IBM XL Fortran for AIX, V14.1

Getting Started with XL Fortran

Version 14.1

SC14-7334-00

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Note
Before using this information and the product it supports, read the information in "Notices" on page 51.

First edition

This edition applies to IBM XL Fortran for AIX, V14.1 (Program 5765-J04; 5725-C74) and to all subsequent releases and modifications until otherwise indicated in new editions. Make sure you are using the correct edition for the level of the product.

Contents

About this document

This document contains overview and basic usage information for the IBM® XL Fortran for AIX®, V14.1 compiler.

Who should read this document

This document is intended for Fortran developers who are looking for introductory overview and usage information for XL Fortran. It assumes that you have some familiarity with command-line compilers, a basic knowledge of the Fortran programming language, and basic knowledge of operating system commands. Programmers new to XL Fortran can use this document to find information on the capabilities and features unique to XL Fortran.

How to use this document

Throughout this document, the **xlf** compiler invocation is used to describe the actions of the compiler. You can, however, substitute other forms of the compiler invocation command if your particular environment requires it, and compiler option usage will remain the same unless otherwise specified.

While this document covers information on configuring the compiler environment, and compiling and linking Fortran applications using the XL Fortran compiler, it does not include the following topics:

- Compiler installation: see the *XL Fortran Installation Guide* for information on installing XL Fortran.
- Compiler options: see the *XL Fortran Compiler Reference* for detailed information on the syntax and usage of compiler options.
- The Fortran programming language: see the *XL Fortran Language Reference* for information on the syntax, semantics, and IBM implementation of the Fortran programming language.
- Programming topics: see the *XL Fortran Optimization and Programming Guide* for detailed information on developing applications with XL Fortran, with a focus on program portability and optimization.

Conventions

Typographical conventions

The following table explains the typographical conventions used in the IBM XL Fortran for AIX, V14.1 information.

Table 1. Typographical conventions

Typeface	Indicates	Example
bold	Lowercase commands, executable names, compiler options, and directives.	The compiler provides basic invocation commands, **xlf**, along with several other compiler invocation commands to support various Fortran language levels and compilation environments.

Table 1. Typographical conventions (continued)

Typeface	Indicates	Example
italics	Parameters or variables whose actual names or values are to be supplied by the user. Italics are also used to introduce new terms.	Make sure that you update the *size* parameter if you return more than the *size* requested.
underlining	The default setting of a parameter of a compiler option or directive.	nomaf | maf
`monospace`	Programming keywords and library functions, compiler builtins, examples of program code, command strings, or user-defined names.	To compile and optimize myprogram.f, enter: `xlf myprogram.f -O3`.
UPPERCASE bold	Fortran programming keywords, statements, directives, and intrinsic procedures. Uppercase letters may also be used to indicate the minimum number of characters required to invoke a compiler option/suboption.	The **ASSERT** directive applies only to the **DO** loop immediately following the directive, and not to any nested **DO** loops.

Qualifying elements (icons and bracket separators)

In descriptions of language elements, this information uses icons and marked bracket separators to delineate the Fortran language standard text as follows:

Table 2. Qualifying elements

Icon	Bracket separator text	Meaning
F2008 ... F2008	N/A	The text describes an IBM XL Fortran implementation of the Fortran 2008 standard.
F2003 ... F2003	Fortran 2003 begins / ends	The text describes an IBM XL Fortran implementation of the Fortran 2003 standard, and it applies to all later standards.
IBM ... IBM	IBM extension begins / ends	The text describes a feature that is an IBM XL Fortran extension to the standard language specifications.

Note: If the information is marked with a Fortran language standard icon or bracket separators, it applies to this specific Fortran language standard and all later ones. If it is not marked, it applies to all Fortran language standards.

Syntax diagrams

Throughout this information, diagrams illustrate XL Fortran syntax. This section will help you to interpret and use those diagrams.

- Read the syntax diagrams from left to right, from top to bottom, following the path of the line.

  The ►►— symbol indicates the beginning of a command, directive, or statement.

The ⟶ symbol indicates that the command, directive, or statement syntax is continued on the next line.

The ►— symbol indicates that a command, directive, or statement is continued from the previous line.

The ⟶◄ symbol indicates the end of a command, directive, or statement.

Fragments, which are diagrams of syntactical units other than complete commands, directives, or statements, start with the |— symbol and end with the —| symbol.

IBM XL Fortran extensions are marked by a number in the syntax diagram with an explanatory note immediately following the diagram.

Program units, procedures, constructs, interface blocks and derived-type definitions consist of several individual statements. For such items, a box encloses the syntax representation, and individual syntax diagrams show the required order for the equivalent Fortran statements.

- Required items are shown on the horizontal line (the main path):

- Optional items are shown below the main path:

Note: Optional items (not in syntax diagrams) are enclosed by square brackets ([and]). For example, `[UNIT=]u`

- If you can choose from two or more items, they are shown vertically, in a stack.

  If you *must* choose one of the items, one item of the stack is shown on the main path.

  If choosing one of the items is optional, the entire stack is shown below the main path.

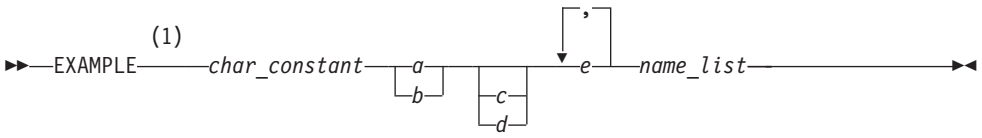
- An arrow returning to the left above the main line (a repeat arrow) indicates that you can make more than one choice from the stacked items or repeat an item. The separator character, if it is other than a blank, is also indicated:

- The item that is the default is shown above the main path.

- Keywords are shown in nonitalic letters and should be entered exactly as shown.
- Variables are shown in italicized lowercase letters. They represent user-supplied names or values. If a variable or user-specified name ends in *_list*, you can provide a list of these terms separated by commas.
- If punctuation marks, parentheses, arithmetic operators, or other such symbols are shown, you must enter them as part of the syntax.

Sample syntax diagram

The following is an example of a syntax diagram with an interpretation:



Notes:

1 IBM extension

Interpret the diagram as follows:

- Enter the keyword EXAMPLE.
- EXAMPLE is an IBM extension.
- Enter a value for *char_constant*.
- Enter a value for *a* or *b*, but not for both.
- Optionally, enter a value for *c* or *d*.
- Enter at least one value for *e*. If you enter more than one value, you must put a comma between each.
- Enter the value of at least one *name* for *name_list*. If you enter more than one value, you must put a comma between each. (The *_list* syntax is equivalent to the previous syntax for *e*.)

How to read syntax statements

Syntax statements are read from left to right:

- Individual required arguments are shown with no special notation.
- When you must make a choice between a set of alternatives, they are enclosed by { and } symbols.
- Optional arguments are enclosed by [and] symbols.
- When you can select from a group of choices, they are separated by | characters.
- Arguments that you can repeat are followed by ellipses (...).

Example of a syntax statement

```
EXAMPLE char_constant {a|b}[c|d]e[,e]... name_list{name_list}...
```

The following list explains the syntax statement:

- Enter the keyword EXAMPLE.
- Enter a value for *char_constant*.
- Enter a value for *a* or *b*, but not for both.

- Optionally, enter a value for *c* or *d*.
- Enter at least one value for *e*. If you enter more than one value, you must put a comma between each.
- Optionally, enter the value of at least one *name* for *name_list*. If you enter more than one value, you must put a comma between each *name*.

Note: The same example is used in both the syntax-statement and syntax-diagram representations.

Examples in this information

The examples in this information, except where otherwise noted, are coded in a simple style that does not try to conserve storage, check for errors, achieve fast performance, or demonstrate all possible methods to achieve a specific result.

The examples for installation information are labelled as either *Example* or *Basic example*. *Basic examples* are intended to document a procedure as it would be performed during a basic, or default, installation; these need little or no modification.

Notes on the terminology used

Some of the terminology in this information is shortened as follows:

- The term *free source form format* often appears as *free source form*.
- The term *fixed source form format* often appears as *fixed source form*.
- The term *XL Fortran* often appears as *XLF*.

Related information

The following sections provide related information for XL Fortran:

IBM XL Fortran information

XL Fortran provides product information in the following formats:

- README files

  README files contain late-breaking information, including changes and corrections to the product information. README files are located by default in the XL Fortran directory and in the root directory of the installation CD.
- Installable man pages

  Man pages are provided for the compiler invocations and all command-line utilities provided with the product. Instructions for installing and accessing the man pages are provided in the *IBM XL Fortran for AIX, V14.1 Installation Guide*.
- Information center

  The information center of searchable HTML files can be launched on a network and accessed remotely or locally. Instructions for installing and accessing the online information center are provided in the *IBM XL Fortran for AIX, V14.1 Installation Guide*.

  The information center is viewable on the web at http://publib.boulder.ibm.com/infocenter/comphelp/v121v141/index.jsp.
- PDF documents

PDF documents are located by default in the /usr/lpp/xlf/doc/*LANG*/pdf/ directory, where *LANG* is one of en_US or ja_JP. The PDF files are also available on the web at http://www.ibm.com/software/awdtools/fortran/xlfortran/aix/library/.

The following files comprise the full set of XL Fortran product information:

Table 3. XL Fortran PDF files

Document title	PDF file name	Description
IBM XL Fortran for AIX, V14.1 Installation Guide, GC14-7335-00	install.pdf	Contains information for installing XL Fortran and configuring your environment for basic compilation and program execution.
Getting Started with IBM XL Fortran for AIX, V14.1, SC14-7334-00	getstart.pdf	Contains an introduction to the XL Fortran product, with information on setting up and configuring your environment, compiling and linking programs, and troubleshooting compilation errors.
IBM XL Fortran for AIX, V14.1 Compiler Reference, SC14-7336-00	compiler.pdf	Contains information about the various compiler options and environment variables.
IBM XL Fortran for AIX, V14.1 Language Reference, SC14-7337-00	langref.pdf	Contains information about the Fortran programming language as supported by IBM, including language extensions for portability and conformance to nonproprietary standards, compiler directives and intrinsic procedures.
IBM XL Fortran for AIX, V14.1 Optimization and Programming Guide, SC14-7338-00	proguide.pdf	Contains information on advanced programming topics, such as application porting, interlanguage calls, floating-point operations, input/output, application optimization and parallelization, and the XL Fortran high-performance libraries.

To read a PDF file, use the Adobe Reader. If you do not have the Adobe Reader, you can download it (subject to license terms) from the Adobe website at http://www.adobe.com.

More information related to XL Fortran including IBM Redbooks® publications, white papers, tutorials, and other articles, is available on the web at:

http://www.ibm.com/software/awdtools/fortran/xlfortran/aix/library/

Standards and specifications

XL Fortran is designed to support the following standards and specifications. You can refer to these standards for precise definitions of some of the features found in this information.

- *American National Standard Programming Language FORTRAN, ANSI X3.9-1978*.
- *American National Standard Programming Language Fortran 90, ANSI X3.198-1992*.
- *ANSI/IEEE Standard for Binary Floating-Point Arithmetic, ANSI/IEEE Std 754-1985*.
- *Federal (USA) Information Processing Standards Publication Fortran, FIPS PUB 69-1*.
- *Information technology - Programming languages - Fortran, ISO/IEC 1539-1:1991 (E)*. (This information uses its informal name, Fortran 90.)
- *Information technology - Programming languages - Fortran - Part 1: Base language, ISO/IEC 1539-1:1997*. (This information uses its informal name, Fortran 95.)

- *Information technology - Programming languages - Fortran - Part 1: Base language, ISO/IEC 1539-1:2004*. (This information uses its informal name, Fortran 2003.)
- *Information technology - Programming languages - Fortran - Part 1: Base language, ISO/IEC 1539-1:2010*. (This information uses its informal name, Fortran 2008.)
- *Military Standard Fortran DOD Supplement to ANSI X3.9-1978, MIL-STD-1753* (United States of America, Department of Defense standard). Note that XL Fortran supports only those extensions documented in this standard that have also been subsequently incorporated into the Fortran 90 standard.
- *OpenMP Application Program Interface Version 3.1*, available at http://www.openmp.org

Other IBM information

- *Parallel Environment for AIX: Operation and Use*
- The IBM Systems Information Center, at http://publib.boulder.ibm.com/infocenter/systems/index.jsp?topic=/com.ibm.aix.doc/doc/base/aixparent.htm is a resource for AIX information.

  You can find the following books for your specific AIX system:
  - *AIX Commands Reference, Volumes 1 - 6*
  - *Technical Reference: Base Operating System and Extensions, Volumes 1 & 2*
  - *AIX National Language Support Guide and Reference*
  - *AIX General Programming Concepts: Writing and Debugging Programs*
  - *AIX Assembler Language Reference*
- *ESSL for AIX V5.1/ESSL for Linux on POWER® V5.1 Guide and Reference* available at the Engineering and Scientific Subroutine Library (ESSL) and Parallel ESSL web page.

Technical support

Additional technical support is available from the XL Fortran Support page at http://www.ibm.com/software/awdtools/fortran/xlfortran/aix/support/. This page provides a portal with search capabilities to a large selection of Technotes and other support information.

If you cannot find what you need, you can send email to compinfo@ca.ibm.com.

For the latest information about XL Fortran, visit the product information site at http://www.ibm.com/software/awdtools/fortran/xlfortran/aix/.

How to send your comments

Your feedback is important in helping to provide accurate and high-quality information. If you have any comments about this information or any other XL Fortran information, send your comments by email to compinfo@ca.ibm.com.

Be sure to include the name of the information, the part number of the information, the version of XL Fortran, and, if applicable, the specific location of the text you are commenting on (for example, a page number or table number).

Chapter 1. Introducing XL Fortran

IBM XL Fortran for AIX, V14.1 is an advanced, high-performance compiler that can be used for developing complex, computationally intensive programs, including interlanguage calls with C and C++ programs.

This section discusses the features of the XL Fortran compiler at a high level. It is intended for people who are evaluating the compiler, and for new users who want to find out more about the product.

Commonality with other IBM compilers

IBM XL Fortran for AIX, V14.1 is part of a larger family of IBM C, C++, and Fortran compilers.

XL Fortran, together with XL C and XL C/C++, comprise the family of XL compilers.

These compilers are derived from a common code base that shares compiler function and optimization technologies for a variety of platforms and programming languages. Programming environments include IBM AIX, IBM Blue Gene®/P, IBM i, selected Linux distributions, IBM z/OS®, and IBM z/VM®. The common code base, along with compliance with international programming language standards, helps support consistent compiler performance and ease of program portability across multiple operating systems and hardware platforms.

Operating system support

This section describes the operating systems that IBM XL Fortran for AIX, V14.1 supports.

IBM XL Fortran for AIX, V14.1 supports the following operating systems:

- AIX
  - AIX V5.3 TL 5300-07 or later
  - AIX V6.1
  - AIX V7.1
- PASE
  - IBM i V6.1 PASE V6.1 with PTF SI30636 or later
  - IBM i V7.1 PASE V7.1

See the README file and "Before installing XL Fortran" in the *XL Fortran Installation Guide* for a complete list of requirements.

The compiler, its libraries, and its generated object programs will run on systems with the required software and disk space.

To exploit the various supported hardware configurations, the compiler provides options to tune the performance of applications specific to the type of hardware that will be used to execute the compiled applications.

A highly configurable compiler

You can use a variety of compiler invocation commands and options to tailor the compiler to your unique compilation requirements.

Compiler invocation commands

XL Fortran provides several different commands that you can use to invoke the compiler, for example, **xlf**, **xlf90**, **xlf95**, **xlf2003**, and **xlf2008**. Each invocation command is unique in that it instructs the compiler to tailor compilation output to meet a specific language level specification. Compiler invocation commands are provided to support all standardized Fortran language levels, and many popular language extensions as well.

The compiler also provides corresponding "**_r**" versions of most invocation commands, for example, **xlf_r**. The "**_r**" invocations instruct the compiler to link and bind object files to thread safe components and libraries, and produce thread safe object code for compiler-created data and procedures.

For more information about XL Fortran compiler invocation commands, see "Compiling XL Fortran programs" in the *XL Fortran Compiler Reference* .

Compiler options

You can choose from a large selection of compiler options to control compiler behavior. Different categories of options help you to debug your applications, optimize and tune application performance, select language levels and extensions for compatibility with non-standard features and behaviors supported by other Fortran compilers, and perform many other common tasks that would otherwise require changing the source code.

XL Fortran lets you specify compiler options through a combination of environment variables, compiler configuration files, command line options, and compiler directive statements embedded in your program source.

For more information about XL Fortran compiler options, see "Summary of compiler options" in the *XL Fortran Compiler Reference*.

Custom compiler configuration files

The installation process creates a default plain text compiler configuration file containing stanzas that define compiler option default settings.

Your compilation needs may frequently involve specifying compiler option settings other than the default settings provided by XL Fortran. If so, you can use makefiles to define your compiler option settings, or alternatively, you can create custom configuration files to define your own sets of frequently used compiler option settings.

For more information about using custom compiler configuration files, see “Using custom compiler configuration files” on page 39.

Utilization tracking configuration file

The utilization and reporting tool can be used to detect whether your organization's use of the compiler exceeds your license entitlements.

The utilization tracking and reporting feature of the compiler has its own configuration file. The main compiler configuration file contains an entry that points to this file. The different installations of the compiler product can use a single utilization tracking configuration file to centrally manage the functionality of the utilization tracking and reporting feature.

For detailed information about the utilization tracking and reporting feature, see "Tracking and reporting compiler usage" in the *XL Fortran Compiler Reference*.

Language standard compliance

This section provides language standard compliance information for IBM XL Fortran for AIX, V14.1.

The compiler supports the following programming language specifications for Fortran:

- ANSI X3.9-1978 (referred to as FORTRAN 77)
- ISO/IEC 1539-1:1991(E) and ANSI X3.198-1992 (referred to as Fortran 90 or F90)
- ISO/IEC 1539-1:1997 (referred to as Fortran 95 or F95)
- ISO/IEC 1539-1:2004 (referred to as Fortran 2003 or F2003)
- Partial support for ISO/IEC 1539-1:2010 (referred to as Fortran 2008 or F2008)

In addition to the standardized language levels, XL Fortran supports language extensions, including:

- OpenMP Application Program Interface V3.1
- Language extensions to support vector programming
- Common Fortran language extensions defined by other compiler vendors, in addition to those defined by IBM
- Industry extensions that are found in Fortran products from various compiler vendors
- Extensions specified in SAA Fortran

See "Language standards" in the *XL Fortran Language Reference* for more information about Fortran language specifications and extensions.

Source-code migration and conformance checking

XL Fortran helps protect your investment in your existing Fortran source code by providing compiler invocation commands that instruct the compiler to inspect your application for conformance to a specific language level and warn you if constructs and keywords are found that do not conform to the specified language level.

You can also use the **-qlanglvl** compiler option to specify a given language level, and the compiler will issue warnings if language elements in your program source do not conform to that language level. Additionally, you can name your source files with common filename extensions such as .f77, .f90, f95, .f03, or .f08, then use the generic compiler invocations such as **xlf** or **xlf_r** to automatically select the appropriate language level appropriate to the filename extension.

You can rebuild your FORTRAN 77, Fortran 90, Fortran 95, Fortran 2003, and Fortran 2008 source code with IBM XL Fortran for AIX, V14.1 and link them all into the same application. Similarly, object code or libraries compiled with previous versions of XL Fortran are still compatible with the newest XL Fortran compiler and runtime environment, except for two cases. See “Compatibility with earlier versions” on page 21 for more information.

See -qlanglvl in the *XL Fortran Compiler Reference* for more information.

Tools, utilities, and commands

This topic introduces the main tools, utilities, and commands that are included with XL Fortran. It does not contain all compiler tools, utilities, and commands.

Tools

Utilization reporting tool

The utilization reporting tool generates a report describing your organization's utilization of the compiler. These reports help determine whether your organization's use of the compiler matches your compiler license entitlements. The **urt** command contains options that can be used to customize the report. For more information, see Tracking and reporting compiler usage in the *XL Fortran Compiler Reference*.

Utilities

CreateExportList utility

The **CreateExportList** utility creates a file that contains a list of all the global symbols found in a given set of object files. For more information, see Exporting symbols with the CreateExportList utility in the *XL Fortran Compiler Reference*.

Commands

genhtml command

The **genhtml** command converts an existing XML diagnostic report produced by the **-qlistfmt** option. You can choose to produce XML or HTML diagnostic reports by using the **-qlistfmt** option. The report can help with finding optimization opportunities. For more information about how to use this command, see **genhtml** command in the *XL Fortran Compiler Reference*.

Profile-directed feedback (PDF) related commands

cleanpdf command

The **cleanpdf** command removes all profiling information from the directory to which profile-directed feedback data is written.

mergepdf command

The **mergepdf** command provides the ability to weigh the importance of two or more PDF records when combining them into a single record. The PDF records must be derived from the same executable.

resetpdf command

The current behavior of the cleanpdf command is the same as the **resetpdf** command, and is retained for compatibility with earlier releases on other platforms.

showpdf command

The **showpdf** command displays the following types of profiling information for all the procedures executed in a PDF run (compilation under the **-qpdf1** option):

- Block-counter profiling
- Call-counter profiling
- Value profiling

- Cache-miss profiling, if you specified the **-qpdf1=level=2** option during the **-qpdf1** phase.

You can view the first two types of profiling information in either text or XML format. However, you can view value profiling and cache-miss profiling information only in XML format.

For more information, see -qpdf1, -qpdf2 in the *XL Fortran Compiler Reference*.

xlfndi The **xlfndi** script installs XL Fortran to a non-default directory location. For more information, see Updating an advanced installation using **xlfndi** in the *XL Fortran Installation Guide*.

Program optimization

XL Fortran provides several compiler options that can help you control the optimization and performance of your programs.

With these options, you can perform the following tasks:

- Select different levels of compiler optimizations.
- Control optimizations for loops, floating point, and other types of operations.
- Optimize a program for a particular class of machines or for a very specific machine configuration, depending on where the program will run.

Optimizing transformations can give your application better overall execution performance. XL Fortran provides a portfolio of optimizing transformations tailored to various supported hardware. These transformations offer the following benefits:

- Reducing the number of instructions executed for critical operations
- Restructuring generated object code to make optimal use of the Power Architecture®
- Improving the usage of the memory subsystem
- Exploiting the ability of the architecture to handle large amounts of shared memory parallelization

For more information, see these related topics:

- "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*
- "Optimizing and tuning options" in the *XL Fortran Compiler Reference*

64-bit object capability

The XL Fortran compiler's 64-bit object capability addresses increasing demand for larger storage requirements and greater processing power.

The AIX operating system provides an environment that allows you to develop and execute programs that exploit 64-bit processors through the use of 64-bit address spaces.

To support larger executables that can be fit within a 64-bit address space, a separate 64-bit object format is used. The binder binds these objects to create 64-bit executables. Objects that are bound together must all be of the same object format. The following scenarios are not permitted and will fail to load, execute, or both:

- A 64-bit object or executable that has references to symbols from a 32-bit library or shared library
- A 32-bit object or executable that has references to symbols from a 64-bit library or shared library
- A 64-bit executable that explicitly attempts to load a 32-bit module
- A 32-bit executable that explicitly attempts to load a 64-bit module
- Attempts to run 64-bit applications on 32-bit platforms

On both 64-bit and 32-bit platforms, 32-bit executables will continue to run as they currently do on a 32-bit platform.

XL Fortran supports 64-bit mode mainly through the use of the **-q64** and **-qarch** compiler options. This combination determines the bit mode and instruction set for the target architecture.

For more information, see "Using XL Fortran in a 64-bit environment" in the *XL Fortran Compiler Reference*.

Shared memory parallelization

XL Fortran supports application development for multiprocessor system architectures.

You can use any of the following methods to develop your parallelized applications with XL Fortran:

- Directive-based shared memory parallelization (OpenMP, SMP)
- Instructing the compiler to automatically generate shared memory parallelization
- Message passing based shared or distributed memory parallelization (MPI)
- POSIX threads (Pthreads) parallelization
- Low-level UNIX parallelization using `fork()` and `exec()`

The parallel programming facilities of the AIX operating system are based on the concept of threads. Parallel programming exploits the advantages of multiprocessor systems, while maintaining a full binary compatibility with existing uniprocessor systems. This means that a multithreaded program that works on a uniprocessor system can take advantage of a multiprocessor system without recompiling.

For more information, see "Parallel programming with XL Fortran" in the *XL Fortran Optimization and Programming Guide*.

OpenMP directives

OpenMP directives are a set of API-based commands supported by XL Fortran and many other IBM and non-IBM C, C++, and Fortran compilers.

You can use OpenMP directives to instruct the compiler how to parallelize a particular loop. The existence of the directives in the source removes the need for the compiler to perform any parallel analysis on the parallel code. OpenMP directives require the presence of Pthread libraries to provide the necessary infrastructure for parallelization.

OpenMP directives address three important issues of parallelizing an application:

1. Clauses and directives are available for scoping variables. Frequently, variables should not be shared; that is, each processor should have its own copy of the variable.
2. Work sharing directives specify how the work contained in a parallel region of code should be distributed across the processors.
3. Directives are available to control synchronization between the processors.

As of XL Fortran for AIX, V14.1, XL Fortran supports all features of the OpenMP API Version 3.1 specification. See “OpenMP 3.1” on page 12 for an overview of the support provided by this feature.

For more information about program performance optimization, see:

- "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*
- www.openmp.org

Diagnostic listings

The compiler output listings and the XML or HTML reports provide important information to help you develop and debug your applications more efficiently.

Listing information is organized into optional sections that you can include or omit. For more information about the applicable compiler options and the listing itself, see "Understanding XL Fortran compiler listings" in the *XL Fortran Compiler Reference*.

It is also possible to get information from the compiler in XML or HTML format about some of the optimizations that the compiler was able to perform and also which optimization opportunities were missed. This information can be used to reduce programming effort when tuning applications, especially high-performance applications. The report is defined by an XML schema and is easily consumable by tools that you can create to read and analyze the results. For detailed information about this report and how to use it, see "Using reports to diagnose optimization opportunities" in the *XL Fortran Optimization and Programming Guide*.

Symbolic debugger support

You can instruct XL Fortran to include debugging information in your compiled objects by using the -g compiler option.

The debugging information can be examined by **dbx** or any other symbolic debugger that supports the AIX XCOFF executable format to help you debug your programs.

Chapter 2. What's new for IBM XL Fortran for AIX, V14.1

This section describes features and enhancements added to the compiler in IBM XL Fortran for AIX, V14.1.

Fortran 2008 features

XL Fortran implements selected features of the Fortran 2008 standard.

This version of XL Fortran provides support for the following Fortran 2008 features:

- **ALLOCATE** enhancements
- Complex part designators
- Implied-shape arrays
- Internal procedures as actual arguments or procedure pointer targets
- Intrinsic types in the **TYPE()** type specifier
- Pointer dummy argument enhancement
- The declaration of multiple type-bound procedures in a single procedure statement
- The **-qxlf2008=checkpresence** suboption
- The **BLOCK** construct
- The **CONTIGUOUS** attribute and **IS_CONTIGUOUS** intrinsic function
- The **END** statement for internal and module subprograms
- The **EXIT** statement
- The **EXECUTE_COMMAND_LINE** intrinsic subroutine
- The **HYPOT** intrinsic procedure
- The **ISO_FORTRAN_ENV** intrinsic module
- The **LEADZ** and **TRAILZ** intrinsic procedures
- The math intrinsic procedures extension
- The **NEWUNIT=** specifier
- The **POPCNT** and **POPPAR** inquiry intrinsic functions
- The **RADIX=** argument
- The **STOP** and **ERROR STOP** statements

ALLOCATE enhancements

The **MOLD=** specifier has been added to the **ALLOCATE** statement. In addition, you can omit the bounds in the **ALLOCATE** statement if you provide *source_expr* in the **SOURCE=** or **MOLD=** specifier.

Complex part designators

Complex part designators have been added in Fortran 2008. Using complex part designators, you can directly access the real or imaginary part of complex entities. You can use the designators instead of the REAL() and IMAG() intrinsics.

Implied-shape arrays

Implied-shape arrays have been added in Fortran 2008. An implied-shape array inherits its shape from the constant expression in its declaration.

Internal procedures as actual arguments or procedure pointer targets

To conform with the Fortran 2008 standard, procedure pointers can now point to internal procedures. In addition, you can use internal procedures and pointers to internal procedures as actual arguments.

Intrinsic types in the TYPE() type specifier

The **TYPE()** type specifier has been extended to declare entities of both derived type and intrinsic type.

Pointer dummy argument enhancement

In Fortran 2008, a dummy argument that has the POINTER and INTENT(IN) attributes can be argument associated with a nonpointer actual argument that has the TARGET attribute.

The declaration of multiple type-bound procedures in a single procedure statement

In Fortran 2008, you can declare multiple type-bound procedures using one type-bound procedure statement.

The -qxlf2008=checkpresence suboption

The **-qxlf2008=checkpresence** suboption has been introduced to check the allocation status or pointer association status of actual arguments during argument association of optional dummy arguments.

The BLOCK construct

The **BLOCK** construct has been added in Fortran 2008. It defines an executable block that can contain declarations.

The CONTIGUOUS attribute and IS_CONTIGUOUS intrinsic function

The **CONTIGUOUS** attribute specifies that the array elements in an array pointer or an assumed-shape array are not separated by other data objects, which guarantees that the array object is stored in contiguous memory.

The **IS_CONTIGUOUS** intrinsic function is used to test whether an array is stored in contiguous memory.

The END statement for internal and module subprograms

In Fortran 2008, you can omit the **FUNCTION** and **SUBROUTINE** keywords on the **END** statements for internal and module subprograms.

The EXECUTE_COMMAND_LINE intrinsic subroutine

The **EXECUTE_COMMAND_LINE** subroutine has been added in Fortran 2008. You can use it to pass a command to the operating system for execution.

The EXIT statement

The **EXIT** statement can now be used to terminate execution of one of the following constructs:

- ASSOCIATE
- BLOCK
- DO
- IF
- SELECT CASE
- SELECT TYPE

The HYPOT intrinsic procedure

The **HYPOT** intrinsic procedure is introduced to calculate the Euclidean distance between two values.

The ISO_FORTRAN_ENV intrinsic module

The following constants are added:

- **CHARACTER_KINDS**
- **INT8**, **INT16**, **INT32**, and **INT64**
- **INTEGER_KINDS**
- **IOSTAT_INQUIRE_INTERNAL_UNIT**
- **LOGICAL_KINDS**
- **REAL32**, **REAL64**, and **REAL128**
- **REAL_KINDS**

The following functions are added:

- **COMPILER_OPTIONS**
- **COMPILER_VERSION**

The LEADZ and TRAILZ intrinsic procedures

The **LEADZ** and **TRAILZ** intrinsic procedures are introduced to count the number of leading and trailing zeros in an integer.

The math intrinsic procedures extension

The following new intrinsic procedures have been introduced:

- **ACOSH**
- **ASINH**
- **ATANH**
- **ERFC_SCALED**
- **LOG_GAMMA**

Notes:

1. The **LOG_GAMMA** intrinsic procedure is the Fortran 2008 standard compliant alias of the **LGAMMA** intrinsic procedure.
2. The **ERF**, **ERFC**, and **GAMMA** intrinsic procedures are now Fortran 2008 standard compliant.

Complex arguments are now supported in the following intrinsic procedures:

- **ACOS**
- **ASIN**
- **ATAN**
- **COSH**
- **SINH**
- **TAN**
- **TANH**

Note: The **ATAN** intrinsic procedure can now optionally take two arguments, **ATAN(Y, X)**, and have the same results as the **ATAN2** intrinsic procedure.

The NEWUNIT= specifier

The **OPEN** statement has been updated with the **NEWUNIT=** specifier to specify the unit number automatically. In the **BACKSPACE**, **CLOSE**, **ENDFILE**, **FLUSH**, **INQUIRE**, **OPEN**, **READ**, **REWIND**, and **WRITE** statements, the range of unit values now includes the NEWUNIT value.

The POPCNT and POPPAR inquiry intrinsic functions

The **POPCNT** and **POPPAR** functions have been updated to conform with the Fortran 2008 standard. They can be used in constant expressions now.

The RADIX= argument

A **RADIX=** argument has been added to the **SELECTED_REAL_KIND** and **IEEE_SELECTED_REAL_KIND** intrinsic procedures.

The STOP and ERROR STOP statements

The **STOP** statement has been enhanced to take an integer or character constant expression as stop code. The **STOP** statement initiates normal termination of a program while the **ERROR STOP** statement initiates error termination.

OpenMP 3.1

IBM XL Fortran for AIX, V14.1 supports the OpenMP Application Program Interface Version 3.1 specification. The XL Fortran implementation is based on IBM's interpretation of the OpenMP Application Program Interface Version 3.1.

OpenMP 3.1 includes the following updates to OpenMP 3.0:

- Adds `FINAL` and `MERGEABLE` clauses to the `TASK` construct to support optimization.
- Adds the `TASKYIELD` construct to allow users to specify where in the program can perform task switching.
- Adds the `omp_in_final` runtime library routine to support specialization of final task regions.

- Extends the ATOMIC construct to include READ, WRITE, and CAPTURE forms; adds the UPDATE clause to apply the existing form of the ATOMIC construct.
- Allows dummy arguments with the INTENT(IN) attribute to be specified on the FIRSTPRIVATE clause.
- Allows unallocated allocatable arrays to be specified on the COPYIN clause.
- Allows Fortran 90 Pointers to be specified on the FIRSTPRIVATE clause.
- Adds the OMP_PROC_BIND environment variable to control whether OpenMP threads are allowed to move between processors.
- Extends the OMP_NUM_THREADS environment variable to specify the number of threads to use for nested parallel regions.

Related information

- "Parallel programming with XL Fortran" in the *XL Fortran Optimization and Programming Guide*
- www.openmp.org

Performance and optimization

Additional features and enhancements assist with performance tuning and application optimization.

Reports about compiler optimizations

There are a number of enhancements to the listing reports to give you more information about how the compiler optimized your code. You can use this information to get further benefits from the optimization capabilities of the compiler. For more details about these enhanced reports, see “New diagnostic reports.”

For additional information about performance tuning and program optimization, see "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*.

New diagnostic reports

The new diagnostic reports can help you identify opportunities to improve the performance of your code.

Compiler reports in HTML format

It is now possible to get information in XML or HTML format about the optimizations that the compiler was able to perform and also which optimization opportunities were missed. This information can be used to reduce programming effort for tuning applications, especially high-performance applications.

The **-qlistfmt** option and its associated suboptions can be used to generate the XML or HTML report. By default, this option now generates all the available content if you do not specify the type of content.

To view the HTML version of an XML report that has been already generated, you can now use the **genhtml** tool. For more information about how to use this tool, see **genhtml** command in the *XL Fortran Compiler Reference*.

For detailed information about this report and how to use it, see "Using reports to diagnose optimization opportunities" in the *XL Fortran Optimization and Programming Guide*.

Enhancements to profiling reports

New sections have been added to your listing file to help you analyze your programs. When using the **-qreport** option with the **-qpdf2** option, you can get the following sections added to the listing file in the section entitled `PDF Report`:

Relevance of profiling data
: This section shows the relevance of the profiling data to the source code during the **-qpdf1** phase. The relevance is indicated by a number in the range of 0 - 100. The larger the number is, the more relevant the profiling data is to the source code, and the more performance gain can be achieved by using the profiling data.

Missing profiling data
: This section might include a warning message about missing profiling data. The warning message is issued for each function for which the compiler does not find profiling data.

Outdated profiling data
: This section might include a warning message about outdated profiling data. The compiler issues this warning message for each function that is modified after the **-qpdf1** phase. The warning message is also issued when the optimization level changes from the **-qpdf1** phase to the **-qpdf2** phase.

For detailed information about profile-directed feedback, see "Profile-directed feedback" in the *XL Fortran Optimization and Programming Guide*.

For additional information about the listing files, see "Understanding XL Fortran compiler listings" in the *XL Fortran Compiler Reference*.

Enhancements to showpdf reports

In addition to block-counter and call-counter profiling information currently provided, you can also use the **showpdf** utility to view cache-miss profiling and value profiling information. Value profiling and cache-miss profiling information can be displayed only in XML format. However, all the other types of profiling information can be displayed in either text or XML format. In this release, the profile-directed feedback (PDF) information is saved in two files. One is a PDF map file that is generated during the **-qpdf1** phase, and the other is a PDF file that is generated during the execution of the resulting application. You can run the **showpdf** utility to display the PDF information contained in these two files. For more information, see "Viewing profiling information with showpdf" in the *XL Fortran Optimization and Programming Guide*.

New and enhanced diagnostic options

The entries in the following table describe new or changed compiler options and directives that give you control over compiler listings.

The information presented here is a brief overview. For detailed information about these and other performance-related compiler options, see "Listings, messages and compiler information" in the *XL Fortran Compiler Reference*.

Table 4. Listings-related compiler options and directives

Option/directive	Description
-qlistfmt	The **-qlistfmt** option has been enhanced to generate HTML reports as well as XML reports, containing information about optimizations performed by the compiler and missed optimization opportunities. The default behavior of this option has changed. Now, if you do not specify a particular type of content, the option generates all the available content, rather than generating none.

New or changed compiler options and directives

This section describes new or changed compiler options and directives.

You can specify compiler options on the command line. You can also modify compiler behavior through directives embedded in your application source files. See the *XL Fortran Compiler Reference* for detailed descriptions and usage information for these and other compiler options.

New or changed compiler options

-g, -qdbg
: The **-g** or **-qdbg** option is extended to have new levels to improve the debugging of optimized programs.

-qassert
: **-qassert=minitercnt=***n* and **-qassert=maxitercnt=***n* are added to specify the expected minimum and maximum iteration counts of the loops in the program.

-qfunctrace
: The **-qfunctrace** option is extended to allow you to specify module procedures and module names.

-qhaltonmsg
: Stops compilation before producing any object files, executable files, or assembler source files if a specified error message is generated.

-qinitalloc
: The new option **-qinitalloc** is added to initialize allocatable and pointer variables that are allocated but not initialized.

-qlanglvl
: The following suboptions are added or updated:

  -qlanglvl=2008std
  -qlanglvl=2008pure
  : These two new suboptions are added to enable language level checking for supported Fortran 2008 features.

-qlistfmt
: The **-qlistfmt** option is enhanced to generate HTML reports as well as XML reports, containing information about optimizations performed by the compiler and missed optimization opportunities.

  The default behavior of **-qlistfmt** has changed. In this release, if you do not specify a particular type of content, the option generates all the available content, rather than generating none.

-qmaxerr

-qmaxerr stops compilation when the number of error messages of a specified severity level or higher reaches a specified number.

-qoptfile

The new option **-qoptfile** specifies a file containing a list of additional command line options to be used for the compilation.

-qpic **-qpic=large** now enables large TOC access and prevents TOC overflow conditions when the Table of Contents is larger than 64 Kb.

-qshowpdf

The default value is changed from **-qnoshowpdf** to **-qshowpdf**.

-qxlf2008

The new suboption **-qxlf2008=checkpresence** is added so that you can check dummy argument presence according to the Fortran 2008 standard.

-qxlf2003

The new suboption **-qxlf2003=dynamicacval** is added to control whether you can use unlimited polymorphic entities for array constructors, and whether dynamic types of array constructor values are used.

New or changed directives

ALIGN

Using the ALIGN directive, you can specify the alignment for your variables in memory.

ASSERT

You can use assertions **MINITERCNT***(n)* and **MAXITERCNT***(n)* to specify the minimum and maximum number of iterations for a given loop.

Chapter 3. Migrating from earlier versions

By migrating to the latest version of the compiler, you are able to take advantage of the new features of the compiler, including features to help boost the performance of the applications being compiled.

A later version of the compiler includes new and enhanced features. These features can provide the following benefits:

- Improved optimization of compiled applications with additional performance benefits
- Support for new language standards to facilitate code portability between multiple operating systems and hardware platforms
- Exploitation of the latest functionality in new hardware and operating systems

Migrating to the latest version of the compiler gives you the ability to exploit the new features with benefits of increased performance optimization, support of new language specifications, and exploitation of new hardware and software environments.

For detailed information about the new features in the current release, see Chapter 2, “What's new for IBM XL Fortran for AIX, V14.1,” on page 9. The white paper *Upgrading XL Fortran Compilers* at http://www.ibm.com/support/docview.wss?uid=swg27022098 also provides additional information for compiler migration.

In general, a new version of the compiler is compatible with its earlier versions. However, there could be exceptions. For example, different diagnostic messages could be generated. Always back up your source code and other important data before migrating the compiler.

The following sections list the enhancements added to the compiler in earlier versions, which can assist you in migrating to a later version of the compiler.

Upgrading to XL Fortran V14.1

This section provides information about upgrading to XL Fortran V14.1.

The XL Fortran compiler helps you to port or to migrate source code among Fortran compilers by providing full Fortran 90, Fortran 95, Fortran 2003, and partial Fortran 2008 language support, and selected language extensions (including intrinsic functions and data types) from many different compiler vendors. Throughout this document, we refer to these extensions as “industry extensions”.

To protect your investment in FORTRAN 77 source code, you can easily invoke the compiler with a set of defaults that provide compatibility with earlier versions of XL Fortran. The **f77**, **fort77**, **xlf**, **xlf_r**, and **xlf_r7** commands provide maximum compatibility with existing FORTRAN 77 programs. The default options provided with the **f90**, **xlf90**, **xlf90_r**, and **xlf90_r7** commands give access to the full range of Fortran 90 language features. The default options provided with the **f95**, **xlf95**, **xlf95_r**, and **xlf95_r7** commands give access to the full range of Fortran 95 language features. The default options provided with the **f2003**, **xlf2003**, and **xlf2003_r** commands give access to the full range of Fortran 2003 language

features. The default options provided with the **f2008**, **xlf2008**, and **xlf2008_r** commands give access to the Fortran 2008 language features supported in this release.

Additionally, you can name your source files with extensions such as **.f77**, **.f90**, **.f95**, **.f03**, or **.f08** and use the generic compiler invocations such as **xlf** or **xlf_r** to automatically select language-level appropriate defaults.

To protect your investments in FORTRAN 77 object code, you can link Fortran 90 and Fortran 95 programs with existing FORTRAN 77 object modules and libraries. See "Linking new objects with existing ones" on page 47 for details.

More advice is provided in the following sections to help make the transition from an earlier version of the XL Fortran compiler as fast and simple as possible.

Related information

- Chapter 2, "What's new for IBM XL Fortran for AIX, V14.1," on page 9

Things to note in the latest release of XL Fortran

Because XL Fortran V14.1 is highly compatible with XL Fortran Versions 13 through 3 inclusive, most of the advice in this section applies to upgrades from Version 2, or earlier levels of XL Fortran.

- The **xlf90**, **xlf90_r**, **xlf90_r7**, and **f90** commands provide Fortran 90 conformance. The **xlf95**, **xlf95_r**, **xlf95_r7**, and **f95** commands provide Fortran 95 conformance. The **xlf2003**, **xlf2003_r**, and **f2003** commands provide Fortran 2003 conformance. The **xlf2008**, **xlf2008_r**, and **f2008** commands provide partial Fortran 2008 conformance. However, these commands may cause some problems with existing FORTRAN 77 programs. The **xlf**, **xlf_r**, **xlf_r7**, **f77**, and **fort77** commands avoid some of these problems by keeping the old behavior wherever possible.
- Fortran 90 introduced the idea of kind parameters for types. Except for the types complex and character, XL Fortran uses numeric kind parameters that correspond to the lengths of the types. For the type complex, the kind parameter is equal to the length of the real portion, which is half of the overall length. For the type character, the kind parameter is equal to the number of bytes that are required to represent each character, and this value is **1**. A FORTRAN 77 declaration that is written using the * extension for length specifiers can now be rewritten with a kind parameter:

  ```
  INTEGER*4  X   ! F77 notation with extension.
  INTEGER(4) X   ! F90 standard notation.
  COMPLEX*8  Y   ! *n becomes (n) for all types except
  COMPLEX(4) Y   ! COMPLEX, where the value is halved.
  ```

  This new form is the one we use consistently throughout the XL Fortran manuals.

  Because the values of kind parameters may be different for different compilers, you may want to use named constants, placed in an include file or a module, to represent the kind parameters used in your programs. The **SELECTED_CHAR_KIND**, **SELECTED_INT_KIND** and **SELECTED_REAL_KIND** intrinsic functions also let you determine kind values in a portable way.
- Fortran 90 introduced a standardized free source form for source code, which is different from the XL Fortran Version 2 free source form. The **-qfree** and **-k** options now use the Fortran 90 free source form; the Version 2 free source form is available through the option **-qfree=ibm**.

- The library that provides Fortran 90, Fortran 95, Fortran 2003, and partial Fortran 2008 support is **libxlf90.a**, located in /usr/lib. A **libxlf.a** library of stub routines is provided in /usr/lib, but it is only used for linking existing Version 1 or 2 object files or running existing executables. When a Version 1 or Version 2 object file calls entry points in **libxlf.a**, those entry points then call equivalent entry points in **libxlf90.a**. If you recompile such object files, the result could be improved I/O performance, because the entry points in **libxlf90.a** are called directly.

Avoiding or fixing upgrade problems

Although XL Fortran is generally compatible with FORTRAN 77 programs, there are some changes in XL Fortran and the Fortran 90, Fortran 95, Fortran 2003, and Fortran 2008 languages that you should be aware of.

To preserve the behavior of existing compilation environments, the **xlf** and **f77** commands both work as they did in earlier XL Fortran versions wherever possible. As you write entirely new Fortran 90, Fortran 95, Fortran 2003, or Fortran 2008 programs or adapt old programs to avoid potential problems, you can begin using the **xlf90**, **xlf95**, **xlf2003**, and **xlf2008** commands, which use Fortran 90, Fortran 95, Fortran 2003, and Fortran 2008 conventions for source-code format.

Note that in the following table, you can substitute **xlf_r** or **xlf_r7** for **xlf**, **xlf90_r** or **xlf90_r7** for **xlf90**, **xlf95_r** or **xlf95_r7** for **xlf95**, **xlf2003_r** for **xlf2003**, and **xlf2008_r** for **xlf2008**.

Table 5. Potential problems migrating programs to XL Fortran V14.1. The column on the right shows which problems you can avoid by using the **xlf** or **f77** command.

Potential Problem	Solution or Workaround	xlf Avoids?
Compilation Problems		
New intrinsic procedure names may conflict with external procedure names. The intrinsic procedure is called instead of the external procedure.	Use the **-qextern** option, or insert **EXTERNAL** statements to avoid the ambiguity. Consider switching to the Fortran 90 or Fortran 95 procedure if it does what you want.	
The **.XOR.** intrinsic operator is not recognized.	Use the option **-qxlf77=intxor**.	✔
Zero-sized objects are not allowed by the compiler.	Use the **xlf90** or **xlf95** command, or use the **-qzerosize** option with the **xlf** or **f77** command.	
Performance / Optimization Problems		
Existing programs or programs linked with older XL Fortran object files run more slowly or do not show expected performance improvements on new hardware.	Recompile everything.	
Programs compiled with **-O3** or **-qhot** optimization behave differently from those unoptimized (different results, exceptions, or compilation messages).	Try adding the **-qstrict** option.	

Table 5. Potential problems migrating programs to XL Fortran V14.1 (continued). The column on the right shows which problems you can avoid by using the **xlf** or **f77** command.

Potential Problem	Solution or Workaround	xlf Avoids?
The option combination **-O** and **-1** cannot be abbreviated to **-O1**, to avoid misunderstandings. (There are **-O2**, **-O3**, **-O4**, and **-O5** optimization levels, but there is no **-O1**.)	Specify **-O** and **-1** as separate options.	
Programs that use integer **POINTER**s produce incorrect results when optimized.	Specify the option **-qalias=intptr** with the **xlf90** or **xlf95** command, or use the **xlf** command.	✔
Runtime problems		
Programs that read to the end of the file and then try to append records without first executing a **BACKSPACE** statement do not work correctly. The write requests generate error messages.	To compile existing programs, specify the option **-qxlf77=softeof** with the **xlf90** or **xlf95** command, or use the **xlf** command. For new programs, add the **BACKSPACE** statement before writing past the endfile record.	✔
Uninitialized variables are not necessarily set to zero, and programs that ran before may exceed the user stack limit. The reason is that the default storage class is now **AUTOMATIC**, rather than **STATIC** (an implementation choice allowed by the language).	Ensure that you explicitly initialize your variables, use the **-qsave** option with the **xlf90** or **xlf95** command, or add **SAVE** statements where needed in the source.	✔
Writing data to some files opened without a **POSITION=** specifier overwrites the files, instead of appending the data.	Use the option **-qposition=appendold**, or add POSITION= specifiers where needed.	✔
Newly compiled programs are unable to read existing data files containing **NAMELIST** data. The reason is that the Fortran 90 and Fortran 95 standards define a namelist format that is different from that used on AIX in the past.	Set the environment variable **XLFRTEOPTS** to the string **namelist=old**. The programs that produced the old **NAMELIST** data must be recompiled.	
Some I/O statements and edit descriptors accept or produce slightly different input and output. For example, real output now has a leading zero when appropriate. The changes to I/O formats are intended to be more usable and typical of industry practice, so you should try to use the defaults for any new data you produce.	When you need to maintain compatibility with existing data files, compile with the **xlf** command. If the incompatibility is due to a single specific I/O change, see if the **-qxlf77** option has a suboption for compatibility with earlier versions. If so, you can switch to the **xlf90** or **xlf95** command and use the **-qxlf77** option on programs that use the old data files.	✔

Table 5. Potential problems migrating programs to XL Fortran V14.1 (continued). The column on the right shows which problems you can avoid by using the **xlf** or **f77** command.

Potential Problem	Solution or Workaround	xlf Avoids?
Numeric results and I/O output are not always exactly identical with XL Fortran Version 2. Certain implementation details of I/O, such as spacing in list-directed output and the meanings of some **IOSTAT** values, have changed since XL Fortran Version 2. (This entry is similar to the previous one except that these differences are not compatible with earlier versions.)	You may need to generate existing data files again or to change any programs that depend on these details. When compatibility with earlier versions is not provided by the **-qxlf77** compiler option or **XLFRTEOPTS** runtime options, there is no way to get the old behavior back.	
SIGN(A,B) now returns **-|A|** when **B = -0.0**. Prior to XL Fortran Version 7.1, it returned **|A|**.	This behavior conforms with the Fortran 95 standard and is consistent with the IEEE standard for binary floating-point arithmetic. It occurs because the **-qxlf90=signedzero** option is turned on. Turn it off, or specify a command that does not use this option by default.	✓
A minus sign is printed for a negative zero in formatted output. A minus sign is printed for negative values that have an outputted form of zero (that is, in the case where trailing non-zero digits are truncated from the output so that the resulting output looks like zero). Prior to XL Fortran Version 7.1, minus signs were not printed in these situations.	This behavior conforms with the Fortran 95 standard and occurs because the **-qxlf90=signedzero** option is turned on. Turn it off, or specify a command that does not use this option by default.	✓
The handling of IEEE infinity and not-a-number (NaN) exceptional values has changed. By default, XL Fortran displays IEEE infinity and NaN exceptional values based on the command used to compile the source code. This can result in a mixture of IEEE exceptional value outputs if there are multiple object files that were compiled with different options.	XL Fortran allows control over the display of IEEE infinity and NaN exceptional values. To get the previous behavior, set the **XLFRTEOPTS** environment variable to the **naninfoutput=old** string.	✓

Compatibility with earlier versions

This section describes issues about compatibility with earlier versions and their workarounds.

OpenMP threadprivate data compatibility issue between V13.1 and its earlier versions

Starting from XL Fortran V13.1, the implementation of the threadprivate data, that is, OpenMP threadprivate variable, has been improved. The operating system thread local storage is used instead of the runtime implementation. The new implementation might improve performance on some applications.

If you plan to mix the object files `.o` that you have compiled with levels prior to 13.1 with the object files that you compiled with XL Fortran, and the same OpenMP threadprivate variables are referenced in both old and new object files, different implementations might cause incompatibility issues. A link error, a compile time error or other undefined behaviors might occur. To support compatibility with earlier versions, you can use the **-qsmp=noostls** suboption to switch back to the old implementation. You can recompile the entire program with the default suboption **-qsmp=ostls** to get the benefit of the new implementation.

If you are not sure whether the object files you have compiled with levels prior to XL Fortran contain any old implementation, you can use the **nm** command to determine whether you need to use the **-qsmp=noostls** suboption. The following code is an example that shows how to use the **nm** command:

```
> nm oldfiles.o
...
._xlGetThStorageBlock U           -
._xlGetThValue        U           -
...
```

In the preceding example, if `_xlGetThStorageBlock` or `_xlGetThValue` is found, this means the object files contain old implementation. In this case, you must use **-qsmp=noostls**; otherwise, use the default suboption **-qsmp=ostls**.

Binary compatibility issue between V11.1 or V12.1 and its later releases

Because of a change to the signature of a compiler-generated routine, mixing code compiled with XL Fortran V11.1 or V12.1 with code containing parameterized derived types compiled with the latest compiler may require recompiling all the source files. Otherwise, a runtime error will occur if the older code uses certain polymorphic references that can resolve to parameterized derived type objects where a length parameter is involved.

For example, the new application extends a derived type whose declaration was compiled using either XL Fortran V11.1 or XL Fortran V12.1, and the extending type has length derived type parameters, and the new application passes an object that has a dynamic type of the extending type through polymorphism via argument association or function reference to a procedure compiled using XL Fortran V11.1 or XL Fortran V12.1 compiler version.

XL Fortran runtime detects the above issue and halts the execution with the following error message:

```
XL Fortran detected a mismatch in a compiler-generated routine. If your
code contains compilation units compiled with XL Fortran V11.1 or V12.1,
recompile them with the latest XL Fortran compiler.
```

Example of argument association:

```
11.1/12.1
module m
   type base
     integer i
   end type

contains

  subroutine sub(arg)
    class(base) :: arg
    class(base), allocatable :: local

    allocate(local, source=arg)
  end subroutine
end module
```

```
13.1 or later
  use m

  type, extends(base) :: child (l)
    integer, len :: l
    integer :: m(l)
    integer :: n(l)
  end type

  class(base), allocatable :: b1
  allocate(child(5) :: b1)
  call sub(b1)
end
```

The problem is the ALLOCATE statement in 11.1/12.1 code is calling a compiler-generated routine that is compiled using newer releases of XL Fortran compiler other than XL Fortran V11.1 or XL Fortran V12.1 through type bound procedure call. Since the signature of the compiler-generated routine is different between 11.1/12.1 releases and newer releases, module m needs to be recompiled using newer releases of XL Fortran compiler.

Example of function call:

```
11.1/12.1
module m
  type base
    integer i
  contains
    procedure :: bar => bar_base
  end type
  type container
   class(base), allocatable :: b1
  end type
contains
  subroutine bar_base(a)
    class(base) a
    print *, "base"
  end subroutine
end module

program main
  use m
  interface
    function foo()
      import
      type(container) :: foo
    end function
  end interface
  type(container) :: c1
  c1 = foo()
  call c1%b1%bar
end program
```

```
13.1 or later
module n
  use m
  type, extends(base) :: child(l)
    integer, len :: l
    integer a(l)
  contains
    procedure :: bar => bar_child
  end type
contains
  subroutine bar_child(a)
    class(child(*)) a
    print *, "child"
    print *, a%a
  end subroutine
end module

function foo()
  use n
  type(container) :: foo
  allocate(child(6) :: foo%b1)
end function
```

The problem is c1 = foo() in program main is calling a compiler-generated routine that is compiled using newer releases of XL Fortran compiler other than V11.1 or V12.1 through type bound procedure call via function foo. Since the signature of the compiler-generated routine is different between 11.1/12.1 releases and newer releases, program main needs to be recompiled using newer releases of XL Fortran compiler.

Enhancements added in Version 13.1

This section describes features and enhancements added to the compiler in Version 13.1.

Operating system support

This section provides information about the operating systems supported in this release.

XL Fortran V13.1 supports the following operating systems:

- AIX V5.3 TL 5300-07 or later
- AIX 6.1
- IBM i V6.1 PASE V6.1 with PTF SI30636 or later

Note: For operating systems supported by earlier versions of the compilers, see AIX OS levels supported by XL Compilers.

Support for POWER7 processors

XL Fortran for AIX, V13.1 supports POWER7® processors.

The new features and enhancements introduced in support for the POWER7 processors, fall under the following four categories:

- Vector scalar extension data types and intrinsic procedures
- MASS libraries for POWER7 processors
- Hardware directives and intrinsics for POWER7 processors
- Compiler options for POWER7 processors

Vector scalar extension data types and intrinsic procedures

This release of the compiler supports the Vector Scalar eXtension (VSX) instruction set in the POWER7 processors. New data types and intrinsic procedures are introduced to support the VSX instructions. With the VSX intrinsic procedures and the original Vector Multimedia eXtension (VMX) intrinsic procedures, you can efficiently manipulate vector operations in your application.

For more information about the VSX data types and intrinsic procedures, see Vector in the and Vector intrinsic procedures in the *XL Fortran Language Reference*.

Mathematical Acceleration Subsystem (MASS) libraries for POWER7 processors

Vector libraries

The vector MASS library **libmassvp7.a** contains vector procedures that have been tuned for the POWER7 architecture. The procedures can be used in either 32-bit mode or 64-bit mode.

Procedures supporting previous Power® processors, either single-precision or double-precision, are included for POWER7 processors.

The following new procedures are added, in both single-precision and double-precision function groups:

- exp2
- exp2m1

- log21p
- log2

For more information about the vector libraries, see Using the vector libraries in the *XL Fortran Optimization and Programming Guide*.

SIMD libraries

The MASS SIMD library **libmass_simdp7.a** contains an accelerated set of frequently used math intrinsic procedures that provide improved performance over the corresponding standard system library procedures.

For more information about the SIMD libraries, see Using the SIMD library for POWER7 in the *XL Fortran Optimization and Programming Guide*.

Hardware directives and intrinsics for POWER7 processors

New hardware directives and intrinsics are added to support the following POWER7 processor features:

- New POWER7 prefetch extensions and cache control
- New POWER7 hardware instructions

For more information, see "Directives and intrinsics new for this release" on page 33.

New compiler options for POWER7 processors

New arch and tune compiler options

The **-qarch** compiler option specifies the processor architecture for which code is generated. The **-qtune** compiler option tunes instruction selection, scheduling, and other architecture-dependent performance enhancements to run best on a specific hardware architecture.

-qarch=pwr7 produces object code containing instructions that will run on the POWER7 hardware platforms. With **-qtune=pwr7**, optimizations are tuned for the POWER7 hardware platforms.

For more information, see -qarch in the and -qtune in the *XL Fortran Language Reference*.

XL Fortran language-related updates

XL Fortran fully implements the Fortran 2003 standard.

Fortran 2003 compliance

XL Fortran fully implements the Fortran 2003 standard. This version of XL Fortran provides the following features:

- Support for parameterized derived types, including kind and length parameters.
- Support for generic interfaces with the same name as derived types.

For more information, see Fortran 2003.

OpenMP 3.0

In this release, XL Fortran fully implements the OpenMP API Version 3.0 specification. The XL Fortran implementation is based on IBM's interpretation of the OpenMP Application Program Interface Version 3.0.

Features implemented for OpenMP in this release are:

- Full support for OpenMP task level parallelizations. The new OpenMP constructs `TASK` and `TASKWAIT` give users the ability to parallelize irregular algorithms, such as pointer chasing or recursive algorithms for which the existing OpenMP constructs were not adequate.
- Allocatable arrays. You can specify allocatable arrays on `PRIVATE`, `FIRSTPRIVATE`, `LASTPRIVATE`, `REDUCTION`, `COPYIN`, and `COPYPRIVATE` clauses.
- Nested parallelism. A list of runtime routines are available for you to set or get the nested levels and thread limit. These include:
  - `omp_get_thread_limit`
  - `omp_get_max_active_levels`
  - `omp_set_max_active_levels`

  To return nested parallelism information, you can now use the following routines:
  - `omp_get_level`
  - `omp_get_ancestor_thread_num`
  - `omp_get_team_size`
  - `omp_get_active_level`
- Stack size control. You can now control the size of the stack for threads created by the OpenMP runtime library using the new environment variable `OMP_STACKSIZE`.
- Users can give hints to the expected behavior of waiting threads using the new environment variable `OMP_WAIT_POLICY`.
- The storage of a private variable is not allowed to reuse the storage of the original variable on the master thread.
- Some restrictions on the `PRIVATE` clause have been removed. A variable that appears in the `REDUCTION` clause of a parallel construct can now also appear in a `PRIVATE` clause on a work-sharing construct.
- A new `SCHEDULE` type, `AUTO`, allows the compiler and runtime system to control scheduling. You can use the following routines to get or set schedule type:
  - `omp_get_schedule`
  - `omp_set_schedule`
- Consecutive loop constructs with `STATIC` schedule with `NOWAIT` clause now guarantee the same iterations are being assigned to the same thread in the constructs.
- You can set the `OMP_THREAD_LIMIT` environment variable to determine the number of OpenMP threads to use for the whole program. Set `OMP_MAX_ACTIVE_LEVELS` if you want to control the maximum number of nested, active parallel regions.

The following is an enhancement to OpenMP in this release:

- You can specify the **-qsmp=ostls** option to use Thread Local Storage (TLS) provided at operating system (OS) level to implement `THREADPRIVATE` data. However, your operating system must already support TLS for you to use the **-qsmp=ostls** suboption. Use **-qsmp=noostls** to disable OS level TLS support.

For more information, see:

- "Parallel programming with XL Fortran" in the *XL Fortran Optimization and Programming Guide*
- OpenMP

Performance and optimization

Additional features and enhancements assist with performance tuning and application optimization.

Enhancements to -qpdf

The use of the **-qpdf** option consists of two steps. First, compile your program with the **-qpdf1** option and run it with a typical set of data to generate the profiling data. Second, compile your program again with the **-qpdf2** option to optimize the program based on the profiling data.

In previous releases, if you modify the source files and compile them with the **-qpdf2** option, the compilation stops with an error. As of XL Fortran for AIX, V13.1, the compiler issues a list of warnings but the compilation does not stop. This allows you to continue using the profiling data after modifying the source files.

Some new suboptions are added to the **-qpdf** option. You can use these new suboptions to get more control over performance improvements and extend **-qpdf** to support multiple-pass profiling, cache-miss profiling, and extended value profiling.

The new **-qpdf** suboptions are:

level Supports multiple-pass profiling, single-pass profiling, cache-miss profiling, value profiling, block-counter profiling, and call-counter profiling. You can compile your program with **-qpdf1=level=0|1|2** to specify the type of profiling information to be generated by the resulting application.

exename
Specifies the name of the generated PDF file according to the output file name specified by the **-o** option.

defname
Reverts the PDF file to its default file name.

For detailed information about these suboptions, see -qpdf1, -qpdf2 in the *XL Fortran Compiler Reference*.

Reports about compiler optimizations

There are a number of enhancements to the listing reports to give you more information about how the compiler optimizes your code. You can use this information to get further benefits from the optimization capabilities of the compiler. For more details about these enhanced reports, see “New diagnostic reports” on page 28.

Performance-related compiler options and directives

The entries in the following table describe new or changed compiler options and directives.

Information presented here is a brief overview. For detailed information about these options, directives, and other performance-related compiler options, see "Optimization and tuning options" in the *XL Fortran Compiler Reference*.

Table 6. Performance-related compiler options and directives

-qhot	Two suboptions **-qhot=fastmath** and **-qhot=nofastmath** are added to **-qhot**, to tune your applications to use the fast scalar versions of the math routines or to use the default versions. **-qhot=level=2** is also added for loop transformation analysis of nested loops. For details, see the -qhot section in the *XL Fortran Compiler Reference*.
-qinline=level=*number*	A new option is added to -qinline to provide guidance to the compiler about the relative value of inlining in relation to the default value of 5.*number* is a range of integer values 0 - 10 that indicates the level of inlining you want to use. For details, see -qinline in the *XL Fortran Compiler Reference*.
-qipa	A new enhancement added to **-qipa** is `-r -qipa=relink`. You can generate relinkable objects while preserving IPA information by specifying `-r -qipa=relink`. This creates a nonexecutable package that contains all object files. By using this suboption, you can postpone linking until the last stage. **-qipa=clonearch** is no longer supported. Consider using **-qtune=balanced**. For detailed information, see -qipa section in the *XL Fortran Compiler Reference*.
-qpdf	**-qpdf** provides suboptions to give you more control flexibility in controlling different PDF optimizations. For more information, see the -qpdf1, -qpdf2 section in the *XL Fortran Compiler Reference*.
-qprefetch	A new enhancement is added to **-qprefetch** for inserting prefetch instructions automatically where there are opportunities to improve code performance: `-qprefetch=assistthread`. For details, see -qprefetch in the *XL Fortran Compiler Reference*.

For additional information about performance tuning and program optimization, see "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*.

New diagnostic reports

The new diagnostic reports can help you identify opportunities to improve the performance of your code.

Compiler reports in XML format

It is now possible to get information in XML format about the optimizations that the compiler was able to perform and also which optimization opportunities were missed. This information can be used to reduce programming effort for tuning applications, especially high-performance applications.

The information from the compiler is produced in XML 1.0 format. The report is defined by an XML schema and is easily consumable by tools that you can create to read and analyze the results. A stylesheet, `xlstyle.xsl`, is provided to render the report into a human readable format that can be read by anyone with a browser which supports XSLT.

In this release, the following four optimization categories are available in the report:

- Inlining
- Loop transformations
- Data reorganizations
- Profile-directed feedback information

The new **-qlistfmt** option and its associated suboptions can be used to generate the new XML 1.0 report.

For detailed information about this report and how to use it, see "Using reports to diagnose optimization opportunities" in the *XL Fortran Optimization and Programming Guide*.

Enhancements to profiling reports

New sections have been added to your listing file to help you analyze your programs. When using the **-qreport** option with the **-qpdf2** option, you can get the following sections added to the listing file in the section entitled `PDF Report`:

Loop iteration count
: The most frequent loop iteration count and the average iteration count, for a given set of input data, is calculated for most loops in a program. This information is only available when the program is compiled at optimization level -O5.

Block and call count
: This section of the report covers the call structure of the program and the respective execution count for each called function. It also includes block information for each function. For non-user defined functions, only execution count is given. The total block and call coverage, and a list of the user functions ordered by decreasing execution count are printed in the end of this report section. In addition, the block count information is printed at the beginning of each block of the pseudo-code in the listing files.

Cache miss
: This section of the report is printed in a single table. It reports the number of cache misses for certain functions, with additional information about the functions such as: cache level, cache miss ratio, line number, file name, and memory reference.

  Note: You must use the **-qpdf1=level=2** option to get this report.
  You can also select the level of cache to profile using the **PDF_PM_EVENT** environment variable during run time.

For detailed information about profile-directed feedback, see "Profile-directed feedback" in the *XL Fortran Optimization and Programming Guide*.

For additional information about the listing files, see "Understanding XL Fortran compiler listings" in the *XL Fortran Compiler Reference*.

Report of data reorganization

The compiler can generate the following information in the listing files:

- Data reorganizations (a summary of how program variable data gets reorganized by the compiler)

- The location of data prefetch instructions inserted by the compiler

To generate data reorganization information, specify the optimization level **-qipa=level=2** or **-O5** together with **-qreport**. The data reorganization messages for program variable data are added to the data reorganization section of the listing file with the label `DATA REORGANIZATION SECTION` during the IPA link pass. Reorganizations include:

- common block splitting
- array splitting
- array transposing
- memory allocation merging
- array interleaving
- array coalescing

To generate information about data prefetch insertion locations, use the optimization level of **-qhot**, or any other option that implies **-qhot** together with **-qreport**. This information appears in the `LOOP TRANSFORMATION SECTION` of the listing file.

Additional loop analysis

A new suboption has been added to **-qhot** to add more aggressive loop analysis. **-qhot=level=2** together with **-qsmp** and **-qreport** add information about loop nests on which the aggressive loop analysis was performed to the `LOOP TRANSFORMATION SECTION` of the listing file. This information can also appear in the XML listing file created with the **-qlistfmt** option.

New and enhanced diagnostic options

The entries in the following table describe new or changed compiler options and directives that give you control over compiler listings.

Information presented here is a brief overview. For detailed information about these and other performance-related compiler options, see "Listings, messages and compiler information" in the *XL Fortran Compiler Reference*.

Table 7. Listings-related compiler options and directives

Option/directive	Description
-qlistfmt	Generates a report in an XML 1.0 format containing information about optimizations performed by the compiler and missed optimization opportunities. The report contains information about inlining, loop transformations, data reorganization and profile-directed feedback.
-qreport	The listing now contains a `PDF report` section when used with **-qpdf2**. Another new section in the listing files is a `DATA REORGANIZATION` section when used with **-qipa=level=2** or **-O5**.

Utilization tracking and reporting tool

The utilization tracking and reporting feature is a lightweight and simple mechanism for tracking the compiler utilization within your organization. It is

disabled by default. You can use this feature to detect whether your organization's use of the compiler exceeds your compiler license entitlements.

When utilization tracking is enabled, each invocation of the compiler is recorded in a compiler utilization file. You can run the utilization reporting tool to generate a report from one or more of these files to get a picture of the overall usage of the compiler within your organization. The **urt** command can be used to control how the report is generated. In particular, the report indicates the number of concurrent users using the compiler.

The utilization tracking and reporting feature is easy to set up and manage, and utilization tracking does not impact the usage or performance of the compiler.

For detailed information about the utilization tracking and reporting feature, see "Tracking and reporting compiler usage" in the *XL Fortran Compiler Reference*.

New or changed compiler options and directives

This section describes new and changed compiler options and directives in XL Fortran, V13.1.

You can specify compiler options on the command line. You can also modify compiler behavior through directives embedded in your application source files. See the *XL Fortran Compiler Reference* for detailed descriptions and usage information for these and other compiler options.

Table 8. New or changed compiler options and directives

Option or directive	Description
-qarch	A new suboption has been added to **-qarch**, specifying **-qarch=pwr7** produces object code that contains instructions that run on the POWER7 hardware platforms.
-qassert	New suboptions have been added for **-qassert** to provide more information about the characteristics of the files that can help to fine-tune optimizations. The **-qassert=contig** option tells the compiler that all array pointers are associated with contiguous targets, and that all assumed-shape arrays are associated with contiguous actual arguments. The **-qassert=refalign** option tells the compiler that all pointers only point to naturally-aligned data.
-qbindcextname	Controls whether the **-qextname** option affects **BIND(C)** entities.
-qfunctrace	Inserts calls to user-defined tracing procedures at procedure entry and exit.
-qfunctrace_xlf_catch	Specifies the name of the catch tracing subroutine.
-qfunctrace_xlf_enter	Specifies the name of the entry tracing subroutine.
-qfunctrace_xlf_exit	Specifies the name of the exit tracing subroutine.

Table 8. New or changed compiler options and directives (continued)

Option or directive	Description
-qhot	A new suboption has been added for **-qhot**. The **-qhot** compiler option is a powerful alternative to hand tuning that provides opportunities to optimize loops and array language. The **-qhot=fastmath** option enables the replacement of math routines with available math routines from the XLOPT library only if **-qstrict=nolibrary** is enabled. **-qhot=nofastmath** disables the replacement of math routines by the XLOPT library. -qhot=fastmath is enabled by default if -qhot is specified regardless of the hot level.
-qinline	Attempts to inline functions instead of generating calls to those functions, for improved performance.
-qlibmpi	Tunes code based on the known behavior of the Message Passing Interface (MPI) functions.
-qlistfmt	Generates a report in an XML 1.0 format containing information about some optimizations performed by the compiler and some missed optimization opportunities for inlining, loop transformations, profile-directed feedback, and data reorganization.
-qmkshrobj	Creates a shared object from generated object files.
-qpdf1,-qpdf2	New suboptions have been added to **-qpdf1,-qpdf2**.
-qprefetch	A new suboption has been added to **-qprefetch**. When you work with applications that generate a high cache-miss rate, you can use **-qprefetch=assistthread** to exploit assist threads for data prefetching.
-qsaveopt|-qnosaveopt	The existing **-qsaveopt** option is enhanced to also include the user's configuration file name and the options specified in the configuration files.
-qsimd	Controls whether the compiler can automatically take advantage of vector instructions for processors that support them.
-qstackprotect	Protects your applications against malicious code or programming errors that overwrite or corrupt the stack.
-qstrict	A new suboption has been added to the **-qstrict** option to allow more control over optimizations and transformations that violate strict program semantics. **-qstrict=vectorprecision** disables vectorization in loops where it might produce different results in vectorized iterations than in nonvectorized ones.
-qtune	A new suboption has been added to **-qtune**. If you specify **-qtune=pwr7**, optimizations are tuned for the POWER7 hardware platforms.

Table 9. Deprecated directives and options

Option or directive	Description
SCHEDULE	This directive is deprecated and might be removed in a future release. You can use the OpenMP equivalent.
-Q	This option is deprecated and replaced with **-qinline**.
-qenablevmx	This option is deprecated and replaced with the **-qsimd=auto** option.
-qhot=simd | nosimd	**-qhot=simd | nosimd** are deprecated and might be removed in a future release. You can use **-qsimd**.
-qipa=inline | noinline	**-qipa=inline | noinline** are deprecated and might be removed in a future release. You can use **-qinline**.
-qipa=clonearch | noclonearch	**-qipa=clonearch | noclonearch** is no longer supported. You can use **-qtune=balanced**.
-qipa=clonearch | noclonearch	**-qipa=cloneproc | nocloneproc** is no longer supported. You can use **-qtune=balanced**.

Directives and intrinsics new for this release

This section lists directives and intrinsics that are new for XL Fortran, V13.1.

VSX built-in functions

Vector Scalar eXtension (VSX) is newly added for POWER7 processors.

For more information about VSX built-in functions, see Vector intrinsic procedures.

POWER7 prefetch extensions and cache control

The POWER7 processor has cache control and stream prefetch extensions that support store stream prefetch and prefetch depth control. XL Fortran provides the following new directives to provide direct programmer access to these instructions:

- `PROTECTED_STREAM_STRIDE`
- `TRANSIENT_PROTECTED_STREAM_COUNT_DEPTH`
- `UNLIMITED_PROTECTED_STREAM_DEPTH`
- `TRANSIENT_UNLIMITED_PROTECTED_STREAM_DEPTH`
- `PARTIAL_DCBT`
- `DCBTT`
- `DCBTSTT`
- `DCBFLP`

The compiler can insert the directives automatically when it optimizes the code. You can disable automatic use of these instructions with **-qnoprefetch**.

For more information about the directives, see Hardware-specific directives in the *XL Fortran Language Reference*.

POWER7 intrinsics

New XL Fortran built-in functions corresponding to each new POWER7 hardware instruction are added in this release. With these functions, you can directly manipulate specific hardware instructions in your code, which can improve the performance of your application.

- `BPERMD`
- `DIVDE`
- `DIVWE`

Comparison intrinsics

This new function compares bytes.

- `CMPB`

Decimal floating-point functions

This new function adds and generates sixes.

- `__addg6s`

Compatibility of redistributable library libxlopt.a

Starting from this release, compatibility of the redistributable library, libxlopt.a, will be maintained. The libxlopt.a library will be compatible with the XL Fortran for AIX, V13.1 compiler and its later releases.

Previously, the version of the redistributable library had to be the same as the version of the compiler with which the application was compiled.

You can download and use the latest redistributable library for multiple applications compiled with XL Fortran for AIX, V13.1 or later.

Enhancements added in Version 12.1

This section describes features and enhancements added to the compiler in Version 12.1.

Operating system support

This section provides information about the supported operating systems.

XL Fortran V12.1 supports the following operating systems:

- AIX V5.3
- AIX V6.1
- AIX V7.1

This version of the compiler does not support AIX V5.2.

Note: For operating systems supported by earlier versions of the compilers, see AIX OS levels supported by XL Compilers.

XL Fortran language-related updates

This section describes the language-related changes introduced in version 12.1.

Fortran 2003 enhancements

The OPEN and INQUIRE statements have been updated with the ENCODING= specifier to indicate the encoding form of the file.

IEEE module enhancements

The IEEE_ARITHMETIC module defines a new constant, IEEE_OTHER_VALUE.

The IEEE_ARITHMETIC module defines three new functions: IEEE_SET_UNDERFLOW_MODE, IEEE_GET_UNDERFLOW_MODE and IEEE_SUPPORT_UNDERFLOW_MODE.

OpenMP 3.0

IBM XL Fortran for AIX, V12.1, has added some of the features of the OpenMP API Version 3.0 specification. The XL Fortran implementation is based on IBM's interpretation of the OpenMP Application Program Interface Draft 3.0 Public Comment.

The main differences between Version 2.5 and Version 3.0 implemented in this release are:

- Addition of task level parallelization. The new OpenMP constructs TASK and TASKWAIT give users the ability to parallelize irregular algorithms, such as pointer chasing or recursive algorithms for which the existing OpenMP constructs were not adequate.
- Nesting support - a COLLAPSE clause has been added to the DO, and PARALLEL DO directives to allow parallelization of perfect loop nests. This means that multiple loops in a nest can be parallelized.

For more information, see:

- "Parallel programming with XL Fortran" in the *XL Fortran Optimization and Programming Guide*
- www.openmp.org

Performance and optimization

XL Fortran, V12.1 includes features and enhancements to assist with performance tuning and optimization of your applications.

Enhancements to -qstrict

Many suboptions have been added to the **-qstrict** option to allow more fine-grained control over optimizations and transformations that violate strict program semantics. In previous releases, the **-qstrict** option disabled all transformations that violate strict program semantics. This is still the behavior if you use **-qstrict** without suboptions. Likewise, in previous releases **-qnostrict** allowed transformations that could change program semantics. Because a higher level of optimizations might require relaxing strict program semantics, the addition of the suboptions relaxes selected rules to get specific benefits of faster code without turning off all semantic verifications.

You can use 16 new suboptions separately or use a suboption group. Here is a list of suboption groups:

all Disables all semantics-changing transformations, including those controlled by the other suboptions.

ieeefp
Controls whether individual operations conform to IEEE 754 semantics.

order Controls whether individual operations can be reordered in a way that violate program language semantics.

precision
Controls optimizations and transformations that can affect the precision of program results.

exceptions
Controls optimizations and transformations that can affect the runtime exceptions generated by the program.

For detailed information about these suboptions, see "-qstrict" in the *XL Fortran Compiler Reference*.

Performance-related compiler options and directives

The entries in the following table describe new or changed compiler options and directives.

Information presented here is a brief overview. For detailed information about these and other performance-related compiler options, see "Optimization and tuning options" in the *XL Fortran Compiler Reference*.

Table 10. Performance-related compiler options and directives

Option/directive	Description
EXECUTION_FREQUENCY	The `EXECUTION_FREQUENCY` directive marks source code that might be executed very frequently or very infrequently. When optimization is enabled, the directive is used as a hint to the optimizer.
-qreport	The listing now contains information about how many streams are created for each loop and which loops cannot be SIMD vectorized due to non-stride-one references. You can use this information to improve the performance of your applications.
-qsmp	When **-qsmp=omp** is in effect, some of the additional functionality of OpenMP API 3.0 is now available. For more information, see “OpenMP 3.0” on page 25.

For additional information about performance tuning and program optimization, see "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*.

New or changed compiler options and directives

This section describes new and changed compiler options and directives in XL Fortran, V12.1.

You can specify compiler options on the command line. You can also modify compiler behavior through directives embedded in your application source files. See the *XL Fortran Compiler Reference* for detailed descriptions and usage information for these and other compiler options.

Table 11. New or changed compiler options and directives

Option or directive	Description
-qstrict	Many suboptions have been added to the **-qstrict** option to allow more control over optimizations and transformations that violate strict program semantics. See "Performance and optimization" on page 27 for more information.
-qfpp	Allows Fortran-specific preprocessing features in the C preprocessor which ships with XL Fortran. Since it is a C preprocessor option it is invoked with the **-WF** option as **-WF, -qfpp**.
-qppsuborigarg	Instructs the C preprocessor to substitute original macro arguments before further macro expansion. Since it is a C preprocessor option it is invoked with the **-WF** option as **-WF, -qppsuborigarg**.
EXECUTION_FREQUENCY	The `EXECUTION_FREQUENCY` directive marks source code that you expect will be executed very frequently or very infrequently.
IGNORE_TKR	The `IGNORE_TKR` directive facilitates portability of code written for other compilers. It simplifies the writing of generic interfaces, especially for system libraries by directing the compiler to ignore type, kind and rank of dummy arguments.
-qreport	When used together with compiler options that enable automatic parallelization or vectorization, the **-qreport** option now reports the number of streams in a loop and produces information when loops cannot be SIMD vectorized due to non-stride-one references.
-qsmp	When **-qsmp=omp** is in effect, some of the additional functionality of OpenMP API 3.0 is now available. For more information, see "OpenMP 3.0" on page 35.
-qtimestamps	This option can be used to remove timestamps from generated binaries.

Chapter 4. Setting up and customizing XL Fortran

For complete prerequisite and installation information for XL Fortran, refer to "Before installing" in the *XL Fortran Installation Guide*.

Using custom compiler configuration files

You can customize compiler settings and options by modifying the default configuration file or by creating your own.

You have the following options to customize compiler settings:

- The XL Fortran compiler installation process creates a default compiler configuration file. You can directly modify this configuration file to add default options for specific needs. However, if you later apply updates to the compiler, you must reapply all of your modifications to the newly installed configuration file.
- You can create your own custom configuration file that either overrides or complements the default configuration file. The compiler can recognize and resolve compiler settings you specify in your custom configuration files together with compiler settings specified in the default configuration file. Compiler updates that might later affect settings in the default configuration file does not affect the settings in your custom configuration files.

For more information, see "Using custom compiler configuration files" in the *XL Fortran Compiler Reference*.

Configuring compiler utilization tracking and reporting

In addition to the compiler configuration file, there is a separate configuration file for the utilization tracking and reporting feature. Utilization tracking is disabled by default, but you can enable it by modifying an entry in this configuration file. Various other aspects of utilization tracking can also be configured using this file.

Although the compiler configuration file is separate from the utilization tracking configuration file, it contains an entry that specifies the location of the utilization tracking configuration file so that the compiler can find this file.

For more information about how to configure the utilization tracking and reporting feature, see Tracking and reporting compiler usage in the *XL Fortran Compiler Reference*.

Chapter 5. Developing applications with XL Fortran

Fortran application development consists of repeating cycles of editing, compiling and linking (by default a single step combined with compiling), and running.

Notes:

1. Before you can use the compiler, you must first ensure that XL Fortran is properly installed and configured. For more information, see the *XL Fortran Installation Guide*.
2. To learn about writing Fortran programs, refer to the *XL Fortran Language Reference*.

The compiler phases

A typical compiler invocation executes some or all of these activities in sequence. For link time optimizations, some activities will be executed more than once during a compilation. As each program runs, the results are sent to the next step in the sequence.

1. Preprocessing of source files
2. Compilation, which may consist of the following phases, depending on what compiler options are specified:
   a. Front-end parsing and semantic analysis
   b. Loop transformations
   c. High-level optimization
   d. Low-level optimization
   e. Register allocation
   f. Final assembly
3. Assemble the assembly (**.s**) files, and the unpreprocessed assembler (**.S**) files after they are preprocessed
4. Object linking to create an executable application

To see the compiler step through these phases, specify the **-v** compiler option when you compile your application. To see the amount of time the compiler spends in each phase, specify **-qphsinfo**.

Editing Fortran source files

To create Fortran source programs, you can use any text editor available to your system, such as **vi** or **emacs**.

Source programs must be saved using a recognized file name suffix. See "XL Fortran input and output files" on page 46 for a list of suffixes recognized by XL Fortran.

For a Fortran source program to be a valid program, it must conform to the language definitions specified in the *XL Fortran Language Reference*.

Compiling with XL Fortran

XL Fortran is a command-line compiler. Invocation commands and options can be selected according to the needs of a particular Fortran application.

Compiling Fortran 2008 programs

The Fortran 2008 language standard is partially supported in this release. Use the following invocations (or their variants) to conform more closely to their corresponding Fortran language standards:

Fortran 2008
f2008, xlf2008

These compiler invocations accept Fortran 90 free source form by default. To use fixed source form with these invocations, you must specify the **-qfixed** command-line option.

By default, these invocation commands do not conform completely to the Fortran 2008 language standard supported in this release. If you need full compliance, compile with the following additional compiler option settings:

```
-qlanglvl=2008std -qnodirective -qnoescape -qextname
-qfloat=nomaf:rndsngl:nofold -qnoswapomp -qstrictieeemod
```

Also, specify the following run time options before running the program, with a command similar to the following:

```
export XLFRTEOPTS="err_recovery=no:langlvl=2008std:
                   iostat_end=2003std:internal_nldelim=2003std"
```

The default settings are intended to provide the best combination of performance and usability, so you might change them only when absolutely required. Some of the options mentioned above are only required for compliance in very specific situations. For example, you might need to specify **-qextname** only when an external symbol, such as a common block or subprogram, is named **main**.

Compiling Fortran 2003 programs

Use the following invocations (or their variants) to conform more closely to their corresponding Fortran language standards:

Fortran 2003
f2003, xlf2003

These compiler invocations are the preferred compiler invocation commands that you should use when creating and compiling new applications.

They accept Fortran 90 free source form by default. To use fixed source form with these invocations, you must specify the **-qfixed** command-line option.

By default, these invocation commands do not conform completely to the Fortran 2003 language standard. If you need full compliance, compile with the following additional compiler option settings:

```
-qlanglvl=2003std -qnodirective -qnoescape -qextname
-qfloat=nomaf:rndsngl:nofold -qnoswapomp -qstrictieeemod
```

Also, specify the following run time options before running the program, with a command similar to the following:

```
export XLFRTEOPTS="err_recovery=no:langlvl=2003std:
                   iostat_end=2003std:internal_nldelim=2003std"
```

The default settings are intended to provide the best combination of performance and usability, so you should change them only when absolutely required. Some of the options mentioned above are only required for compliance in very specific situations. For example, you would need to specify **-qextname** only when an external symbol, such as a common block or subprogram, is named **main**.

-qxlf2003 compiler option

The **-qxlf2003** compiler option provides compatibility with XL Fortran V10.1 and the Fortran 2003 standard for certain aspects of the language.

When compiling with the Fortran 2003 or Fortran 2008 compiler invocations, the default setting is **-qxlf2003=polymorphic**. This setting instructs the compiler to allow polymorphic items such as the CLASS type specifier and SELECT TYPE construct in your Fortran application source.

For all other compiler invocations, the default is **-qxlf2003=nopolymorphic**.

Compiling Fortran 95, or Fortran 90 programs

Use the following invocations (or their variants) to conform more closely to their corresponding Fortran language standards:

Fortran 95
: f95, xlf95

Fortran 90
: f90, xlf90

These compiler invocations accept Fortran 90 free source form by default. To use fixed source form with these invocations, you must specify the **-qfixed** command-line option.

I/O formats are slightly different between these commands and the other commands. I/O formats for the Fortran 95 compiler invocations are also different from those of Fortran 90 invocations. We recommend that you switch to the Fortran 95 formats for data files whenever possible.

By default, these invocation commands do not conform completely to their corresponding Fortran language standards. If you need full compliance, compile with the following additional compiler option settings:

For full Fortran 90 compliance:

```
-qlanglvl=90std -qnodirective -qnoescape -qextname
-qfloat=nomaf:rndsngl:nofold -qnoswapomp
```

For full Fortran 95 compliance:

```
-qlanglvl=95std -qnodirective -qnoescape -qextname
-qfloat=nomaf:rndsngl:nofold -qnoswapomp
```

Also, specify the following runtime options before running the program, with a command similar to the following:

For full Fortran 90 compliance:

```
export XLFRTEOPTS="err_recovery=no:langlvl=90std"
```

For full Fortran 95 compliance:

```
export XLFRTEOPTS="err_recovery=no:langlvl=95std"
```

The default settings are intended to provide the best combination of performance and usability, so you should change them only when absolutely required. Some of the options mentioned above are only required for compliance in very specific situations. For example, you would need to specify **-qextname** only when an external symbol, such as a common block or subprogram, is named **main**.

Compiling Fortran 77 programs

Where possible, using the **xlf** compiler invocation maintains compatibility with existing programs by using the same I/O formats as FORTRAN 77 and some implementation behaviors compatible with earlier versions of XL Fortran.

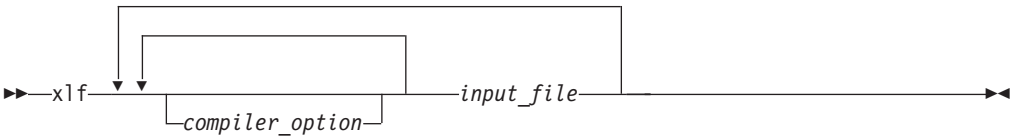
The **f77** compiler invocation is identical to **xlf**, assuming that you have not customized the configuration file.

Though you may need to continue using these invocations for compatibility with existing makefiles and build environments, programs compiled with these invocations may not conform to the Fortran 2008, Fortran 2003, Fortran 95, or Fortran 90 language level standards.

Invoking the compiler

The compiler invocation commands perform all necessary steps to compile Fortran source files, assemble any **.s** and **.S** files, and link the object files and libraries into an executable program.

To compile a source program, use the basic invocation syntax shown below:



For most applications, you should compile with **xlf** or a thread safe counterpart.

Additional invocation commands are available to meet specialized compilation needs, primarily to provide explicit compilation support for different levels and extensions of the Fortran language. See "Compiling XL Fortran programs" in the *XL Fortran Compiler Reference* for more information about compiler invocation commands available to you.

When working with source files whose filename extensions indicates a specific level of Fortran, such as .f08, .f03, .f95, .f90, or .f77, compiling with **xlf**, or corresponding generic thread safe invocations will cause the compiler to automatically select the appropriate language-level defaults.

Compiling parallelized XL Fortran applications

XL Fortran provides thread-safe compiler invocation commands that you can use when compiling parallelized applications for use in multiprocessor environments.

These invocations are similar to their corresponding base compiler invocations, except that they link and bind compiled objects to thread-safe components and libraries. The generic XL Fortran thread-safe compiler invocation is:

- xlf_r, xlf_r7

XL Fortran provides additional thread-safe invocations to meet specific compilation requirements. See "Compiling XL Fortran programs" in the *XL Fortran Compiler Reference* for more information.

Note: Using any of these commands alone does not imply parallelization. For the compiler to recognize SMP or OpenMP directives and activate parallelization, you must also specify **-qsmp** compiler option. In turn, you should specify the **-qsmp** option only in conjunction with one of these thread-safe invocation commands. When you specify **-qsmp**, the driver links in the libraries specified on the smp libraries line in the active stanza of the configuration file.

For more information on parallelized applications see "Parallel programming" in the *XL Fortran Optimization and Programming Guide*.

POSIX Pthreads API support

On AIX Version 5.1 and higher, XL Fortran supports 64-bit thread programming with the 1003.1-1996 (POSIX) standard Pthreads API. It also supports 32-bit programming with both the Draft 7 and the 1003.1-1996 standard APIs.

You can use invocation commands (which use corresponding stanzas in the xlf.cfg configuration file) to compile and then link your programs with either the 1003.1-1996 standard or the Draft 7 interface libraries.

- To compile and then link your program with the 1003.1-1996 standard interface libraries, use the **_r** variants of the compiler invocation commands. For example, you could specify:

  ```
  fortran_r test.f
  ```

- To compile and then link your program with the Draft 7 interface libraries, use the **_r** variants of the compiler invocation commands. For example, you could specify:

  ```
  fortran_r7 test.f
  ```

  Apart from the level of thread support, the **_r7** invocation variants and their corresponding stanzas in the **vac.cfgvac.cfgxlf.cfg** configuration file provide the same support as their corresponding **_r** counterparts.

Specifying compiler options

Compiler options perform a variety of functions, such as setting compiler characteristics, describing the object code to be produced, controlling the diagnostic messages emitted, and performing some preprocessor functions.

You can specify compiler options:

- On the command-line with command-line compiler options
- In your source code using directive statements
- In a makefile
- In the stanzas found in a compiler configuration file
- Or by using any combination of these techniques

It is possible for option conflicts and incompatibilities to occur when multiple compiler options are specified. To resolve these conflicts in a consistent fashion, the compiler usually applies the following general priority sequence to most options:

1. Directive statements in your source file *override* command-line settings
2. Command-line compiler option settings *override* configuration file settings
3. Configuration file settings *override* default settings

Generally, if the same compiler option is specified more than once on a command-line when invoking the compiler, the last option specified prevails.

Note: Some compiler options do not follow the priority sequence described above.

For example, the **-I** compiler option is a special case. The compiler searches any directories specified with **-I** in the xlf.cfg file before it searches the directories specified with **-I** on the command-line. The option is cumulative rather than preemptive.

See the *XL Fortran Compiler Reference* for more information about compiler options and their usage.

You can also pass compiler options to the linker, assembler, and preprocessor. See "Specifying options on the command line" in the *XL Fortran Compiler Reference* for more information about compiler options and how to specify them.

XL Fortran input and output files

These file types are recognized by XL Fortran.

For detailed information about these and additional file types used by the compiler, see "Types of input files" in the *XL Fortran Compiler Reference* and "Types of output files" in the *XL Fortran Compiler Reference*.

Table 12. Input file types

Filename extension	Description
.a	Archive or library files
.f, .F, .f77, .F77, .f90, .F90, .f95, .F95, .f03, .F03, .f08, .F08	Fortran source files
.mod	Module symbol files
.o	Object files
.s	Assembler files
.so	Shared object files

Table 13. Output file types

Filename extension	Description
a.out	Default name for executable file created by the compiler
.mod	Module symbol files
.lst	Listing files
.o	Object files
.s	Assembler files
.so	Shared object files

Linking your compiled applications with XL Fortran

By default, you do not need to do anything special to link an XL Fortran program. The compiler invocation commands automatically call the linker to produce an executable output file.

For example, running the following command:

```
xlf file1.f file2.o file3.f
```

compiles `file1.f` and `file3.f` to produce the object files `file1.o` and `file3.o`, then all object files (including `file2.o`) are submitted to the linker to produce one executable.

Compiling and linking in separate steps

To produce object files that can be linked later, use the **-c** option.

```
xlf -c file1.f               # Produce one object file (file1.o)
xlf -c file2.f file3.f       # Or multiple object files (file2.o, file3.o)
xlf file1.o file2.o file3.o  # Link object files with default libraries
```

For more information about compiling and linking your programs, see "Linking XL Fortran programs" in the *XL Fortran Compiler Reference*.

Linking new objects with existing ones

If you have **.o** or other object files that you compiled with an earlier versions of XL Fortran, you can link them with object files that you compile with the current level of XL Fortran.

See "Linking new objects with existing ones" in the *XL Fortran Compiler Reference* for more information.

Relinking an existing executable file

The linker accepts executable files as input, so you can link an existing executable file with updated object files.

You cannot, however, relink executable files that were previously linked using the **-qipa** option.

If you have a program consisting of several source files and only make localized changes to some of the source files, you do not necessarily have to compile each file again. Instead, you can include the executable file as the last input file when compiling the changed files:

```
xlf95 -omansion front_door.f entry_hall.f parlor.f sitting_room.f \
  master_bath.f kitchen.f dining_room.f pantry.f utility_room.f

vi kitchen.f # Fix problem in OVEN subroutine
xlf95 -o newmansion kitchen.f mansion
```

Limiting the number of files to compile and link the second time reduces the compile time, disk activity, and memory use.

Note: You should avoid this type of linking unless you are experienced with linking. If done incorrectly, it can result in interface errors and other problems. If you do encounter problems, compiling with the **-qextchk** compiler option can help you diagnose problems with linking.

Dynamic and static linking

XL Fortran allows your programs to take advantage of the operating system facilities for both dynamic and static linking.

Dynamic linking means that the code for some external routines is located and loaded when the program is first run. When you compile a program that uses shared libraries, the shared libraries are dynamically linked to your program by default. Dynamically linked programs take up less disk space and less virtual memory if more than one program uses the routines in the shared libraries. During linking, they do not require any special precautions to avoid naming conflicts with library routines. They may perform better than statically linked programs if several programs use the same shared routines at the same time. They also allow you to upgrade the routines in the shared libraries without relinking.

Because this form of linking is the default, you need no additional options to turn it on.

Static linking means that the code for all routines called by your program becomes part of the executable file.

Statically linked programs can be moved to run on systems without the XL Fortran runtime libraries. They may perform better than dynamically linked programs if they make many calls to library routines or call many small routines. They do require some precautions in choosing names for data objects and routines in the program if you want to avoid naming conflicts with library routines. They also may not work if you compile them on one level of the operating system and run them on a different level of the operating system.

Running your compiled application

After a program is compiled, you can run the generated executable file on the command line.

The default file name for the program executable file produced by the XL Fortran compiler is **a.out**. You can select a different name with the **-o** compiler option.

You should avoid giving your program executable file the same name as system or shell commands, such as `test` or `cp`, as you could accidentally execute the wrong command. If you do decide to name your program executable file with the same name as a system or shell command, you should execute your program by specifying the path name to the directory in which your executable file resides, such as `./test`.

To run a program, enter the name of the program executable file together with any run time arguments on the command line.

Canceling execution

To suspend a running program, press the **Ctrl+Z** key while the program is in the foreground. Use the **fg** command to resume running.

To cancel a running program, press the **Ctrl+C** key while the program is in the foreground.

Setting runtime options

You can use environment variable settings to control certain runtime options and behaviors of applications created with the XL Fortran compiler. Other environment variables do not control actual runtime behavior, but can have an impact on how your applications will run.

For more information on environment variables and how they can affect your applications at run time, see the *XL Fortran Installation Guide*.

Running compiled applications on other systems

In general, applications linked on a system using an earlier version of AIX will run with more recent versions of AIX. However, applications linked on a system using a newer version of AIX will not necessarily run with earlier versions of AIX.

If you want to run an application developed with the XL Fortran compiler on another system that does not have the compiler installed, you will need to install a runtime environment on that system.

You can obtain the latest XL Fortran Runtime Environment PTF images, together with licensing and usage information, from the XL Fortran Support page at:

www.ibm.com/software/awdtools/fortran/xlfortran/support

XL Fortran compiler diagnostic aids

XL Fortran issues diagnostic messages when it encounters problems compiling your application. You can use these messages and other information provided in compiler output listings to help identify and correct such problems.

For more information about listing, diagnostics, and related compiler options that can help you resolve problems with your application, see the following topics in the *XL Fortran Compiler Reference*:

- "Understanding XL Fortran compiler listings"
- "Error checking and debugging options"
- "Listings, messages, and compiler information options"

Debugging compiled applications

You can use a symbolic debugger to debug applications compiled with XL Fortran.

Specifying the **-g** or **-qlinedebug** compiler options at compile time instructs the XL Fortran compiler to include debugging information in compiled output. For more information debugging options, see "Error checking and debugging" in the *XL Fortran Compiler Reference*.

You can then use **dbx** or any other symbolic debugger that supports the AIX XCOFF executable format to step through and inspect the behavior of your compiled application.

Optimized applications pose special challenges when debugging. When debugging highly optimized applications, you should consider using the **-qoptdebug** compiler

option. For more information about optimizing your code, see "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*.

Determining what level of XL Fortran is installed

When contacting software support for assistance, you will need to know what level of XL Fortran is installed on your machine.

To display the version and release level of the compiler you have installed on your system, invoke the compiler with the **-qversion** compiler option.

For example, to obtain detailed version information, enter the following at the command line:

```
xlf -qversion=verbose
```

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Product Number: 5765-J04; 5725-C74

Printed in USA

SC14-7334-00