Maximizing system performance with compilers for IBM System z

Contents

Compilers are often the most inexpensive layer in the software stack, yet they are also powerful levers to supercharge the hardware and software on which you run your business.

Executive summary

IBM System z® servers provide a flexible, secure and reliable IT architecture that can help you meet the requirements of today's demanding business climate. Serving as the bridge between user applications and the increasingly complex hardware architectures that run businesses, compiler technology is integral to processor efficiency, application performance and hardware usability. By improving the performance of your application, you can reduce cost, gain system capacity, save energy, and improve return on your IT investment.

The value proposition of state-of-the-art compilers is twofold. First, they can help organizations cost-effectively optimize return on investment for the hardware on which they run. Secondly, they can aid in diagnosing problems, increasing programmer productivity and lowering maintenance costs. Compilers are often the most inexpensive layer in the software stack, yet they are also powerful levers to supercharge the hardware and software on which you run your business.

IBM's flexible compiler products focus not only on providing portability and reliability, but also on modernizing legacy applications and maximizing application performance. This paper discusses the features and benefits of C/C++, COBOL and PL/I compiler products for the IBM z/OS® platform.

Introduction

IBM compilers on System z are used to develop and maintain business-critical applications. Because System z provides scalability, security, and reliability, it is the platform of choice for running a variety of business-critical workloads such as financial, human resources, payroll and data warehousing applications. The applications customers develop and deploy on z/OS are often used to process large amounts of data, and work in conjunction with IBM middleware such as IBM CICS®, IBM Information Management System (IMS) and IBM DB2®.

IBM compilers are designed to unleash the full power of IBM System z processors and help improve programmer productivity. State-of-the-art compilation technology enables programmers to exploit the performance improvements of new hardware without making source code changes. Compilers can transform and optimize code generation to fully exploit the system on which an application will run. The emergence of service-oriented architecture can help customers modernize existing business-critical applications written in C/C++, COBOL and PL/I. Furthermore, legacy applications can be extended to integrate with new technologies such as Web services, Java™ and XML with minimal cost and risk.

IBM offers the following compiler products on System z:

* *IBM Enterprise COBOL for z/OS*
* *IBM Enterprise PL/I for z/OS*
* *IBM z/OS XL C/C++*

IBM Enterprise COBOL for z/OS

A majority of the world's business data and financial transactions are processed in COBOL, and IBM has more than 40 years of experience delivering COBOL compilers to the marketplace. With IBM Enterprise COBOL for z/OS, users create, maintain and modernize mission-critical COBOL applications, which are then executed on z/OS systems. Enterprise COBOL for z/OS enables users to integrate COBOL and Web-based business processes in Web services, XML and Java applications. Java interoperability capabilities of COBOL can also be used to access Enterprise JavaBeans™ (EJB™) that run on a J2EE™-compliant EJB server such as IBM WebSphere® Application Server. It also provides access to DB2, CICS, and IMS, as well as other data and transaction systems.

Enterprise COBOL for z/OS is part of the family of IBM COBOL compilers, which also includes a distributed COBOL compiler on IBM Power Systems™ servers, IBM COBOL for AIX®.

Features of the IBM Enterprise COBOL for z/OS, Version 4.1 compiler include:

- **Integration of COBOL applications with Web-oriented business processes**
  Provides support for Java-based, object-oriented syntax to facilitate the interoperation of COBOL and Java programs. Provides support for native XML and IBM Rational® Developer for System z (RDz).

With IBM Enterprise COBOL for z/OS, users create, maintain and modernize mission-critical COBOL applications.

- **Enhanced XML support**

  Enterprise COBOL introduces XML capabilities to COBOL. The support includes a high-speed parser that enables COBOL programs to process XML documents in principal run-time environments such as CICS, IMS and IBM WebSphere MQ. COBOL syntax is extended to provide more flexibility and control over output of XML documents. Enhancements for XML support include improved support for XML namespaces, direct support for parsing XML documents that are encoded in UTF-8 Unicode, and support for very large XML documents. With Enterprise COBOL for z/OS, Version 4.1, you can also use z/OS XML System Services parser. This offloads the processing to an IBM System z Application Assist Processors (zAAPs) specialty engine, which can provide additional cost savings.

- **Support for the IBM System z10™ processor**

- **Performance enhancements**

  Improved Unicode performance and improved exploitation of IBM z/Architecture®

- **Enhanced middleware support**

  DB2

  — *Exploitation of DB2 9 with new SQL data types and syntax*
  — *New compiler option to coordinate the coded character set ID between COBOL and DB2*
  — *COBOL listing includes DB2 options in effect*

  CICS

  — *Support of integrated CICS translator, which enables CICS statements in COBOL source and passes them through the compiler without the need for a preprocessing step*

- **Support for higher data-item size limits**

  Several limits on COBOL data-item size have been significantly raised to facilitate programming with large amounts of data.

Enterprise COBOL for z/OS v4.1 provides a set of intrinsic functions, including string handling, financial capabilities, statistical functions and mathematical formulas.

IBM Enterprise PL/I for z/OS

First introduced in the 1960s, PL/I is a general-purpose programming language with outstanding facilities for developing scientific, engineering and commercial applications. Enterprise PL/I for z/OS enables developers to use existing PL/I code with the latest technologies or to integrate PL/I applications and Web-oriented business processes.

IBM Enterprise PL/I for z/OS enables developers to use existing PL/I code with the latest technologies or to integrate PL/I applications and Web-oriented business processes.

With Enterprise PL/I for z/OS, you can leverage more than 30 years of IBM experience in application development to meet your business needs. It helps you maintain and create mission-critical, line-of-business PL/I applications targeted for execution on IBM z/OS. With the most recent version of Enterprise PL/I compiler, you can also expand your current IT infrastructure by integrating existing mission-critical PL/I applications with Web-based business processes in Web services, XML and PL/I applications. It also provides access to IBM DB2, CICS, and IMS middleware subsystems.

Enterprise PL/I for z/OS is part of the family of IBM PL/I compilers. In addition to System z, IBM offers a distributed PL/I product on Power Systems servers, IBM PL/I for AIX.

Features of the IBM Enterprise PL/I for z/OS, Version 3.8 compiler include:

- **Built-in language support for high speed XML parsing and generation**
  Enterprise PL/I for z/OS supports the generation of XML. Via a built-in function, you can dump the contents of a structure as XML into a buffer. This built-in sub-routine uses the XML System Services parser. It provides support for namespaces, UTF-8 encoded documents and XML documents larger than 2 GB. Because the XML System Services parser enables offloading of XML processing to zAAP specialty engines, XML parsing for your PL/I applications has become more cost effective.

- **Improved middleware support**
  With the integrated CICS and SQL preprocessor, it is not necessary to run a separate job step to pre-compile EXEC CICS and EXEC SQL statements into PL/I code. This will also improve the debugging capability of programs that contain CICS and SQL statements. You can now debug the source code you wrote and not code generated by CICS or SQL pre-processors. Enterprise PL/I for z/OS, Version 3.8 provides improved support for DB2 9, CICS, Version 3.2, and IMS, Version 10. Enhancements have also been made to the integrated SQL pre-processor to support DBCS.

- **Support for the System z10 processor**
  Enterprise PL/I for z/OS, Version 3.8 provides full exploitation of the System z10 architecture, including the decimal floating point (DFP) unit and DFP math functions.

- **Performance improvements**
  Enhancements for performance improvements include enabling more exploitation of 64-bit registers in 32-bit code, support for the GOFF object format, support for more built-in functions, and improved exploitation of the z/Architecture.

- **Globalization enhancements**
  Enterprise PL/I supports Unicode with built-in conversion. The latest release has built-in functions to provide better support for UTF-8 and UTF-16.
- **Improved compatibility with prior PL/I compilers**
  Enterprise PL/I for z/OS contains many enhancements to make it more compatible for migration from the OS PL/I, Version 2 and PL/I for MVS and VM compilers.

IBM z/OS XL C/C++

The z/OS XL C/C++ compiler is capable of performing aggressive optimizations to C/C++ applications.

z/OS XL C/C++ is an optional priced feature of the z/OS operating system. It enables you to produce high-performing C/C++ business software applications on z/OS. You can invoke the C/C++ compiler via a JCL, under TSO, ISPF panel or using c89/xlc commands in the z/OS USS environment.

z/OS XL C/C++ is part of the family of IBM C/C++ compilers. It adheres to international standards to enable portability of applications to z/OS from both IBM and non-IBM platforms. z/OS XL C/C++ contains the latest features and optimization technologies and is designed to exploit System z architecture and services provided by the z/OS LE and Run-Time Library Extension. The z/OS XL C/C++ optimizer is capable of performing aggressive optimizations to C/C++ applications. Optimizations include loop optimizations, inter-procedural analysis (or whole program optimization), profile-directed feedback, and memory hierarchy optimization. z/OS XL C/C++ supports both 32-bit and 64-bit executables.

z/OS XL C/C++ provides system programming capabilities with the "METAL C" compiler option.

z/OS XL C/C++ now provides system programming capabilities with the "METAL C" compiler option. You now have an option to use C language in place of Assembler language (HLASM) for system program development. You can also use it to generate code that does not have LE run-time dependencies. In addition, you can embed HLASM source within C statements and obtain system services required by the XL C application program directly by calling Assembler Services. z/OS now provides a Metal C Runtime Library that is independent of the LE.

Features of the IBM z/OS XL C/C++, Version 1R10 compiler include:

- **Support for the System z10 processor**
  Provides new performance-related compiler option to fully exploit the capabilities of System z10 processors. This includes exploiting the Decimal Floating Point unit of the z10 processor to offer greater computational performance and precision for business and financial applications.
- **Enhanced middleware support**
  Provides support for DB2, Version 7, 8 and 9 co-processors; and CICS Transaction Server 3.1 and 3.2 integrated translator. This enables CICS and SQL statements in C/C++ source and passes them through the compiler without the need for a preprocessing step. This permits a more seamless operation of C/C++ within the CICS and DB2 environments. The SQL co-processor now supports the DFP type of host variable.
- **Introduction of on-demand loading for debug information**
  Provides faster access to debug information, significantly decreasing the time required for the debugger to start up. This feature improves programmer productivity for debugging large applications.
- **Performance improvements**
  Continual improvements to the generated code enable you to take advantage of new instructions in the hardware architecture and enhancements to the optimizer. You can benefit from these improvements by recompiling your existing source without any code changes.

z/OS C/C++ supports UNIX® System Services on z/OS. This includes use of the z/OS UNIX Hierarchical File System (HFS) for storage of compiler source and output and the z/OS UNIX Shell and Utilities feature. It supports the DSECT Conversion Utility for converting descriptive data produced by High Level Assembler (HLASM) into C/C++ data structures to enable C/C++ programs to interface with Assembler programs. It also supports generation of dynamic link libraries (DLLs) in a way that is similar to Microsoft® Windows® DLL generation, and full program reentrancy for C/C++ programs.

Enhanced product features

The following advanced features available on Enterprise COBOL for z/OS, Enterprise PL/I for z/OS, and z/OS XL C/C++.

Applications developed using IBM Enterprise COBOL for z/OS, Enterprise PL/I for z/OS, z/OS XL C/C++ and High Level Assembler (HLASM) can interoperate with one another.

Support for z/OS Language Environment

z/OS Language Environment provides a common foundation to run programs written using different programming languages. It was architected from the ground up to facilitate interoperation between different programming languages. It provides a consistent means for developing quality applications with multiple languages while maintaining existing applications. Programs developed using Enterprise COBOL for z/OS, Enterprise PL/I for z/OS, and z/OS XL C/C++ can interoperate with one another as well as with programs written in Assembler. This capability allows you to take advantage of the strengths of different programming languages within a single application.

Compatibility with IBM Rational Developer for System z

Rational Developer for System z (RDz) consists of a common development workbench and an integrated set of tools that support end-to-end, model-based development, run-time testing, and rapid deployment of applications. It offers an integrated development environment with advanced, easy-to-use

tools to help accelerate development of your Web applications, traditional COBOL and PL/I applications, Web services and XML-based interfaces for System z. RDz is designed to work with IBM Enterprise COBOL for z/OS and Enterprise PL/I compilers for z/OS products.

Decimal floating point

Approximately 55 percent of numeric data in commercial databases such as DB2 is decimal data.[1] Traditional binary floating point arithmetic is not sufficient to effectively process decimal data in commercial software because it can lead to inaccurate and unexpected results. With binary arithmetic, rounding takes place at power-of-two boundaries (not power-of-ten boundaries), which is why it could lead to inaccuracies. Examples are monetary values and percentages. In situations where these values have to be calculated multiple times (for instance, in banking applications), the cumulative effects of rounding and truncation of binary arithmetic can significantly impact the precision of these calculations. Currently, most DFP arithmetic calculations are carried out in software, which is estimated to be 100 to 1,000 times slower than in hardware.[1] System z10 processors now contain a DFP unit that was designed to bring significant performance and accuracy improvements to commercial software operating on decimal data. The most recent versions of z/OS XL C/C++ and Enterprise PL/I are enhanced to support DFP data types and have the capability to exploit the DFP unit in System z10 processors. Support for the DFP format is in addition to the current hex and binary floating point formats.

> *System z10 processors now contain a Decimal Floating Point (DFP) unit to bring performance and accuracy improvements to commercial software operating on decimal data. z/OS C/C++ and Enterprise PL/I for z/OS are enhanced to exploit the DFP unit.*

Summary

Organizations often upgrade only their System z hardware and not their software stack. They sometimes overlook the importance of the software stack, which includes z/OS, compilers and middleware. As a result, they are running new high-powered System z servers with outdated compilers and middleware,

which severely limits the servers' potential and can translate to greater power consumption, slower response times, numerous administrative challenges and higher costs.

IBM compilers on System z are designed to enable applications to take full advantage of all of the hardware features provided by IBM z/Architecture and the most recent middleware subsystems. By using leading-edge optimization technologies and modernization features in IBM compilers, you can improve your return on investment from capital investments in hardware and increase programmer productivity.

IBM has a long history of delivering innovative, high-quality compiler products on System z. Combined with our premium services, IBM compilers provide the modernization support and the performance you need to optimize your business-critical applications.

For more information

To learn more about how IBM can help you increase your system performance with upgraded compilers, contact your IBM sales representative or IBM Business Partner.

For more information on the IBM family of COBOL compilers, visit **ibm.com**/software/awdtools/cobol.

For information on the IBM family of PL/I compilers, visit **ibm.com**/software/awdtools/pli.

For more information on the IBM family of C/C++ compilers, visit **ibm.com**/software/awdtools/xlcpp.

For more information on the IBM C/C++ community, visit **ibm.com**/software/rational/cafe/community/ccpp.

The customer is responsible for ensuring compliance with legal requirements. It is the customer's sole responsibility to obtain advice of competent legal counsel as to the identification and interpretation of any relevant laws and regulatory requirements that may affect the customer's business and any actions the customer may need to take to comply with such laws. IBM does not provide legal advice or represent or warrant that its services or products will ensure that the customer is in compliance with any law or regulation.

[1] "Decimal Floating-Point: Algorism for Computers," Michael F. Cowlishaw, *Proceedings of the 16th IEEE Symposium on Computer Arithmetic*, IEEE, June 2003.

Recyclable, please recycle