such as ACC2 that were used by IBM C/370 Version 1 and Version 2 under CICS are not issued under OS/390 Language Environment. An equivalent OS/390 Language Environment abend code is issued instead; for example, 4nnn.

CICS Reason Codes

Reason codes that appeared in the CICS message console log have been changed. The new ones are documented in the *OS/390 Language Environment Debugging Guide and Run-Time Messages*.

Standard Stream Support under CICS

Under CICS, with OS/390 Language Environment, records sent to the transient data queues associated with stdout and stderr with default settings take the form of a message as follows:

ASA	terminal id	transaction id	sp	Time Stamp YYYYMMDDHHMMSS	sp	data
1	4	4	1	14	1	108

where:

ASA is the carriage-control character
terminal id is a 4-character terminal identifier

transaction id is a 4-character transaction identifier
sp is a space
Time Stamp is the date and time displayed in the format
 YYYYMMDDHHMMSS
data is the data sent to the standard streams stdout and stderr.

C/370 Version 1 and Version 2 used a different format.

stderr Output under CICS

Output from stderr is sent to the CICS transient data queue, CESE. CESE is also used by OS/390 Language Environment for run-time error messages, dumps, and storage reports. If you previously used this file exclusively for C/370 stderr output, you should note that the output may be different.

Transient Data Queue Names under CICS

Transient data queue names are mapped as follows under OS/390 Language Environment:

OLD NAME	NEW NAME
CCSI	CESI
CCSO	CESO
CCSE	CESE

HEAP Option Used with the Interface to CICS

In C/370 Version 1 Release 2 and Version 2, the location of heap storage under CICS was primarily determined by the residence mode (RMODE) of the program. The logic for determining the location of heap was as follows:

With OS/390 Language Environment, the location of heap storage is determined

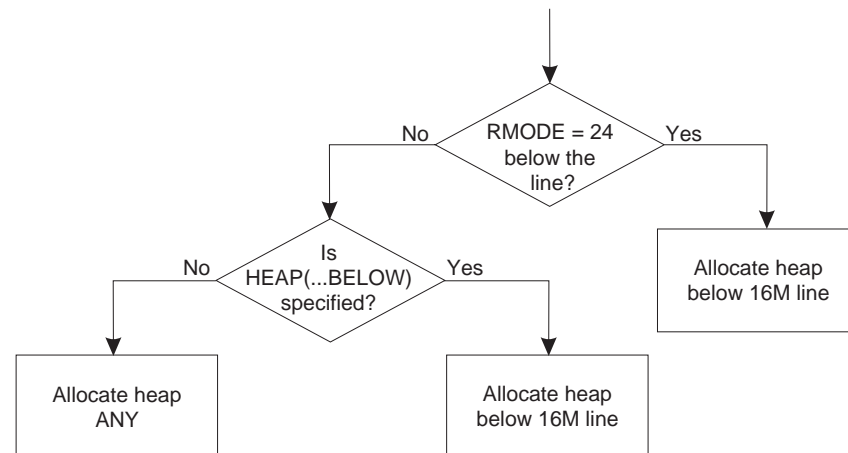


Figure 2. Heap Location Logic

only by the HEAP(...ANYWHERE|BELOW) options. RMODE does not affect where the heap is allocated. Where the location of heap storage is important, you may want to change source accordingly.

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If you have installed the C component of OS/390 Language Environment below the line (that is, if your applications run in RMODE 24 AMODE 24), see the note on page 33.

COBOL Library Routines

All of the language libraries in OS/390 Language Environment are packaged as a single unit in SCEERUN. Because of this packaging, for C-only applications, OS/390 Version 2 Release 6 Language Environment has the potential to invade the user's name space.

For example, OS/390 Language Environment-enabled COBOL is available under OS/390 Version 2 Release 6 Language Environment, and the following situations are possible:

- If there is a user C function name prefixed with IGZ or ILB that happens to correspond to a COBOL routine, there is the chance of binding in the COBOL routine at link-edit time.
- If there is a `fetch()` statement for a routine with a name prefixed with IGZ or ILB that happens to correspond to a COBOL routine that is dynamically loaded, it is possible that the COBOL routine will be loaded at run time.

To prevent the first problem, specify the user link libraries ahead of the OS/390 Language Environment link libraries.

To prevent the second problem, specify the user execution libraries ahead of the OS/390 Language Environment execution libraries.

Passing Control to the Cross System Product

As in IBM C/370 Version 1 and Version 2, control can be passed between Cross System Product (CSP) and OS/390 Language Environment in three ways: XFER, DXFR, and CALL.

If you have code that passes control from OS/390 Version 2 Release 6 Language Environment to CSP, which in turn passes control back to OS/390 Version 2 Release 6 Language Environment, the behavior is undefined. Code that passes control from CSP to OS/390 Version 2 Release 6 Language Environment, which in turn passes control back to CSP, is supported. In summary, OS/390 Version 2 Release 6 Language Environment must appear only once in the chain of passed control.

Syntax for the CC Command

With C/C++ MVS Version 3 Release 2 and subsequent products, the CC command can be invoked using a new syntax. At customization time, your system programmer can customize the CC EXEC to accept only the old syntax (the one supported by compilers prior to C/MVS Version 3 Release 2), only the new syntax, or both syntaxes.

You should customize the CC EXEC to accept only the new syntax, because the old syntax may not be supported in the future. If you customize the CC EXEC to accept only the old syntax, keep in mind that it does not support Hierarchical File System (HFS) files. If you customize the CC EXEC to accept both the old and new

syntaxes, you must invoke it using either the old *or* the new syntax, not a mixture of both. If you invoke this EXEC with the old syntax, it will not support HFS files.

Refer to the OS/390 Program Directory for more information about installation and customization, and to the *OS/390 C/C++ User's Guide* for more information about compiler options.

atexit List during abort()

Unlike under IBM C/370 Version 1 and Version 2, the `atexit` list is not driven after a call to `abort()` under OS/390 Language Environment.

Time Functions

For OS/390 Language Environment, in the absence of customized locale information, the `ctime()`, `localtime()`, and `mktime()` functions return Coordinated Universal Time (UTC).

If you were running with the C/370 Version 2 Release 2 library, and applied both PTF UN61216 and PTF UN77602, or did not apply either one, the functions will return local time in the absence of customized locale information. Therefore, you will see a change in behavior when you migrate to OS/390 Version 2 Release 6 Language Environment .

You should customize your locale information. Otherwise, in rare cases, you may encounter errors. In a POSIX application, you can supply time zone and alternative time (e.g., daylight) information with the `TZ` environment variable. In a non-POSIX application, you can supply this information with the `_TZ` environment variable. If no `TZ` environment variable is defined for a POSIX application or no `_TZ` environment variable is defined for a non-POSIX application, any customized information provided by the `LC_TOD` locale category is used. By setting the `TZ` environment variable for a POSIX application, or the `_TZ` environment variable for a non-POSIX application, or by providing customized time zone or daylight information in an `LC_TOD` locale category, you allow the time functions to preserve both time and date, correctly adjusting for alternative time on a given date.

Refer to the *OS/390 C/C++ Programming Guide* for more information about both environment variables and customizing a locale.

Direction of Compiler Messages to stderr

All messages generated by the OS/390 C/C++ compiler are sent to `stderr`. In the past, some messages were sent to `stdout`.

Compiler Listings

As of OS/390 C/C++ Version 2 Release 6, `OPT(1)` maps to `OPT(2)`. The compiler listing no longer contains the part of the pseudo-assembler listing that was associated with `OPT(1)`. Listing formats, especially the pseudo-assembler parts, will continue to change from release to release. **Do not build dependencies on the structure or content of listings.** For information about listings for the current release, refer to the *OS/390 C/C++ User's Guide*.

Chapter 7. Input and Output Operations Compatibility

Changes were made to input and output support in the C/370 Version 2 Release 2 and LE/370 Release 3 libraries. These changes also apply to OS/390 Version 2 Release 6 Language Environment. If your programs performed input and output operations with the following products, you should read the changes listed in this section. These products are:

- The C/370 Version 1 library
- The C/370 Version 2 Release 1 library

References in this chapter to previous releases or previous behavior apply to the products listed above.

You will generally be able to migrate “well-behaved” programs: programs that do not rely on undocumented behavior, restrictions, or invalid behaviors of previous releases. For example, if library documentation only specified that a return code was a negative value, and your code relies on that value being -3, your code is not well-behaved and is relying on undocumented behavior.

Another example of a program that is not well-behaved is one that specifies `recfm=F` for a terminal file and depends on Language Environment to ignore this parameter, as it did previously.

However, you may still need to change even well-behaved code under circumstances described in the following section.

Opening Files

- When you call the `fopen()` or `freopen()` library function, you can specify each parameter only once. If you specify any keyword parameter in the *mode* string more than once, the function call fails. Previously, you could specify more than one instance of a parameter.
- The library no longer supports uppercase open modes on calls to `fopen()` or `freopen()`. You must specify, for example, `rb` instead of `RB`, to conform to the ANSI/ISO standard.
- You cannot open a non-HFS file more than once for a write operation. Previous releases allowed you, in some cases, to open a file for write more than once. For example, you could open a file by its data set name and then again by its ddname. This is no longer possible for non-HFS files, and is not supported.
- Previously, `fopen()` allowed spaces and commas as delimiters for mode string parameters. Only commas are allowed now.
- If you are using PDSEs or PDSEs, you cannot specify any spaces before the member name.

Writing to Files

- Write operations to files opened in binary mode are no longer deferred. Previously, the library did not write a block that held *nn* bytes out to the system until the user wrote *nn*+1 bytes to the block. The OS/390 Language Environment library follows the rules for full buffering, described in the *OS/390 C/C++ Programming Guide*, and writes data as soon as the block is full. The *nn* bytes are still written to the file, the only difference is in the timing of when it is done.

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- For non-terminal files, the backspace character ('\b') is now placed into files as is. Previously, it backed up the file position to the beginning of the line.
- For all text I/O, truncation for `fwrite()` is now handled the same way that it is handled for `puts()` and `fputs()`. If you write more data than a record can hold, and your output data contains any of the terminating control characters, '\n' or '\r' (or '\f', if you are using ASA), the library still truncates extra data; however, recognizing that the text line is complete, the library writes subsequent data to the next record boundary. Previously, `fwrite()` stopped immediately after the library began truncating data, so that you had to add a control character before writing any more data.
- You can now partially update a record in a file opened with `type=record`. Previous libraries returned an error if you tried to make a partial update to a record. Now, a record is updated up to the number of characters you specify, and the remaining characters are untouched. The next update is to the next record.
- OS/390 Language Environment blocks files more efficiently than some previous libraries did. Applications that depend on the creation of short blocks may fail.
- The behavior of ASA files when you close them has changed. In previous releases, this is what happened:

Written to file	Read from file after <code>fclose()</code> , <code>fopen()</code>
abc\n\n\n	abc\n\n\n\n
abc\n\n	abc\n\n\n
abc\n	abc\n

In this release, you read from the file what you wrote to it. For example:

Written to file	Read from file after <code>fclose()</code> , <code>fopen()</code>
abc\n\n\n	abc\n\n\n
abc\n\n	abc\n\n
abc\n	abc\n

In previous products, writing a single new-line character to a new file created an empty file under MVS. OS/390 Language Environment treats a single new-line character written to a new file as a special case, because it is the last new-line character of the file. The library writes a single blank to the file. When you read this file, you see two new-line characters instead of one. You also see two new-line characters on a read if you have written two new-line characters to the file.

The behavior of appending to ASA files has also changed. The following table shows what you get from an ASA file when you:

1. Open an ASA file for write.
2. Write abc.
3. Close the file.
4. Append xyz to the ASA file.
5. Open the same ASA file for read.

abc Written to File, fclose() then append xyz	What You Read from File after fclose(), fopen()	
	Previous release	New release
abc ⇒ xyz	\nabc\nxyz\n	same as previous release
abc ⇒ \nxyz	\nabc\nxyz\n	\nabc\n\nxyz\n
abc ⇒ \rxyz	\nabc\rxyz\n	\nabc\n\rxyz\n
abc\n ⇒ xyz	\nabc\nxyz\n	same as previous release
abc\n ⇒ \nxyz	\nabc\nxyz\n	\nabc\n\nxyz\n
abc\n ⇒ \rxyz	\nabc\rxyz\n	\nabc\n\rxyz\n
abc\n\n ⇒ xyz	\nabc\n\n\nxyz\n	\nabc\n\nxyz\n
abc\n\n ⇒ \nxyz	\nabc\n\n\nxyz\n	same as previous release
abc\n\n ⇒ \rxyz	\nabc\n\n\nxyz\n	same as previous release

Figure 3. Appending to ASA Files

- The behavior of DBCS strings has changed.
 1. I/O now checks the value of MB_CUR_MAX to determine whether to interpret DBCS characters within a file.
 2. When MB_CUR_MAX is 4, you can no longer place control characters in the middle of output DBCS strings for interpretation. Control characters within DBCS strings are treated as DBCS data. This is true for terminals as well. Previous products split the DBCS string at the '\n' (new-line) control character position by adding an SI (Shift In) control character at the new-line position, displaying the line on the terminal, and then adding an S0 (Shift Out) control character before the data following the new-line character. If MB_CUR_MAX is 1, the library interprets control characters within any string, but does not interpret DBCS strings. S0 and SI characters are treated as ordinary characters.
 3. When you are writing DBCS data to text files, if there are multiple S0 (Shift Out) control-character write operations with no intervening SI (Shift In) control character, the library discards the S0 characters, and marks that a truncation error has occurred. Previous products allowed multiple S0 control-character write operations with no intervening SI control character without issuing an error condition.
 4. When you are writing DBCS data to text files and specify an odd number of DBCS bytes before an SI control character, the last DBCS character is padded with a X'FE' byte. If a SIGIOERR handler exists, it is triggered. Previous products allowed incorrectly placed SI control-character write operations to complete without any indication of an error.
 5. Now, when an S0 has been issued to indicate the beginning of a DBCS string within a text file, the DBCS must terminate within the record. The record will have both an S0 and an SI.

Repositioning within Files

- The behavior of fgetpos(), fseek() and fflush() following a call to ungetc() has changed. Previously, these functions have all ignored characters pushed back by ungetc() and have considered the file to be at the position where the first ungetc() character was pushed back. Also, ftell() acknowledged characters pushed back by ungetc() by backing up one position if there was a character pushed back. Now,
 - fgetpos() behaves just as ftell() does.

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- When a seek from the current position (SEEK_CUR) is performed, `fseek()` accounts for any `ungetc()` character before moving, using the user-supplied offset.
- `fflush()` moves the position back one character for every character that was pushed back.

If you have applications that depend on the previous behavior of `fgetpos()`, `fseek()`, or `fflush()`, you may use the new `_EDC_COMPAT` environment variable so that source code need not change to compensate for the new behavior. `_EDC_COMPAT` is described in the *OS/390 C/C++ Programming Guide*.

- For OS I/O to and from files opened in text mode, the `ftell()` encoding system now supports higher blocking factors for smaller block sizes. In general, you should not rely on `ftell()` values generated by code you developed using previous releases of the library. You can try `ftell()` values taken in previous releases for files opened in text or binary format if you set the environment variable `_EDC_COMPAT` before you call `fopen()` or `freopen()`. Do not rely on `ftell()` values saved across program boundaries. `_EDC_COMPAT` is described in the *OS/390 C/C++ Programming Guide*.
- For record I/O, `ftell()` now returns the relative record number instead of an encoded offset from the beginning of the file. You can supply the relative record number without acquiring it from `ftell()`. You cannot use old `ftell()` values for record I/O, regardless of the setting of `_EDC_COMPAT`. `_EDC_COMPAT` is described in the *OS/390 C/C++ Programming Guide*.
- If you have used `ungetc()` to move the file pointer to a position before the beginning of the file, calls to `ftell()` and `fgetpos()` now fail. Previously, `ftell()` returned the value 0 for such calls, but set `errno` to a non-zero value. Previously, `fgetpos()` did not account for `ungetc()` calls. See the *OS/390 C/C++ Programming Guide* for information on how to change `fgetpos()` behavior by using `_EDC_COMPAT`.

For example, suppose that you are at relative position 1 in the file and `ungetc()` is performed twice. `ftell()` and `fgetpos()` will now report the relative position -1, which is before the start of the file, causing both `ftell()` and `fgetpos()` to fail.

- After you have called `ftell()`, calls to `setbuf()` or `setvbuf()` may fail. Applications should never call I/O functions between calls to `fopen()` or `freopen()` and calls to the functions that control buffering.

Closing and Reopening ASA Files

The behavior of ASA files when you close and reopen them is now consistent:

Written to file	Physical record after close					
	Previous behavior			New behavior		
abc	Char	abc	(1)	same as previous release		
	Hex	4888 0123	(1)			
abc\n	Char	abc	(1)	same as previous release		
	Hex	4888 0123	(1)			
abc\n\n	Char	abc	(1)	Char	abc	(1)
		0	(2)			(2)
	Hex	4888 0123	(1)	Hex	4888 0123	(1)
		F 0	(2)		4 0	(2)
abc\n\n\n	Char	abc	(1)	Char	abc	(1)
		-	(2)			(2)
	Hex	4888 0123	(1)	Hex	4888 0123	(1)
		6 0	(2)		4 0	(2)
abc\r	Char	abc	(1)	same as previous release		
		+	(2)			
	Hex	4888 0123 4 E	(1) (2)			
abc\r	Char	abc	(1)	same as previous release		
		1	(2)			
	Hex	4888 0123	(1)			
		F 1	(2)			

Figure 4. Closing and Reopening ASA Files

fldata() Return Values

There are minor changes to the values that the `fldata()` library function returns. It may now return more specific information in some fields. For more information on `fldata()`, see the “Input and Output” section in the *OS/390 C/C++ Programming Guide*.

Error Handling

The general return code for errors is now `E0F`. In previous products, some I/O functions returned 1 as an error code to indicate failure. This caused some confusion, as 1 is a possible `errno` value as well as a return code. `E0F` is not a valid `errno` value.

Programs that rely on specific values of `errno` may not run as expected, because certain `errno` values have changed. Under OS/390 Language Environment Release

5, error messages have the format EDC5xxx. You can find the error message information for a particular errno value by applying the errno value to EDC5xxx (for example, 021 becomes EDC5021), and looking up the EDC5xxx message in the *OS/390 Language Environment Debugging Guide and Run-Time Messages* manual.

Miscellaneous

- The inheritance model for standard streams now supports repositioning. Previously, if you opened stdout or stderr in update mode, and then called another C program by using the ANSI-style `system()` function, the program that you called inherited the standard streams, but moved the file position for stdout or stderr to the end of the file. Now, the library does not move the file position to the end of the file. For text files, the position is moved only to the nearest record boundary not before the current position. This is consistent with the way stdin behaves for text files.
- The values for `L_tmpnam` and `FILENAME_MAX` have been changed:

Constant	Old values	New values
<code>L_tmpnam</code>	47	1024
<code>FILENAME_MAX</code>	57	1024

- The names produced by the `tmpnam()` library function are now different. Any code that depends on the internal structure of these names may fail.

VSAM I/O Changes

- The library no longer appends an index key when you read from an RRDS file opened in text or binary mode.
- RRDS files opened in text or binary mode no longer support setting the access direction to BWD.

Terminal I/O Changes

- The library will now use the actual `recfm` and `lrecl` specified in the `fopen()` or `freopen()` call that opens a terminal file. Incomplete new records in fixed binary and record files are padded with blank characters until they are full, and the `__recfmF` flag is set in the `fldata()` structure.
Previously, MVS terminals unconditionally set `recfm=U`. Terminal I/O did not support opening files in fixed format.
- The use of an `LRECL` value in the `fopen()` or `freopen()` call that opens a file sets the record length to the value specified.
Previous releases unconditionally set the record length to the default values.
- The use of a `RECFM` value in the `fopen()` or `freopen()` call that opens a file sets the record format to the value specified.
Previous releases unconditionally set the record format to the default values.
- For input text terminals, an input record now has an implicit logical record boundary at `LRECL` if the size of the record exceeds `LRECL`. The character data in excess of `LRECL` is discarded, and a '\n' (new-line) character is added at the end of the record boundary. You can now explicitly set the record length of a file as a parameter on the `fopen()` call.
The old behavior was to allow input text records to span multiple `LRECL` blocks.
- Binary and record input terminals now flag an end-of-file condition with an empty input record. You can clear the EOF condition by using the `rewind()` or `clearerr()` library function.

Previous products did not allow these terminal types to signal an end-of-file condition.

- When an input terminal requires input from the system, all output terminals with unwritten data are flushed in a way that groups the data from the different open terminals together, each separated from the other with a single blank character.

The old behavior is equivalent to the new behavior, except that two blank characters separate the data from each output terminal.

Part 3. From Previous Releases of Language Environment to OS/390 Version 2 Release 6 Language Environment

This part discusses the implications of migrating applications that were created with one of the following compilers:

- The AD/Cycle C/370 Version 1 Release 1 compiler, 5688-216
- The AD/Cycle C/370 Version 1 Release 2 compiler, 5688-216
- The IBM C/C++ for MVS/ESA Version 3 Release 1 compiler, 5655-121
- The IBM C/C++ for MVS/ESA Version 3 Release 2 compiler, 5655-121, also known as the IBM OS/390 C/C++ Version 1 Release 1 compiler, 5645-001

and with one of the following libraries:

- IBM SAA AD/Cycle Language Environment/370 Version 1 Release 1, 5688-198
- IBM SAA AD/Cycle Language Environment/370 Version 1 Release 2, 5688-198
- IBM SAA AD/Cycle Language Environment/370 Version 1 Release 3, 5688-198
- Language Environment Version 1 Release 4, 5688-198
- Language Environment Version 1 Release 5, 5688-198
- The OpenEdition AD/Cycle C/370 Language Support Feature of MVS/ESA SP Version 5 Release 1, 5655-068 and 5655-069
- The C/C++ Language Feature of MVS/ESA SP Version 5 Release 2 Modification 0, 5655-068 and 5655-069
- The C/C++ Language Feature of MVS/ESA SP Version 5 Release 2 Modification 2, 5655-068 and 5655-069
- The Language Environment feature of OS/390 Version 1 Release 1, 5645-001

to the OS/390 Version 2 Release 6 C/C++ product.

This chapter does not discuss converting a C program to C++. The only C++ compiler migration considerations covered are those between different versions of the C++ component of the IBM C/C++ for MVS/ESA compilers and the OS/390 Version 2 Release 6 C/C++ compiler.

In this part, references to the products in the first column of the following table also apply to the products in the second column.

References To These Products	Also Apply To These Products
LE/370 Release 3	MVS/ESA SP Version 5 Release 1 OpenEdition AD/Cycle C/370 Language Support Feature
Language Environment Release 4	C/C++ Language Feature of MVS/ESA SP Version 5 Release 2 Modification 0
Language Environment Release 5	C/C++ Language Feature of MVS/ESA SP Version 5 Release 2 Modification 2
OS/390 Release 1	IBM C/C++ for MVS Version 3 Release 2 compiler and Language Environment Release 5

Chapter 8. Application Executable Program Compatibility

This chapter will help application programmers understand the compatibility considerations of application executable programs. An executable program is the output of the bind process. The output is a load module when stored in a PDS and a program object when stored in a PDSE or HFS. Generally, executable programs linked or bound with previous releases of OS/390 Language Environment (formerly known as both LE/370 and Language Environment for MVS & VM) execute successfully with OS/390 Version 2 Release 6 Language Environment, without source code changes, recompilation, or relinking. This chapter highlights exceptions and shows how to solve specific problems in compatibility.

Executable program compatibility problems requiring source changes are discussed in “Chapter 9. Source Program Compatibility” on page 53.

Note: The terms in this section having to do with linking (bind, binding, link, link-edit) refer to the process of creating an executable program from object modules.

Input and Output Operations

Programs running with LE/370 Release 1 or Release 2 may not work without changes if they have dependencies on any of the input and output behavior listed in “Chapter 11. Input and Output Operations Compatibility” on page 63.

System Programming C Facility (SP C) Executable Programs

If you have an LE/370 Release 1 or Release 2 SP C application that was built with exception handling (that is linked with EDCXERR, EDCXABRT and EDCXHDLR), you must relink it with OS/390 Version 2 Release 6 Language Environment using the SCEESPC dataset.

If your SP C module was built with exception handling, automatic library call is not enabled when you relink, so you must explicitly include the new routine @@SMASK.

Using the LINK Macro to Initiate a main()

When the LINK macro was used to initiate one C main() from another in LE/370 Release 1.0, any run-time options specified in calling a child main() were ignored. The parent run-time options were inherited. The conditions left unhandled in the child were propagated to the parent. Starting with LE/370 Release 1.1, and continuing through to OS/390 Version 2 Release 6 Language Environment run-time options are no longer propagated.

With LE/370 Release 1.0, using LINK to initiate a child main() restricted you from using standard streams in the child and from using memory files in the child. Starting with LE/370 Release 1.1 and continuing through to OS/390 Version 2

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Release 6 Language Environment, these restrictions no longer apply. Therefore, the parent's standard streams and memory files are shared by the child.

Inheritance of Run-Time Options with EXEC CICS LINK

When an EXEC CICS LINK command was used with LE/370 Release 1, run-time options were inherited from an ancestor. Users who used STACK and HEAP to tune C-CICS applications had to take particular note of this. Because of this inheritance, a large heap or stack size specified in the first run unit of a transaction chain of run units could cause shortages when it was allocated for each unit. For programs running under later releases of Language Environment, including OS/390 Version 2 Release 6 Language Environment, run-time options are no longer inherited.

STAE/NOSPIE and SPIE/NOSTAE Mapping

STAE and SPIE options have been replaced with the TRAP option. We recommend that you use the TRAP option, not STAE and SPIE. However, for ease of migration, the STAE and SPIE options are supported as long as the TRAP option is not explicitly specified. If the STAE option and SPIE option are used, they map to TRAP(ON). If NOSTAE and NOSPIE are used, they map to TRAP(OFF). When the values are mixed, for example, STAE/NOSPIE, they map to TRAP(ON). In LE/370 1.0, SPIE/NOSTAE and STAE/NOSPIE are mapped to TRAP(OFF).

Class Library Execution Incompatibilities

There are execution incompatibilities between the class libraries provided with the C++ Version 3 Release 1.0, 1.1, and the OS/390 Version 2 Release 6 C++ compiler. You must recompile and relink applications that are dynamically-bound to those class libraries for the following migration paths:

- Collection Class
 - from C++/MVS Version 3 Release 1.1 (non-RRBC version) to OS/390 Version 2 Release 6 C/C++
 - from C++/MVS Version 3 Release 1.0 to OS/390 Version 2 Release 6 C/C++
- Application Support Class
 - from C++/MVS Version 3 Release 1.1 (non-RRBC version) to OS/390 Version 2 Release 6 C/C++
 - from C++/MVS Version 3 Release 1.0 to OS/390 Version 2 Release 6 C/C++

Refer to “Appendix A. Class Library Migration Considerations” on page 79 for some background information about class libraries and compatibility considerations.

Chapter 9. Source Program Compatibility

In general, you can use source programs with the OS/390 Version 2 Release 6 C/C++ product without modification, if they were created with one of the following:

- AD/Cycle C/370 compiler running with Language Environment Version 1 Release 2 or later
- C/MVS Version 3 Release 1 or Release 2 compiler running with Language Environment Version 1 Release 4 or later
- C++/MVS Version 3 Release 1, and C++/MVS Version 3 Release 2 programs running with Language Environment Release 4 or 5

This chapter highlights the exceptions and shows how to solve specific problems in compatibility.

“Chapter 10. Other Migration Considerations” on page 57 has information on run-time options, which may also affect source code compatibility.

Input and Output Operations

You may have to change programs that ran with the LE/370 Release 1 or Release 2 library so that they work with OS/390 Language Environment, if they have dependencies on any of the input and output behaviors listed in “Chapter 11. Input and Output Operations Compatibility” on page 63.

SIGFPE Exceptions

Decimal overflow conditions were masked in Release 1 and 2 of LE/370. These conditions were enabled when the packed decimal data type was introduced in the AD/Cycle C/370 Release 2 compiler, and continue to be enabled with OS/390 Version 2 Release 6 Language Environment.

If you have old load modules that accidentally generated decimal overflow conditions, they may behave differently with OS/390 Version 2 Release 6 Language Environment by raising unexpected SIGFPE exceptions. Without source alteration, such modules cannot be migrated to the new library, and are unsupported. It is unlikely that such modules will occur in a C-only environment. These unexpected exceptions may occur in mixed language modules, particularly those using C and assembler code where the assembler code explicitly manipulates the program mask.

Program Mask Manipulations

Programs created with LE/370 Release 1 or Release 2 that explicitly manipulated the program mask may require source alteration to execute correctly under OS/390 Version 2 Release 6 Language Environment. Changes are required if you have one of the following types of programs:

- A C program containing assembler interlanguage calls (ILC), in which the invoked code uses the S/370 decimal instructions that might generate an

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unmasked decimal overflow condition, requires modification for migration. There are two methods for migrating the code. The first one is preferred:

- Modify the assembler code to save the existing mask, set the new value, and when finished, restore the saved mask.
- Change the C code so that the produced SIGFPE signal is ignored in the called code. In the following example, the SIGNAL calls surround the overflow-producing code. The SIGFPE exception signal is ignored, and then reenabled:

```
signal(SIGFPE, SIG_IGN); /* ignore exceptions */
...
callit():                /* in called routine */
...
signal(SIGFPE, SIG_DFL); /* restore default handling */
```

- A C program containing assembler ILCs that explicitly alter the program mask, and do not explicitly save and restore it, also requires modification for migration.

If user code explicitly alters the state of the program mask, the value before modification must be saved, and restored to its former value after the modification. You must ensure that the decimal overflow program mask bit is enabled during the execution of C code. Failure to preserve the mask may result in unpredictable behavior.

These changes also apply in a System Programming C environment, and to Customer Information Control System (CICS) programs in the handling and management of the PSW mask.

#line Directive

The AD/Cycle C/370 and C/MVS Version 3 Release 1 compilers ignored the #line directive when either the C/MVS EVENTS or the C/C++ MVS TEST compiler option was in effect. However the C/MVS Version 3 Release 2 and the OS/390 C compilers provide the correct information for the Debug Tool, and the compiler does not ignore the #line directive.

sizeof Operator

The behavior of sizeof when applied to a function return type was changed in the C/C++ MVS Version 3 Release 2 compiler. For example:

```
char foo();
..
s = sizeof foo();
```

If the example is compiled with a compiler prior to C/C++ MVS Version 3 Release 2, char is widened to int in the return type, so sizeof returns s = 4.

If the example is compiled with C/C++ MVS Version 3 Release 2, or with any OS/390 C/C++ compiler, the size of the original char type is retained. In the above example, sizeof returns s = 1. The size of the original type of other data types such as short, and float is also retained.

With OS/390 Version 2 Release 4 C/C++ and subsequent compilers, you can use #pragma wsizeof or the WSIZEOF compiler option to get sizeof to return the widened size for function return types if your code has a dependency on this

behavior. For more information on `#pragma wsizeof`, see *OS/390 C/C++ Language Reference*. For more information on the `Wsizeof` compiler option, see *OS/390 C/C++ User's Guide*.

_Packed Structures and Unions

If you are migrating from an AD/Cycle C/370 compiler to the OS/390 C compiler, you can no longer do the following:

- assign `_Packed` and `non-_Packed` structures to each other
- assign `_Packed` and `non-_Packed` unions to each other
- pass a `_Packed` union or `_Packed` structure as a function parameter if a `non-_Packed` version is expected (or the other way around)

If you attempt to do so, the compiler issues an error message.

Alternate Code Points

The following alternate code points are not supported by the OS/390 C/C++ compilers:

- `X'8B'` as alternate code point for `X'C0'` (the left brace)
- `X'9B'` as alternate code point for `X'D0'` (the right brace)

These alternate code points were supported by the C/370 and AD/Cycle C/370 compilers (the `NOLocale` option was required if you were using the AD/Cycle C/370 Version 1 Release 2 compiler).

Conformance to the ANSI standard

The C/C++ MVS Version 3 Release 2 and OS/390 C/C++ compilers conform to the 1992 draft of the ANSI standard, and no longer interpret wide-character constants that contain escape sequences.

LANGLVL(ANSI)

Starting with the C/C++ MVS Version 3 Release 2 compiler, if you specify `LANGLVL(ANSI)`, the compiler recognizes `char`, `unsigned char`, and `signed char` as three distinct types.

Compiler Messages and Return Codes

There are differences in messages and return codes between different versions of the compiler. Message contents have changed, and return codes for some messages have changed (some errors have become warning, and in very rare situations, some warnings have become errors). You must update accordingly any application that is affected by message contents or return codes. **Do not build dependencies on message content, message numbers, or return codes.** See *OS/390 C/C++ User's Guide* for a list of compiler messages.

Collection Class Library Source Code Incompatibilities

There are source code incompatibilities between the native Collection Class Libraries available with the C++/MVS Version 3 Release 1.0 and OS/390 Release 3 C++ compilers. You must change your source code if you are migrating to OS/390 Version 2 Release 6 C++ from C++/MVS Version 3 Release 1.0 and your application makes use of either of the following:

newCursor method

The return type of the newCursor method is now a pointer to the abstract cursor class ICursor (*ICursor).

Deriving from Reference Classes

Deriving from Reference Classes without overriding existing Collection Class member functions is still possible. However, you can no longer override existing Collection Class functions and use your derived Collection Class in a polymorphic way without additional effort. Refer to the chapter about "Polymorphism and the Collections", in the *OS/390 C/C++ IBM Open Class Library User's Guide* for more information.

These changes were made in the Collection Class Library that was available with the C++/MVS Version 3 Release 1.1 compiler, and do not affect you if you are migrating from the C++/MVS Version 3 Release 1.1, C++/MVS Version 3 Release 2, or an OS/390 C++ compiler.

Also, the structure of the Collection Classes changed in MVS Version 3 Release 1.1. All classes, including the concrete classes, are now related in an abstract hierarchy. The abstract hierarchy makes use of virtual inheritance. When you subclass from a Collection Class and implement your own copy constructor, you must initialize the virtual base class IACollection<Element> in your derived classes. Therefore, if you subclassed from a concrete Collection Class that was shipped with C++/MVS Version 3 Release 1.0, and are migrating to the Collection Classes that are shipped with OS/390 Version 2 Release 6 C/C++, you will have to change the implementation of your copy constructor by adding the virtual base class initialization.

Refer to "Appendix A. Class Library Migration Considerations" on page 79 for some background information about class libraries and compatibility considerations.

DSECT Utility

Header files generated by the DSECT utility now use #pragma pack rather than _Packed for packed structures. In rare cases, you may have to modify and recompile your code.

Chapter 10. Other Migration Considerations

This chapter provides additional considerations on migrating applications from the compilers and libraries listed in “Part 3. From Previous Releases of Language Environment to OS/390 Version 2 Release 6 Language Environment” on page 49 to the OS/390 Version 2 Release 6 C/C++ product.

Class Library Object Module Incompatibilities

There are object incompatibilities between the class libraries provided with the IBM C++/MVS Version 3 Release 1.0, 1.1, and OS/390 C++ compilers. You must recompile and relink applications that are dynamically-bound to those class libraries, for the following migration paths:

- Collection Class
 - from Version 3 Release 1.1 (non-RRBC version) to OS/390 Version 2 Release 6 C/C++
 - from Version 3 Release 1.0 to OS/390 Version 2 Release 6 C/C++
- Application Support Class
 - from Version 3 Release 1.1 (non-RRBC version) to OS/390 Version 2 Release 6 C/C++
 - from Version 3 Release 1.0 to OS/390 Version 2 Release 6 C/C++

Refer to “Appendix A. Class Library Migration Considerations” on page 79 for some background information about class libraries and compatibility considerations.

Removal of Database Access Class Library Utility

Starting with OS/390 Version 2 Release 4 C/C++, the Database Access Class Library utility is no longer available.

Changes That Affect User JCL, CLISTs, and EXECs

This section describes changes that may affect your JCL, CLISTs, and EXECs.

CXX Parameter in JCL Procedures

With C++/MVS Version 3 Release 2 and OS/390 C++ compilers, the CBCC, CBCCL, and CBCCLG procedures, which compile C++ code, now include parameter CXX. You must include this parameter if you have written your own JCL to compile a C++ program. Otherwise, you invoke the C compiler.

When you pass options to the compiler, you must specify parameter CXX. You must use the following format to specify options:

run-time options/CXX compile-time options

SYSMSGs and SYSXMSGs ddnames

With the C/C++ MVS Version 3 Release 2 and OS/390 C/C++ compilers, the method of specifying the language for compiler messages has changed. At compile time, instead of specifying message data sets on the SYSMSGs and SYSXMSGs ddnames, you must now use the NATLANG run-time option. If you specify data sets for these ddnames, they are ignored.

Compiler Messages and Return Codes

There are differences in messages and return codes between different versions of the compiler. Message contents have changed, and return codes for some messages have changed (some errors have become warnings, and in very rare situations, some warnings have become errors). You must update accordingly any application that is affected by message contents or return codes. **Do not build dependencies on message content, message numbers, or return codes.** See *OS/390 C/C++ User's Guide* for a description of compiler messages and return codes.

Changes in Data Set Names

The names of IBM-supplied data sets may change from one release to another. See the OS/390 Program Directory for more information on data set names.

Decimal Exceptions

OS/390 Language Environment provides support for the packed decimal overflow exception using native System/370 hardware enablement, as did LE/370 Release 3, Language Environment Release 4 and Release 5.

The value of the program mask in the program status word (PSW) is 4 (decimal overflow enabled).

Migration and Coexistence

The following points identify migration and coexistence considerations for user applications:

- As of LE/370 Release 3, CICS programs were enabled for decimal exceptions.
- The C packed decimal support routines are not supported in an environment that exploits asynchronous events.

SIGTERM, SIGINT, SIGUSR1, and SIGUSR2 Exceptions

As of LE/370 Release 3, there were changes to application/program behavior for SIGTERM, SIGINT, SIGUSR1, and SIGUSR2 exceptions from previous releases of the LE/370 product. These changes in behavior carried over into the OS/390 Version 2 Release 6 Language Environment product.

The differences or incompatibilities are:

- The defaults for the SIGINT, SIGTERM, SIGUSR1, and SIGUSR2 signals changed in LE/370 Release 3, from what they were in C/370 Version 1 and 2 and LE/370 Release 1 and 2. In the C/370 library and LE/370 Release 1 and Release 2, the defaults for SIGINT, SIGUSR1, and SIGUSR2 were to ignore the signals. As of LE/370 Release 3, the default is to terminate the program and return a return

code of 3000. For SIGTERM, the default has always been to terminate the program, but the return code is now 3000 whereas before it was 0.

- Applications that terminate abnormally will **not** drive the atexit list.

Compile-Time Options

This section describes changes that may affect your compile-time options.

OPTIMIZE Compile-Time Option

In the AD/Cycle C/370 compilers:

- OPT(0) mapped to NOOPT
- OPT and OPT(1) mapped to OPT(1)
- OPT(2) mapped to OPT(2)

In the C/C++ MVS/ESA Version 3 compilers, and the OS/390 Version 1 Release 1 compiler:

- OPT(0) mapped to NOOPT
- OPT, OPT(1) and OPT(2) mapped to OPT

Starting with the OS/390 Version 2 Release 6 C/C++ compiler:

- OPT(0) maps to NOOPT
- OPT, OPT(1) and OPT(2) map to OPT(2).

IDL Compile-Time option

As of OS/390 Version 2 Release 4 C/C++, the IDL compiler option is no longer available. If you continue to require IDL for your applications, new IDL or IDL modifications must be coded by hand. You can then use the IDL compiler to generate your C/C++ source code.

INLINE Compile-Time option

The defaults for the C compile INLINE compiler option were changed in the C/MVS Version 3 Release 1 compiler. In the past, the default for the threshold suboption was 250 ACUs (Abstract Code Units). With the C/MVS Version 3 and the OS/390 C compilers, the default is 100 ACUs.

SEARCH and LSEARCH Compile-Time Option

The include file search process has changed. Prior to the C/MVS V3R2 compiler, if you used the LSEARCH option more than once, the compiler searched only the libraries specified for the last LSEARCH option. Now the OS/390 C compilers search all of the libraries specified for all of the LSEARCH options, from the point of the last NOSEARCH option.

Similarly, if you specify the OS/390 C/C++ SEARCH option more than once, the OS/390 C++ compilers search all of the libraries specified for all of the SEARCH options, from the point of the last NOSEARCH option. Previously, only the libraries specified for the last SEARCH option were searched.

TEST Compile-Time Option

Starting with the OS/390 C/C++ compilers, the default for the PATH suboption of the TEST option has changed from NOPATH to PATH. Also, the INLINE option is ignored when the TEST option is in effect at OPT(0), but the INLINE option is no longer ignored if OPT(1) or OPT(2) is in effect.

Starting with C/C++ MVS Version 3 Release 2, a restriction applies to the TEST compiler option. Now, the maximum number of lines in a single source file cannot exceed 131,072. If you exceed this limit, the results from the Debug Tool and LE/370 Dump Services are undefined.

HALT Compile-Time Option

The C++/MVS V3R2 and OS/390 C++ compilers do not accept 33 as a valid parameter for the HALT compile-time option.

Syntax for the CC Command

With the C/C++ MVS V3R2 and OS/390 C/C++ compilers, the CC command can be invoked using a new syntax. At customization time, your system programmer can customize the CC EXEC to accept only the old syntax (the one supported by compilers before C/C++ MVS Version 3 Release 2), only the new syntax, or both syntaxes.

You should customize the CC EXEC to accept only the new syntax, because the old syntax may not be supported in the future. If you customize the CC EXEC to accept only the old syntax, keep in mind that it does not support Hierarchical File System (HFS) files. If you customize the CC EXEC to accept both the old and new syntaxes, you must invoke it using either the old *or* the new syntax, not a mixture of both. If you invoke this EXEC with the old syntax, it does not support HFS files.

Refer to the OS/390 Program Directory for more information about installation and customization, and to the *OS/390 C/C++ User's Guide* for more information about compiler options.

Time Functions

You should customize your locale information. Otherwise, in rare cases, you may encounter errors. In a POSIX application, you can supply time zone and alternative time (e.g., daylight) information with the TZ environment variable. In a non-POSIX application, you can supply this information with the _TZ environment variable. If no TZ environment variable is defined for a POSIX application or no _TZ environment variable is defined for a non-POSIX application, any customized information provided by the LC_TOD locale category is used. By setting the TZ environment variable for a POSIX application, or the _TZ environment variable for a non-POSIX application, or by providing customized time zone or daylight information in an LC_TOD locale category, you allow the time functions to preserve both time and date, correctly adjusting for alternative time on a given date.

Refer to the *OS/390 C/C++ Programming Guide* for more information about both environment variables and customizing a locale.

Abnormal Termination Exits

The abnormal termination exits CEEBDATX (for batch) and CEECDATX (for CICS) are now automatically linked at install time for OS/390 Language Environment the sample exit is no longer required. These exits were only available in the sample library in LE/370 Release 3. They allow you to automatically produce a system dump (with abend code 4039), when abnormal termination occurs. In previous releases of Language Environment, only an LE formatted dump was generated (which continues to be produced under OS/390 Version 2 Release 6 Language Environment).

For a non-CICS application, you can trigger the dump by ensuring that SYSUDUMP is defined in the GO step of the JCL that you are using (for example, by including the statement SYSUDUMP DD SYSOUT=*). If SYSUDUMP is not included in your JCL, or is defined as DUMMY, the dump will be suppressed. As of C/C++ for MVS/ESA Version 3 Release 1, the standard JCL procedures shipped with the compiler do not include SYSUDUMP.

In a CICS environment, you automatically receive the default transaction dump unless you disable it by using the CEMT transaction, and by specifying the dumpcode '4039'.

You may also modify CEEBDATX and CEECDATX to suppress the dumps. The exits are available in the OS/390 Version 2 Release 6 Language Environment sample library.

Standard Stream Support

Under CICS, with OS/390 Language Environment, records sent to the transient data queues associated with stdout and stderr with default settings take the form of a message as follows:

ASA	terminal id	transaction id	sp	Time Stamp YYYYMMDDHHMMSS	sp	data
1	4	4	1	14	1	108

where:

ASA is the carriage-control character
terminal id is a 4 character terminal identifier
transaction id is a 4 character transaction identifier
sp is a space
Time Stamp is the date and time displayed in the format YYYYMMDDHHMMSS
data is the data sent to the standard streams stdout and stderr

This format was associated with stderr for all releases of Language Environment. However, it has only been used for stdout since LE/370 Release 3; therefore, you should be aware of this change if you are migrating to OS/390 Version 2 Release 6 Language Environment from LE/370 Release 1 or Release 2.

Direction of Compiler Messages to stderr

All messages produced by the C/C++ MVS Version 3 Release 2 and OS/390 C++ compilers are sent to stderr. In the past, some messages were sent to stdout.

Array new

In the C++/MVS Version 3 Release 1 compiler, the array version of new was not supported. It is supported in a PTF (APAR PN72107) available for the C++/MVS Version 3 Release 1 compiler, and it is also supported in the C++/MVS Version 3 Release 2 and OS/390 C/C++ compilers.

If you are migrating from the base C/C++ MVS Version 3 Release 1 compiler to OS/390 Version 2 Release 6 C/C++, and you have written your own global new operator, it is no longer called when you create an array object. For example:

```
void*
operator new (MyClass *, size_t sz) { g_new_count++;
    return MyMalloc(sz); }

main() {
    X new_array[10]; // the global new operator
                    // shown above will not be called if the fix for
                    // APAR PN72107 or the Version 3 Release 2
                    // compiler is installed
}
```

You have to add an overloaded operator to new[] if you require this for arrays.

Compiler Listings

As of OS/390 C/C++ Version 2 Release 6, OPT(1) maps to OPT(2). The compiler listing no longer contains the part of the pseudo-assembler listing that was associated with OPT(1). Listing formats, especially the pseudo-assembler parts, will continue to change from release to release. **Do not build dependencies on the structure or content of listings.** For information about listings for the current release, refer to the *OS/390 C/C++ User's Guide*.

Chapter 11. Input and Output Operations Compatibility

Changes were made to input and output support in the C/370 Version 2 Release 2 and LE/370 Release 3 libraries. These changes also apply to OS/390 Version 2 Release 6 Language Environment. If your programs performed input and output operations with the following products, you should read the changes listed in this section. These products are:

- LE/370 Release 1
- LE/370 Release 2

References in this chapter to previous releases or previous behavior apply to the products listed above.

You will generally be able to migrate “well-behaved” programs: programs that do not rely on undocumented behavior, restrictions, or invalid behaviors of previous releases. For example, if library documentation only specified that a return code was a negative value, and your code relies on that value being -3, your code is not well-behaved and is relying on undocumented behavior.

Another example of a program that is not well-behaved is one that specifies `recfm=F` for a terminal file and depends on Language Environment to ignore this parameter, as it did previously.

However, you may still need to change even well-behaved code under circumstances described in the following section.

Opening Files

- When you call the `fopen()` or `freopen()` library function, you can specify each parameter only once. If you specify any keyword parameter in the *mode* string more than once, the function call fails. Previously, you could specify more than one instance of a parameter.
- The library no longer supports uppercase open modes on calls to `fopen()` or `freopen()`. You must specify, for example, `rb` instead of `RB`, to conform to the ANSI/ISO standard.
- You cannot open a non-HFS file more than once for a write operation. Previous releases allowed you, in some cases, to open a file for write more than once. For example, you could open a file by its data set name and then again by its ddname. This is no longer possible for non-HFS files, and is not supported.
- Previously, `fopen()` allowed spaces and commas as delimiters for mode string parameters. Only commas are allowed now.
- If you are using PDSEs or PDSEs, you cannot specify any spaces before the member name.

Writing to Files

- Write operations to files opened in binary mode are no longer deferred. Previously, the library did not write a block that held *nn* bytes out to the system until the user wrote *nn*+1 bytes to the block. The OS/390 Language Environment library follows the rules for full buffering, described in the *OS/390 C/C++ Programming Guide*, and writes data as soon as the block is full. The *nn* bytes are still written to the file, the only difference is in the timing of when it is done.

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- For non-terminal files, the backspace character ('\b') is now placed into files as is. Previously, it backed up the file position to the beginning of the line.
- For all text I/O, truncation for `fwrite()` is now handled the same way that it is handled for `puts()` and `fputs()`. If you write more data than a record can hold, and your output data contains any of the terminating control characters, '\n' or '\r' (or '\f', if you are using ASA), the library still truncates extra data; however, recognizing that the text line is complete, the library writes subsequent data to the next record boundary. Previously, `fwrite()` stopped immediately after the library began truncating data, so that you had to add a control character before writing any more data.
- You can now partially update a record in a file opened with `type=record`. Previous libraries returned an error if you tried to make a partial update to a record. Now, a record is updated up to the number of characters you specify, and the remaining characters are untouched. The next update is to the next record.
- OS/390 Language Environment blocks files more efficiently than some previous libraries did. Applications that depend on the creation of short blocks may fail.
- The behavior of ASA files when you close them has changed. In previous releases, this is what happened:

Written to file	Read from file after <code>fclose()</code> , <code>fopen()</code>
abc\n\n\n	abc\n\n\n\n
abc\n\n	abc\n\n\n
abc\n	abc\n

In this release, you read from the file what you wrote to it. For example:

Written to file	Read from file after <code>fclose()</code> , <code>fopen()</code>
abc\n\n\n	abc\n\n\n
abc\n\n	abc\n\n
abc\n	abc\n

In previous products, writing a single new-line character to a new file created an empty file under MVS. OS/390 Language Environment treats a single new-line characters written to a new file as a special case, because it is the last new-line character of the file. The library writes a single blank to the file. When you read this file, you see two new-line characters instead of one. You also see two new-line characters on a read if you have written two new-line characters to the file.

The behavior of appending to ASA files has also changed. The following table shows what you get from an ASA file when you:

1. Open an ASA file for write.
2. Write abc.
3. Close the file.
4. Append xyz to the ASA file.
5. Open the same ASA file for read.

abc Written to File, fclose() then append xyz	What You Read from File after fclose(), fopen()	
	Previous release	New release
abc ⇒ xyz	\nabc\nxyz\n	same as previous release
abc ⇒ \nxyz	\nabc\nxyz\n	\nabc\n\nxyz\n
abc ⇒ \rxyz	\nabc\rxyz\n	\nabc\n\rxyz\n
abc\n ⇒ xyz	\nabc\nxyz\n	same as previous release
abc\n ⇒ \nxyz	\nabc\nxyz\n	\nabc\n\nxyz\n
abc\n ⇒ \rxyz	\nabc\rxyz\n	\nabc\n\rxyz\n
abc\n\n ⇒ xyz	\nabc\n\n\nxyz\n	\nabc\n\nxyz\n
abc\n\n ⇒ \nxyz	\nabc\n\n\nxyz\n	same as previous release
abc\n\n ⇒ \rxyz	\nabc\n\n\nxyz\n	same as previous release

Figure 5. Appending to ASA Files

- The behavior of DBCS strings has changed.
 1. I/O now checks the value of MB_CUR_MAX to determine whether to interpret DBCS characters within a file.
 2. When MB_CUR_MAX is 4, you can no longer place control characters in the middle of output DBCS strings for interpretation. Control characters within DBCS strings are treated as DBCS data. This is true for terminals as well. Previous products split the DBCS string at the '\n' (new-line) control character position by adding an SI (Shift In) control character at the new-line position, displaying the line on the terminal, and then adding an S0 (Shift Out) control character before the data following the new-line character. If MB_CUR_MAX is 1, the library interprets control characters within any string, but does not interpret DBCS strings. S0 and SI characters are treated as ordinary characters.
 3. When you are writing DBCS data to text files, if there are multiple S0 (Shift Out) control-character write operations with no intervening SI (Shift In) control character, the library discards the S0 characters, and marks that a truncation error has occurred. Previous products allowed multiple S0 control-character write operations with no intervening SI control character without issuing an error condition.
 4. When you are writing DBCS data to text files and specify an odd number of DBCS bytes before an SI control character, the last DBCS character is padded with a X'FE' byte. If a SIGIOERR handler exists, it is triggered. Previous products allowed incorrectly placed SI control-character write operations to complete without any indication of an error.
 5. Now, when an S0 has been issued to indicate the beginning of a DBCS string within a text file, the DBCS must terminate within the record. The record will have both an S0 and an SI.

Repositioning within Files

- The behavior of fgetpos(), fseek() and fflush() following a call to ungetc() has changed. Previously, these functions have all ignored characters pushed back by ungetc() and have considered the file to be at the position where the first ungetc() character was pushed back. Also, ftell() acknowledged characters pushed back by ungetc() by backing up one position if there was a character pushed back. Now,
 - fgetpos() behaves just as ftell() does

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- When a seek from the current position (SEEK_CUR) is performed, `fseek()` accounts for any `ungetc()` character before moving, using the user-supplied offset
- `fflush()` moves the position back one character for every character that was pushed back.

If you have applications that depend on the previous behavior of `fgetpos()`, `fseek()`, or `fflush()`, you may use the new `_EDC_COMPAT` environment variable so that source code need not change to compensate for the new behavior. `_EDC_COMPAT` is described in the *OS/390 C/C++ Programming Guide*.

- For OS I/O to and from files opened in text mode, the `ftell()` encoding system now supports higher blocking factors for smaller block sizes. In general, you should not rely on `ftell()` values generated by code you developed using previous releases of the library. You can try `ftell()` values taken in previous releases for files opened in text or binary format if you set the environment variable `_EDC_COMPAT` before you call `fopen()` or `freopen()`. Do not rely on `ftell()` values saved across program boundaries. `_EDC_COMPAT` is described in the *OS/390 C/C++ Programming Guide*.
- For record I/O, `ftell()` now returns the relative record number instead of an encoded offset from the beginning of the file. You can supply the relative record number without acquiring it from `ftell()`. You cannot use old `ftell()` values for record I/O, regardless of the setting of `_EDC_COMPAT`. `_EDC_COMPAT` is described in the *OS/390 C/C++ Programming Guide*.
- If you have used `ungetc()` to move the file pointer to a position before the beginning of the file, calls to `ftell()` and `fgetpos()` now fail. Previously, `ftell()` returned the value 0 for such calls, but set `errno` to a non-zero value. Previously, `fgetpos()` did not account for `ungetc()` calls. See the *OS/390 C/C++ Programming Guide* for information on how to change `fgetpos()` behavior by using `_EDC_COMPAT`.

For example, suppose that you are at relative position 1 in the file and `ungetc()` is performed twice. `ftell()` and `fgetpos()` will now report the relative position -1, which is before the start of the file, causing both `ftell()` and `fgetpos()` to fail.

- After you have called `ftell()`, calls to `setbuf()` or `setvbuf()` may fail. Applications should never call I/O functions between calls to `fopen()` or `freopen()` and calls to the functions that control buffering.

Closing and Reopening ASA Files

The behavior of ASA files when you close and reopen them is now consistent:

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Written to file	Physical record after close					
	Previous behavior			New behavior		
abc	Char	abc	(1)	same as previous release		
	Hex	4888 0123	(1)			
abc\n	Char	abc	(1)	same as previous release		
	Hex	4888 0123	(1)			
abc\n\n	Char	abc	(1)	Char	abc	(1)
		0	(2)			(2)
	Hex	4888 0123	(1)	Hex	4888 0123	(1)
		F 0	(2)		4 0	(2)
abc\n\n\n	Char	abc	(1)	Char	abc	(1)
		-	(2)			(2)
	Hex	4888 0123	(1)	Hex	4888 0123	(1)
		6 0	(2)		4 0	(2)
abc\r	Char	abc	(1)	same as previous release		
		+	(2)			
	Hex	4888 0123 4 E	(1) (2)			
abc\r	Char	abc	(1)	same as previous release		
		1	(2)			
	Hex	4888 0123 F 1	(1) (2)			

Figure 6. Closing and Reopening ASA Files

fldata() Return Values

There are minor changes to the values that the `fldata()` library function returns. It may now return more specific information in some fields. For more information on `fldata()`, see the “Input and Output” section in the *OS/390 C/C++ Programming Guide*.

Error Handling

The general return code for errors is now `E0F`. In previous products, some I/O functions returned 1 as an error code to indicate failure. This caused some confusion, as 1 is a possible `errno` value as well as a return code. `E0F` is not a valid `errno` value.

Programs that rely on specific values of `errno` may not run as expected, because certain `errno` values have changed. Under OS/390 Language Environment Release

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5, error messages have the format EDC5xxx. You can find the error message information for a particular errno value by applying the errno value to EDC5xxx (for example, 021 becomes EDC5021), and looking up the EDC5xxx message in the *OS/390 Language Environment Debugging Guide and Run-Time Messages* manual.

Miscellaneous

- The inheritance model for standard streams now supports repositioning. Previously, if you opened stdout or stderr in update mode, and then called another C program by using the ANSI-style system() function, the program that you called inherited the standard streams, but moved the file position for stdout or stderr to the end of the file. Now, the library does not move the file position to the end of the file. For text files, the position is moved only to the nearest record boundary not before the current position. This is consistent with the way stdin behaves for text files.
- The values for L_tmpnam and FILENAME_MAX have been changed:

Constant	Old values	New values
L_tmpnam	47	1024
FILENAME_MAX	57	1024

- The names produced by the tmpnam() library function are now different. Any code that depends on the internal structure of these names may fail.

VSAM I/O Changes

- The library no longer appends an index key when you read from an RRDS file opened in text or binary mode.
- RRDS files opened in text or binary mode no longer support setting the access direction to BWD.

Terminal I/O Changes

- The library will now use the actual recfm and lrecl specified in the fopen() or freopen() call that opens a terminal file. Incomplete new records in fixed binary and record files are padded with blank characters until they are full, and the __recfmF flag is set in the fldata() structure.
Previously, MVS terminals unconditionally set recfm=U. Terminal I/O did not support opening files in fixed format.
- The use of an LRECL value in the fopen() or freopen() call that opens a file sets the record length to the value specified.
Previous releases unconditionally set the record length to the default values.
- The use of a RECFM value in the fopen() or freopen() call that opens a file sets the record format to the value specified.
Previous releases unconditionally set the record format to the default values.
- For input text terminals, an input record now has an implicit logical record boundary at LRECL if the size of the record exceeds LRECL. The character data in excess of LRECL is discarded, and a '\n' (new-line) character is added at the end of the record boundary. You can now explicitly set the record length of a file as a parameter on the fopen() call.
The old behavior was to allow input text records to span multiple LRECL blocks.
- Binary and record input terminals now flag an end-of-file condition with an empty input record. You can clear the EOF condition by using the rewind() or clearerr() library function.

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Previous products did not allow these terminal types to signal an end-of-file condition.

- When an input terminal requires input from the system, all output terminals with unwritten data are flushed in a way that groups the data from the different open terminals together, each separated from the other with a single blank character.

The old behavior is equivalent to the new behavior, except that two blank characters separate the data from each output terminal.

Part 4. From Previous Releases of OS/390 C/C++ to OS/390 Version 2 Release 6 C/C++

This part discusses the implications of migrating applications that were created with one of the following products:

- IBM OS/390 Release 2 C/C++, 5645-001
- IBM OS/390 Release 3 C/C++, 5645-001
- IBM OS/390 Version 2 Release 4 C/C++, 5647-A01
- IBM OS/390 Version 2 Release 5 C/C++, 5647-A01

to the OS/390 Version 2 Release 6 C/C++ product.

Chapter 12. Changes Between Releases of OS/390 C/C++

This chapter describes the changes you may need to make if you are migrating from a previous release of OS/390 C/C++ to OS/390 Version 2 Release 6 C/C++.

IPA Object Module Binary Compatibility

Release-to-release binary compatibility is maintained by the OS/390 C/C++ IPA Compile and IPA Link as follows:

- An object file produced by an OS/390 C/C++ IPA Compile which contains IPA Object or combined IPA and conventional object information can be used as input to the OS/390 C/C++ IPA Link of the same or later Version/Release.
- An object file produced by an OS/390 C/C++ IPA Compile which contains IPA Object or combined IPA and conventional object information cannot be used as input by the OS/390 C/C++ IPA Link of an earlier Version/Release. If this is attempted, an error diagnostic message will be issued by the IPA Link.
- Note that if the IPA object is recompiled by a later OS/390 C/C++ IPA Compile, additional optimizations may be performed and the resulting application program may perform better.

An exception to this is the IPA object files produced by the OS/390 Release 2 C IPA Compile. These must be recompiled from the program source using an OS/390 Release 3 or later compiler before attempting to process them with the OS/390 Version 2 Release 6 C/C++ IPA Link.

IPA Link Step Defaults

Starting with OS/390 C/C++ Version 1 Release 3, the following IPA Link step defaults changed:

- The default optimization level is OPT(1)
- The default is INLINE, unless NOOPT, OPT(0) or NOINLINE is specified.
- The default inlining threshold is now 1000 ACUs. With OS/390 C/C++ Release 2, the threshold was 100 ACUs.
- The default expansion threshold is now 8000 ACUs. With OS/390 C/C++ Release 2, the threshold was 1000 ACUs.

Starting with OS/390 C/C++ Version 2 Release 6, the The default optimization level for the IPA Link step is OPT(2).

Removal of IDL Compile-Time option

As of OS/390 Version 2 Release 4 C/C++, the IDL compiler option is no longer available. If you continue to require IDL for your applications, new IDL or IDL modifications must be coded by hand. You can then use the IDL compiler to generate your C/C++ source code.

Removal of Database Access Class Library Utility

Starting with OS/390 Version 2 Release 4 C/C++, the Database Access Class Library utility is no longer available.

OPTIMIZE Compile-Time Option

In the OS/390 C/C++ Version 1 Release 2, Version 1 Release 3, Version 2 Release 4 and Version 2 Release 5 compilers:

- OPT(0) mapped to NOOPT
- OPT and OPT(1) mapped to OPT(1)
- OPT(2) mapped to OPT(2)

Starting with the OS/390 Version 2 Release 6 C/C++ compiler:

- OPT(0) maps to NOOPT
- OPT, OPT(1) and OPT(2) map to OPT(2)

Name Conflicts with Run-Time Library Functions

Starting with OS/390 Release 4 you might have a problem with name conflicts if you did both of the following:

1. You created functions with the same name as library functions.
2. When linking your application you included the IBM supplied Language Environment link library before the files that contain your function definitions.

Previous releases of the OS/390 C/C++ run-time headers used the `#pragma map` directive to convert many function names into identifiers prefixed with `"@"`. For example, if you included `fcntl.h` in your source, a reference to `open()` in your source code resulted in an external name `@@OPEN` in the object code. Starting with OS/390 Release 4 many `pragma map`s have been eliminated. If you created functions with the same name as library functions, you must ensure that the file containing your version of the function precedes the IBM supplied Language Environment link library in the search order when linking your application. If you have object modules containing identifiers like `OPEN` that you want resolved to your version of `open()`, you may need to alter your JCL to ensure that your version precedes the IBM supplied Language Environment link library in the search order.

Also, if you have multiple, interdependent modules that rely on the name mapping present in prior releases, you cannot recompile one without recompiling the others. For example, module A includes `fcntl.h` and calls `open()` resulting in a reference to `@@OPEN` in the object code. Module B implements your version of `open()` and also includes `fcntl.h`, so that the external name of the called function is mapped to `@@OPEN`. You must recompile both modules.

Table 5 lists the functions that had `pragma map`s deleted in OS/390 Release 4.

Table 5. Functions That Had Pragma Maps Deleted

<code>accept()</code>	<code>access()</code>	<code>alarm()</code>	<code>__atoe()</code>	<code>__atoe_l()</code>
<code>a64l()</code>	<code>basename()</code>	<code>bcmp()</code>	<code>bcopy()</code>	<code>bind()</code>
<code>brk()</code>	<code>bzero()</code>	<code>catclose()</code>	<code>catgets()</code>	<code>catopen()</code>
<code>cclass()</code>	<code>chaudit()</code>	<code>chdir()</code>	<code>chmod()</code>	<code>chown()</code>
<code>chroot()</code>	<code>clearenv()</code>	<code>close()</code>	<code>closedir()</code>	<code>closelog()</code>
<code>clrmemf()</code>	<code>__cnvblk()</code>	<code>confstr()</code>	<code>connect()</code>	<code>creat()</code>

Table 5. Functions That Had Pragma Maps Deleted (continued)

crypt()	csnap()	ctdli()	ctermid()	ctrace()
cuserid()	dirname()	__dlght()	drand48()	dup()
dup2()	dynalloc()	dynfree()	ecvt()	encrypt()
endgrent()	endpwent()	erand48()	__etoa()	__etoa_l()
execl()	execle()	execlp()	execv()	execve()
execvp()	fattach()	fchaudit()	fchdir()	fchmod()
fchown()	fcntl()	fcvt()	fdelrec()	fdetach()
fetch()	fetchep()	ffs()	fileno()	fldata()
flocate()	fmsg()	fnmatch()	fork()	fstat()
fstatvfs()	fsync()	ftime()	ftok()	ftw()
fupdate()	gcsp()	gcvrt()	__gderr()	getcwd()
getdate()	getegid()	__getipc()	geteuid()	getgid()
getgrent()	getgrgid()	getgrnam()	getmsg()	getopt()
getpass()	getpgid()	getpgrp()	getpid()	getpmsg()
getppid()	getpwent()	getpwnam()	getpwuid()	getsid()
getsyntx()	getuid()	getutxid()	getw()	getwd()
glob()	globfree()	grantpt()	hcreate()	hdestroy()
hsearch()	iconv()	index()	insque()	ioctl()
__ipdbcs()	__ipdspcx()	__iphost()	__ipmsgc()	__ipnode()
__iptcpn()	isatty()	isblank()	isnan()	iswblank()
jrand48()	kill()	killpg()	lchown()	lcong48()
lfind()	link()	listen()	lockf()	__loc1()
_longjmp()	lrand48()	lsearch()	lseek()	lstat()
l64a()	maxcoll()	maxdesc()	memccpy()	mkdir()
mkfifo()	mknod()	mkstemp()	mktemp()	mmap()
mount()	mprotect()	mrnd48()	msgctl()	msgget()
msgrcv()	msgsnd()	msgxrcv()	msync()	munmap()
nftw()	nice()	nlist()	nrnd48()	__opargf()
open()	opendir()	openlog()	__operrf()	__opindf()
__opoptf()	pathconf()	pause()	pclose()	pipe()
poll()	popen()	ptsname()	putenv()	putmsg()
putpmsg()	putw()	random()	read()	readdir()
readlink()	readv()	realpath()	re_comp()	recv()
recvfrom()	re_exec()	regcmp()	regcomp()	regerror()
regex()	regexec()	regfree()	release()	remque()
rexec()	rindex()	rmdir()	sbrk()	scalb()
seed48()	seekdir()	semctl()	semget()	semop()
send()	sendto()	setegid()	setenv()	seteuid()
setgid()	setgrent()	__setjmp()	setkey()	setpeer()
setpgid()	setpgrp()	setpwent()	setregid()	setreuid()
setsid()	setstate()	setuid()	shmat()	shmctl()
shmdt()	shmget()	shutdown()	__sigerr()	sighold()
__sigign()	sigpause()	__sigpro()	sigrelse()	sigset()
sigstack()	sigwait()	sleep()	socket()	spawn()
spawnp()	srandom()	srnd48()	stat()	statvfs()
strdup()	strfmon()	strptime()	svc99()	swab()
symlink()	sync()	sysconf()	syslog()	t_accept()
t_alloc()	t_bind()	tcdrain()	tcflow()	tcflush()
tcgetsid()	t_close()	tdelete()	t_error()	tellmdir()
tempnam()	tfind()	t_free()	times()	tinit()
t_listen()	t_look()	__tolower()	t_open()	__toupper()
t_rcv()	t_rcvdis()	t_rcvrel()	truncate()	tsearch()
tsetsubt()	t_snd()	t_snddis()	t_sndrel()	t_sync()
tsyncro()	tterm()	ttynam()	ttyslot()	t_unbind()
twalk()	__tzone()	tzset()	ualarm()	ulimit()

Table 5. Functions That Had Pragma Maps Deleted (continued)

umask()	umount()	uname()	unlink()	unlockpt()
usleep()	utime()	utimes()	valloc()	vfork()
wait()	waitid()	waitpid()	wait3()	w_ioclt()
wordexp()	wordfree()	write()	writew()	__wsinit()
w_statfs()				

Time Functions

You should customize your locale information. Otherwise, in rare cases, you may encounter errors. In a POSIX application, you can supply time zone and alternative time (e.g., daylight) information with the TZ environment variable. In a non-POSIX application, you can supply this information with the _TZ environment variable. If no TZ environment variable is defined for a POSIX application or no _TZ environment variable is defined for a non-POSIX application, any customized information provided by the LC_TOD locale category is used. By setting the TZ environment variable for a POSIX application, or the _TZ environment variable for a non-POSIX application, or by providing customized time zone or daylight information in an LC_TOD locale category, you allow the time functions to preserve both time and date, correctly adjusting for alternative time on a given date.

Refer to the *OS/390 C/C++ Programming Guide* for more information about both environment variables and customizing a locale.

Part 5. Appendixes

Appendix A. Class Library Migration Considerations

This appendix provides some background information on the types of class libraries that are available with the C++/MVS Version 3 and OS/390 C/C++ compilers.

The following four class libraries, along with the Database Access Class Library Utility, are available for use with the OS/390 C++ compilers:

- the I/O Stream Class Library
- the Complex Mathematics Class Library
- the Application Support Class Library
- the Collection Class Library

All four class libraries are available with the C++/MVS Version 3 Release 1.0 and Release 1.1 compilers. The C++/MVS Version 3 Release 2 compiler includes all four class libraries and the Database Access Class Library Utility.

The I/O Stream and Complex Mathematics Class Libraries are offered in native C++ versions only. With C++/MVS V 3.1.1 and subsequent versions, the Application Support Class Library is offered in native C++ and C++ SOM versions. With C++/MVS V3.2, the Collection Class Library is offered in native C++, SOM and Cross Language SOM versions. All six versions are available in both statically bindable and dynamically bindable forms.

In native C++ class libraries, references to methods are dependent upon the order of the method entries in a virtual function table. When new methods are added to a library, the order of the methods can change, and therefore existing applications using those methods may no longer work. However, adding new methods to RRBC-enabled class libraries generally does not cause migration impacts to applications. Between releases or modification levels, migration impacts may also occur for both native and RRBC-enabled libraries if there are changes to the interfaces/semantics of existing functions within a class library.

Whether an application is statically or dynamically bound to a class library will also determine whether or not there are executable incompatibilities. Statically-bound applications do not usually encounter release-to-release executable incompatibilities unless they are recompiled/relinked from source or relinked from objects with the new release. Dynamically-bound applications, however, may encounter release-to-release executable incompatibilities. Source and object incompatibilities may occur regardless of whether an application is statically or dynamically bound.

As of OS/390 Version 2 Release 4 C/C++, the Database Access Class Library (DACL) Utility is not available with the OS/390 C/C++ compiler.

For more information on the topics mentioned above, refer to the following:

- *OS/390 C/C++ IBM Open Class Library User's Guide*
- *OS/390 C/C++ IBM Open Class Library Reference*
- "The IBM System Object Model" chapter in the *OS/390 C/C++ Programming Guide* (for information on Release-to-Release Binary Compatibility)
- The "Building and Using Dynamic Link Libraries" chapter in the *OS/390 C/C++ Programming Guide* (for information on dynamic linking)

- *OS/390 C/C++ User's Guide* (for information on static linking)

Appendix B. Year 2000 Support for C/C++ under MVS & OS/390

All releases of C/370, C/C++ for MVS/ESA, and the C/C++ feature of OS/390 are year 2000 ready.

Language Environment Version 1 Release 5 (program number 5688-198) and all subsequent releases are part of OS/390, and are year 2000 ready.

Applications that contain date sensitive logic need to be examined and, if necessary, updated to deal with the century transition.

The date-time output will be correct for all locales in the year 2000, but the date (only) output will be ambiguous for most locales.

date format

Most OS/390 locales use the two digit year (without century) directive, %y, for date format, d_fmt. For these locales, the date (only) output will be ambiguous in the year 2000.

date-time format

All OS/390 locales use the four digit year (with century) directive, %Y, for date-time format, d_t_fmt. The date-time output will be correct in the year 2000 for all locales.

Listings produced by the C/C++ MVS V3R2 compiler and later compilers display the 4-digit year format. Listings produced by compilers prior to the C/C++ MVS V3R2 compiler display the 2-digit year format. Compiler listings must not be used as programmable interfaces, and so this change should not affect your application.

For further information on Year 2000 Support see:

<http://www.software.ibm.com/ad/va2000/y2k>

and the migration guides referenced there.

Bibliography

This bibliography lists the publications for IBM products that are related to the OS/390 C/C++ product. It includes publications covering the application programming task. The bibliography is not a comprehensive list of the publications for these products, however, it should be adequate for most OS/390 C/C++ users. Refer to the *OS/390 Information Roadmap*, GC28-1727, for a complete list of publications belonging to the OS/390 product.

Related publications not listed in this section can be found on the IBM Online Library Omnibus Edition: MVS Collection CD-ROM (SK2T-0710), the *IBM Online Library Omnibus Edition: OS/390 Collection* CD-ROM (SK2T-6700), or on a tape available with OS/390.

OS/390

- *OS/390 Printing Softcopy BOOKs*, S544-5354
- *OS/390 Introduction and Release Guide*, GC28-1725
- *OS/390 Planning for Installation*, GC28-1726
- *OS/390 Summary of Message Changes*, GC28-1499
- *OS/390 Information Roadmap*, GC28-1727

VS COBOL II Release 4

- *General Information*, GC26-4042
- *Migration Guide for MVS and CMS*, GC26-3151
- *Installation and Customization for MVS*, SC26-4048
- *Application Programming Guide for MVS and CMS*, SC26-4045
- *Application Programming Language Reference*, GC26-4047
- *Application Programming Reference Summary*, SX26-3721
- *Application Programming Debugging*, SC26-4049
- *Application Programming Diagnosis Guide*, LY27-9523
- *Application Programming Diagnosis Reference*, LY27-9522

COBOL FOR MVS & VM Release 2

- *Compiler and Run-Time Migration Guide*, GC26-4764
- *Programming Guide*, SC26-4767
- *Language Reference*, SC26-4769
- *Diagnosis Guide*, SC26-3138
- *Licensed Program Specifications*, GC26-4761
- *Installation and Customization under MVS*, SC26-4766

COBOL for OS/390 & VM Version 2 Release 1

- *Compiler and Run-Time Migration Guide*, GC26-4764
- *Programming Guide*, SC26-9049
- *Language Reference*, SC26-9046
- *Diagnosis Guide*, GC26-9047
- *Licensed Program Specifications*, GC26-9044
- *Installation and Customization under OS/390*, GC26-9045
- *Program Directory for VM*
- *Fact Sheet*, GC26-9048

PL/I for MVS & VM Release 1 Modification 1

- *Language Reference*, SC26-3114
- *Compiler and Run-Time Migration Guide*, SC26-3118
- *Programming Guide*, SC26-3113
- *Compile-Time Messages and Codes*, SC26-3229
- *Reference Summary*, SX26-3821
- *Diagnosis Guide*, SC26-3149
- *Installation and Customization under MVS*, SC26-3119
- *Licensed Program Specifications*, GC26-3116

OS PL/I Version 2 Release 3

- *Programming Guide*, SC26-4307
- *Programming: Language Reference*, SC26-4308
- *Programming: Messages and Codes*, SC26-4309

VS FORTRAN Version 2 Release 6

- *Programming Reference*, SC26-4221
- *Programming Guide*, SC26-4222

CICS/ESA Version 4 Release 1

- *Application Programming Reference*, SC33-1170
- *Application Programming Guide*, SC33-1169
- *Installation Guide*, SC33-1163
- *System Definition Guide*, SC33-1164
- *Resource Definition Guide*, SC33-1166
- *Messages and Codes*, SC33-1177

CICS Transaction Server for OS/390 Release 2

- *Application Programming Guide*, SC33-1687
- *Application Programming Reference*, SC33-1688
- *System Programming Reference*, SC33-1689
- *Distributed Transaction Programming Guide*, SC33-1691
- *Front End Programming Interface User's Guide*, SC33-1692

DB2 Version 3 Release 1

- *SQL Reference*, SC26-4890
- *Reference Summary*, SX26-3801
- *Command and Utility Reference*, SC26-4891
- *Application Programming and SQL Guide*, SC26-4889

DB2 Version 4 Release 1

- *SQL Reference*, SC26-3270
- *Reference Summary*, SX26-3829
- *Command Reference*, SC26-3267
- *Application Programming and SQL Guide*, SC26-3266
- *Utility Guide and Reference*, SC26-3395

DB2 Version 5 Release 1

- *Administration Guide*, SC26-8957
- *Application Programming and SQL Guide*, SC26-8958
- *Call Level Interface Guide and Reference*, SC26-8959
- *Command Reference*, SC26-8960
- *Data Sharing: Planning and Administration*, SC26-8961
- *Installation Guide*, GC26-8970
- *Messages and Codes*, GC26-8979
- *SQL Reference*, SC26-8966
- *Reference for Remote DRDA Requesters and Servers*, SC26-8964
- *Utility Guide and Reference*, SC26-8967

IMS/ESA Version 4 Release 1

- *Application Programming: Design Guide*, SC26-3066
- *Application Programming: DL/I Calls*, SC26-3062
- *Application Programming: Data Communication*, SC26-3058
- *Application Programming: EXEC DL/I Commands*, SC26-3063

IMS/ESA Version 5 Release 1

- *Application Programming: Design Guide*, SC26-8016
- *Application Programming: Transaction Manager*, SC26-8017
- *Application Programming: Database Manager*, SC26-8015
- *Application Programming: EXEC DL/I Commands for CICS and IMS*, SC26-8018

IMS/ESA Version 6 Release 1

- *Application Programming: Design Guide*, SC26-8728
- *Application Programming: Transaction Manager*, SC26-8729
- *Application Programming: Database Manager*, SC26-8727
- *Application Programming: EXEC DL/I Commands for CICS and IMS*, SC26-8726

QMF Version 3 Release 2

- *Introducing QMF*, GC26-4713
- *Using QMF*, SC26-8078
- *Developing QMF Applications*, SC26-4722
- *Reference*, SC26-4716
- *Managing QMF for MVS*, SC26-8218
- *Reference*, SC26-4716
- *Messages and Codes*, SC26-4834
- *Installing on MVS*, SC26-4719

VSAM

- *MVS/ESA VSAM Catalog Administration: Access Method Services Reference*, SC26-4501
- *MVS/ESA VSAM Administration: Macro Instruction Reference*, SC26-4517
- *MVS/ESA VSAM Administration Guide for MVS/DFP*, SC26-4518
- *MVS/ESA Integrated Catalog Administration: Access Method Services Reference*, SC26-4500
- *DFSMS/MVS Access Method Services for VSAM*, SC26-4905
- *MVS/DFP Access Method Services for VSAM Catalogs*, SC26-4570
- *MVS/Extended Architecture VSAM Catalog Administration: Access Method Services Reference (Data Facility Product, Version 2)*, GC26-4136

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