Conditionally-supported Special Math Functions for C++14

Contents

Abstract

This paper proposes to merge International Standard 29124:2010, "Extensions to the C++ Library to support mathematical special functions," into C++14 as a conditionally-supported standard library feature.

1 Background and proposal

Mathematical Special Functions were proposed [Bro03a, Bro03b, Bro03c] for C++ with the following rationale:

> While these functions are clearly numerical in nature and will likely be most heavily used by the scientific and engineering communities, other communities of programmers also have needs, ranging from frequent to intermittent, for these functions. . . . [W]e believe that adoption of this proposal would send a clear message to the various numeric computing communities that, contrary to significant popular belief within these communities, C++ is an eminently suitable programming language for their problem domain, too.

Modulo some additional discussion and wordsmithing [Pla03, Pla04, Mar04, Pla05], the proposal's wording was subsequently published as one of the clauses comprising WG21's TR1 [ISO07].

When it came time to determine what to do with TR1 relative to C++0X, WG21 decided[1] to adopt essentially all of TR1 into the Working Paper, with the notable exclusion of the clause specifying Mathematical Special Functions. During the discussion that led to that decision, it was principally argued that these functions' implementation would be a development hardship and maintenance burden for vendors, noting that "Users aren't breaking down our doors clamoring

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[1] The decision was made at the Berlin meeting (2006) via two motions.

for these functions."[2] Still later, following WG14's lead [ISO09],[3] WG21 voted to issue its own Mathematical Special Functions International Standard [Bro10, ISO10].[4]

On a separate front, WG21 voted to introduce the new term of art *conditionally-supported* [Mil04a, Mil04b]. Currently defined as a "program construct that an implementation is not required to support" [DuT12], this term has since its inception found use in specifications throughout the Core clauses of the C++11 standard. We believe the term could equally profit the Library clauses, as it provides a mechanism by which vendor concerns, such as those recounted above, can be addressed.

We therefore **propose to merge [ISO10] into the C++14 standard as a conditionally-supported standard library feature.** We do so for the following principal reasons:

- "Conditionally-supported" was not an available term of art at the time TR1 was being considered for integration into C++0X. Its application in the context of mathematical special functions would clearly and succinctly address any lingering concerns regarding vendors' implementation burden.

- More importantly, the merger will decrease future WG21 burden by managing a single International Standard, rather than two. This reduces not only the number of published Standards, but also the number of working papers, issues lists, Project Editors, and the like.

- Finally, it is relevant to take this step in time for C++14, because [ISO10] will come before WG21, per the usual rule for periodic review, in 2015. That would then be an appropriate time and means to retire [ISO10].

2   Proposed wording

All proposed wording is relative to WG21 draft [DuT12]. Text in green text is to be added; editorial notes are displayed against a gray background .[5]

Append the following text to the end of clause [c.math] as a new paragraph.

Additionally, the appearance in **<cmath>** of the functions and other specifications of clause [sf] is conditionally supported. The macro **__STDCPP_MATH_SPEC_FUNCS__** shall correspondingly be conditionally defined by the implementation with the same value as the macro **__cplusplus** [cpp.predefined].

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[2] However, it was evidently not deemed a similar hardship and burden to integrate C99's new math functions (some of which, like the hyperbolic functions, are actually mathematically classified as special functions) into C++11. As enumerated by [Pla02], the functions added to **<math.h>** consisted of "**acosh**, **asinh**, **atanh**, **cbrt**, **copysign**, **erf**, **erfc**, **exp2**, **expm1**, **fdim**, **fma**, **fmax**, **fmin**, **hypot**, **ilogb**, **lgamma**, **llrint**, **llround**, **log1p**, **log2**, **logb**, **lrint**, **lround**, **nan**, **nearbyint**, **nextafter**, **nexttoward**, **remainder**, **remquo**, **rint**, **round**, **scalbln**, **scanbn**, **tgamma**, and **trunc**, plus float versions (ending in f) and long double versions (ending in l)" as well as additional new macros, function macros, and entirely new related headers such as **<fenv.h>**. ☺

[3] In explaining why it wanted to issue an International Standard rather than a Technical Report on this topic, WG14 noted that the state of the art had advanced considerably since the project's inception: "[Now t]here are several implementations, complete or under development, all using the functionality that the committee intended to document. . . " [Ben07].

[4] According to the WG21 Convener, these two International Standards are reportedly the first in ISO history that were approved after two ballots each, rather than via the usual three-ballot process, because there were no "no" votes.

[5] The technical content of [ISO10], in the form of LaTeX machine-readable text, will be made advailable to the Project Editor to help insure the smoothest possible transition.

At the level of and following [c.math], create a new subclause with heading and initial content the same as [ISO10]'s clause [sf], "Mathematical special functions," renumbering as appropriate to the new context. Then adjust the newly-imported [sf.cmath]/2 as follows:

. . . . The detailed signatures added in namespace **std** to header **<cmath>** are: . . .

Merge [ISO10]'s clause [norm], "Normative References," into [intro.refs], and merge [ISO10]'s clause [terms], "Terms, definitions, and symbols," into [intro.defs], each in an order determined at the discretion of the Project Editor.

3 Acknowledgments

Many thanks to everyone who helped during the evolution of Mathematical Special Functions in the C++ standard library.

Special thanks to WG14 for its early and enthusiastic embrace of Mathematical Special Functions for the C library.

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5   Revision history

Revision	Date	Changes
1.0	2013-03-12	• Published as N3548.