IBM XL C/C++ for Multicore Acceleration for Linux on IBM System p, V9.0 delivers Cell Broadband Engine Architecture application development capability

At a glance

Based on mature, high-performance IBM compiler technology, XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 includes:

- Exploitation of the performance capability of processors compliant with the new Cell Broadband Engine™ Architecture
- Advanced compiler optimization technology
- Multiple level of increasing optimization to meet the needs of programmers who are developing high-performance applications
- Automatic generation of code overlays for the Synergistic Processor Units (SPUs)
- C and C++ programming language standards conformance
- Mathematical Acceleration Subsystem libraries that consist of scalar and vector mathematical intrinsic functions tuned for the PowerPC Processor Units (PPUs); and Single Instruction Multiple Data (SIMD) and vector functions tuned for the SPUs
- Tools and utilities to help improve productivity
- Support on Red Hat Enterprise Linux 5.1
- IBM Software Development Kit for Multicore Acceleration, V3.0 support

For ordering, contact:

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Overview

XL C/C++ for Multicore Acceleration for Linux™ on System p™, V9.0 is the newest addition to the XL family of compilers. This version of XL C/C++ is a cross-compiler. Compilations are hosted on an System p server that generates optimized code for the Cell Broadband Engine™ (Cell/B.E.) processor within the BladeCenter® QS21. The XL C/C++ for Multicore Acceleration for Linux on System p product gives application developers the tools to exploit the unique performance capability of processors compliant with the new Cell Broadband Engine Architecture.

The Cell Broadband Engine Architecture is an innovative and powerful microprocessor architecture that extends the 64-bit Power Architecture™ technology. It has the potential to accelerate applications in numerically intense, graphical, and streaming applications, among others, in a variety of industries. The Cell/B.E. Architecture resulted from a collaboration between Sony, Toshiba, and IBM to develop the next-generation processor.

The XL family of compilers has grown at IBM beginning in the
mid-1980's with development of the earliest IBM POWER™-based AIX® systems. Since then, the compilers have been under continuous development, with special attention to producing highly optimized code that fully exploits the POWER and PowerPC® range of systems. Recent additions to the XL family support the high-performance Blue Gene®/P and Blue Gene/L supercomputers.

All of this expertise and heritage serving the enterprise business and supercomputing environments is now unleashed to programmers of the Cell Broadband Engine Architecture, allowing them to take advantage of proven IBM compiler technology.

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**Key prerequisites**

- **Host environment:** System p
- **Target environment:** BladeCenter QS21
- **IBM Software Development Kit for Multicore Acceleration, V3.0**
- **Red Hat Enterprise Linux 5.1 (RHEL5.1) for POWER**

*Note:* Although XL C/C++ for Multicore Acceleration for Linux on System p, V9.0, may work on Fedora 7, it is not a supported platform.

**Planned availability dates**

- **October 19, 2007:** Electronic software delivery
- **November 16, 2007:** Physical software delivery

**Description**

XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 is part of a larger family of IBM C, C++, and Fortran compilers. These compilers are derived from a common code base that share compiler functions and optimization technologies on a variety of platforms and programming languages, such as AIX, selected Linux distributions, z/OS®, z/VM®, Blue Gene/L, and Blue Gene/P operating systems. 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.

XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 is a cross-compiler. Applications are compiled on a System p server running Red Hat Enterprise Linux 5.1, with the resulting executable code targeted for a Cell Broadband Engine (Cell/B.E.) Architecture host also running Red Hat Enterprise Linux 5.1.

At the heart of the new Cell Broadband Engine processor is the PPU. The PPU is a 64-bit processor fully compliant with the Power Architecture standard, and capable of running both operating systems and applications. The Cell/B.E. processor also incorporates a set of eight Synergistic Processor Units (SPUs) into its design. The SPUs are optimized for running computationally intensive applications, operate independently of each other, and can access memory shared between all SPUs and the PPU.

**A highly configurable compiler**

XL C/C++ offers a wealth of features to allow the compiler to be tailored to unique compilation requirements.

**Compiler invocation and linking commands:** XL C/C++ compiles PPU and SPU program code in separate steps using compiler invocation commands targeted specifically for each type of program code. Several versions of PPU-specific compiler invocation commands are delivered including `ppuxlc`, `ppuxlC`, and `ppuxlc++`. Other variants are also provided to help meet special compilation needs. SPU-specific invocation commands are also provided with `spuxlc`, `spuxlC`, `spuxlc++`, and their variants.

**Compiler options:** A large selection of compiler options are available to control compiler behavior. Different categories of options help debug applications, optimize and tune application performance, select language levels and extensions for compatibility with non-standard features and behaviors supported by other C or C++ compilers, and perform many other common tasks.
that would otherwise require changing the source code.

XL C/C++ allows compiler options to be specified through a combination of environment variables, compiler configuration files, command line options, and compiler directive statements embedded in the program source.

Automated program analysis and transformations

The XL C/C++ compiler is capable of performing sophisticated program analysis and transformation of program code that can result in significant performance improvements with relatively little development effort. For example, the compiler can:

Use interprocedural analysis (IPA) to optimize across program files: IPA can result in significant performance improvements. Interprocedural analysis can be specified on the compile step only or on both compile and link steps in "whole program" mode. Whole program mode expands the scope of optimization to an entire program unit, which can be an executable or shared object.

Perform automatic SIMD vectorization of your program code: When the -qhot=simd compiler option is in effect, the compiler takes certain operations that are performed in a loop on successive elements of an array, and converts them into a call to a vector instruction. This call calculates several results at one time, which is faster than calculating each result sequentially. Applying this suboption is useful for applications with significant image processing demands. Not all loops can be successfully vectorized. However, specifying the -qreport compiler option together with -qhot=simd will cause the compiler to generate diagnostic information that can help improve the efficiency of loops.

Automatically generate code overlays for the SPUs: Specifying -qipa=overlay instructs the compiler to automatically generate code overlays for the SPUs that allow two or more code segments to be loaded at the same physical address as they are needed. This feature lets developers create SPU programs that would otherwise be too large to fit in the local memory store of the SPUs. In addition, the compiler also provides the -qipa=overlayproc and -qipa=nooverlayproc compiler options to give developers direct control over generation of code overlays.

Program optimization

XL C/C++ delivers several compiler options that can help control the optimization of application programs. With these options, you can:

• Select different levels of compiler optimizations
• Control optimizations for loops, floating point, and other types of operations

XL C/C++ also includes specific optimization features specifically tailored to exploit the unique performance capabilities of the Cell Broadband Engine processors, including specialized data types and highly optimized built-in functions that can be used in application code to perform common computational needs.

Optimizing transformations can give applications better overall execution performance. XL C/C++ offers a portfolio of optimizing transformations tailored to various supported hardware. These transformations can:

• Reduce the number of instructions executed for critical operations
• Restructure generated object code to make optimal use of the Cell Broadband Engine architecture
• Improve the usage of the memory subsystem

Language standards compliance

The XL C/C++ for Multicore Acceleration for Linux on System p compiler supports the following programming language specifications for C and C++:

• ISO/IEC 9899:1999 (referred to as C99)
• ISO/IEC 9899:1990 (referred to as C89)
• ISO/IEC 14882:2003 (referred to as Standard C++)
- ISO/IEC 14882:1998, the first official specification of the language (referred to as C++98)

In addition to the standardized language levels, XL C/C++ supports language extensions, including:

- Language extensions to support vector programming
- Language extensions to support SPU programming
- A subset of GNU C and C++ language extensions

**Compatibility with GNU**: XL C/C++ supports a subset of the GNU compiler command options to facilitate porting applications developed with gcc and g++.

This support is available when the `ppugxlc`, `ppugxlC`, `ppugxlC++`, `spugxlc`, `spugxlC`, or `spugxlC++` invocation commands are used together with select GNU compiler options. Where possible, the compiler maps GNU options to their XL C/C++ compiler option counterparts before invoking the compiler.

**Source-code migration and conformance checking**: XL C/C++ offers compiler invocation commands that instruct the compiler to compile PPU application code to a specific language level. The `-qlanglvl` compiler option can be used to specify a given language level, and the compiler will issue warnings, errors, and severe error messages if language or language extension elements in program source do not conform to that language level.

**Libraries**

XL C/C++ includes the Mathematical Acceleration Subsystem (MASS).

Mathematical Acceleration Subsystem consists of libraries of mathematical intrinsic functions tuned for optimum performance on the SPUs and PPUUs. These libraries offer improved performance over the standard mathematical library routines, are thread-safe, and can be used by C, C++, and Fortran applications. The PPU libraries support both 32- and 64-bit compilations. The MASS library is called automatically when specific levels of optimization are requested by the application. Explicit calls can also be made to MASS library functions regardless of whether optimization options are in effect or not.

**Tools and utilities**

XL C/C++ contains tools and utilities for increased developer productivity including the following:

- `new_install`: After installing XL C/C++ for Multicore Acceleration for Linux on System p, V9.0, running this utility will configure the compiler for use on the system.

- `xlc_configure`: This utility can be used for updating the compiler configuration file following updates to the Software Development Kit for Multicore Acceleration or to create customized compiler configuration files.

- `cleanpdf command (PPU only)`: This command is related to profile-directed feedback (PDF) and is used to remove all profiling information from the directory to which profile-directed feedback data is written.

- `resetpdf command (PPU only)`: 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.

- `ppugxlc` and `ppugxlC++` utilities: When compiling PPU code, these invocation methods can be used to translate a GNU C or GNU C++ invocation command and associated options into a corresponding `ppuxlc` or `ppuxlC++` compiler invocation. These utilities help minimize the number of changes to existing GNU compiler makefiles to help make the transition to using the XL C/C++ compiler.

- `ppugxlc` and `spugxlC++` utilities: When compiling SPU code, these invocation methods can be used to translate a GNU C or GNU C++ invocation command and associated options into a corresponding `spuxlc` or `spuxlC++` compiler invocation. These utilities help minimize the number of changes to existing GNU compiler makefiles to help make the transition to using the XL C/C++ compiler.

**Diagnostic listings**
The compiler output listing can provide important information to aid in development and debugging of applications more efficiently.

Listing information is organized into optional sections that can be included or omitted.

Symbolic debugger support
XL C/C++ can be instructed to include debugging information in the compiled objects. This debug information can be examined by the debuggers provided by the IBM Software Development Kit for Multicore Acceleration, V3.0 to help debug application programs.

Accessibility by people with disabilities
A U.S. Section 508 Voluntary Product Accessibility Template (VPAT) containing details on accessibility compliance can be requested at

Section 508 of the U.S. Rehabilitation Act
XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 is capable as of October 19, 2007, when used in accordance with associated IBM documentation, of satisfying the applicable requirements of Section 508 of the Rehabilitation Act, provided that any assistive technology used with the product properly interoperates with it. A U.S. Section 508 Voluntary Product Accessibility Template (VPAT) can be requested via the IBM Web site at

Product positioning
XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 is part of a larger IBM family of C, C++, and Fortran compilers. These compilers are derived from a common code base that shares in compiler function and optimization technologies on a variety of platforms and programming languages, such as AIX, Linux distributions, Blue Gene/L, Blue Gene/P, z/OS, and z/VM operating systems.

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. Programmers who use XL C/C++ for Multicore Acceleration for Linux on System p benefit from continuous improvements provided through ongoing development of the IBM XL family of compilers.

The C compiler supports the latest ISO C 1999 (International Standard ISO/IEC 9899:1999) standard while the C++ compiler supports the latest ISO/IEC 14882:2003 (referred to as Standard C++). With representation from the IBM compiler development team on the ISO/ANSI C and ISO/ANSI C++ committees, IBM is in a position to understand the latest updates and clarifications to both the C and C++ standards. One of the benefits of conformance to language standards is that it emphasizes the maximum portability among a variety of compiler implementations that also support the standard.

Programmers can now take advantage of the IBM compiler optimization technology that is contained in XL C/C++ for Multicore Acceleration for Linux on System p. There is the flexibility to choose from various levels and types of optimization to obtain moderate to significant performance improvements with relatively little development effort.

XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 brings with it IBM service and support (optionally available). The IBM Service and Support organization is made up of teams of individuals Working Together® to provide you with the responsive platform and cross-platform software support that you require. For complex or code-related problems, IBM has specialized, skilled service teams with access to the experts in our development laboratories, as required. Therefore, there is access to the right level of IBM expertise when you need it — no matter where they are located.

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Reference information
• 207-252, dated October 16, 2007
• 207-193, dated August 28, 2007

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**Displayable softcopy publications**: The publications for XL C/C++ for Multicore Acceleration for Linux™ on System p™ are offered in displayable softcopy form. All unlicensed manuals are included. The displayable manuals are part of the basic machine-readable material. The files are shipped on CD-ROM.

All unlicensed publications are also available from the XL C/C++ Web site at

Technical information

**Specified operating environment**

**Hardware requirements**

- Host environment: System p
- Target environment: BladeCenter® QS21
• Disk space: 200 MB (minimum) of hard disk space
  Note: High levels of optimization can require more space for paging and temporary files

• 256 MB (minimum) of RAM

Software requirements

• IBM Software Development Kit for Multicore Acceleration, V3.0
• Red Hat Enterprise Linux 5.1 (RHEL5.1) for IBM POWER™
• GNU Compiler Collection, gcc 4.1.1, or later
• Perl 5.0, or later, to run the installation utility
• Optional Software
  – Graphical desktop environment such as K Desktop Environment (KDE) or GNOME
  – Portable Document Format (PDF) viewer to access PDF documentation

  Note: Although XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 may work on Fedora 7, it is not a supported platform.

Planning information

Packaging: The XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 package contains:

• One CD-ROM containing the XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 program
• Passport Advantage customer letter
• Passport Advantage media pack pointer sheet

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Security, auditability, and control

XL C/C++ for Multicore Acceleration for Linux on System p, V9.0, uses the security and auditability features of the host hardware and software. The customer is responsible for evaluation, selection, and implementation of security features, administrative procedures, and appropriate controls in application systems and communication facilities.

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Product Identifier Description (PID)
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