Proposal for C2x
WG14 N2411

Title: Querying attribute support
Author, affiliation: Aaron Ballman, GrammaTech
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Proposal category: New features
Target audience: General developers, compiler/tooling developers

Abstract: Users with cross-platform code bases need the ability to interrogate a given implementation to determine whether an attribute is supported or not. This provides a preprocessor mechanism to perform that interrogation.

Prior art: C++ standardized this feature in C++2a, spelled __has_cpp_attribute. Clang is shipping this feature under the proposed spelling.
Querying attribute support

Reply-to: Aaron Ballman (aaron@aaronballman.com)
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Summary of Changes

N2411
- Added the new 6.10.1p4 paragraph to allow __has_c_attribute to be treated like a macro for #ifdef, #ifndef, and #if defined support.
- Update the values for the concrete attributes to be based on when they were adopted (if they were adopted) or a placeholder value.
- Updated 6.10.8p2 to disallow #define or #undef of __has_c_attribute.
- Added rationale describing why __has_c_attribute should behave like defined as opposed to being a function-like macro.
- Updated the original 6.10.1p4 to give semantics to macro expansion of __has_c_attribute.

N2333
- Original proposal.

Introduction

To keep code portable, especially for library code which may be consumed by implementations unknown or unavailable to the author of the code, users need the ability to interrogate a compiler to determine whether an attribute [N2269] is supported or not. The proposed __has_c_attribute function-like macro provides users with a way to query whether an implementation supports a given attribute.

Rationale

The list of supported attributes changes with each revision of the C Standard and implementations are allowed to provide their own attributes. Users writing portable code may wish to guard against quality implementations diagnosing use of unknown or unsupported attributes while still preserving the functionality provided by the attribute where possible. Additionally, some implementations may provide a non-attribute fallback for the desired functionality, possibly allowing a user’s code base to degrade more gracefully in the absence of support for an attribute.

Proposal

C++ uses the __has_cpp_attribute function-like macro to interrogate an implementation’s support for an attribute [P0941R2], and this document proposes adding the __has_c_attribute function-like macro for the same purposes. Separate macros are useful to allow independent queries for both C and C++ code, as an attribute may be supported in only one of the two languages for a given implementation.
This function-like macro is intended to be used in conjunction with other user-defined macros exposing
the attribute, as in the following example.

```c
/* Fallback for compilers not yet implementing this feature. */
#endif /* __has_c_attribute */
#endif /* __has_c_attribute */
#if __has_c_attribute(fallthrough)
#endif /* __has_c_attribute */

This feature-test macro can be used with either a standards-based attribute or with a vendor-supplied
attribute. The result of the macro expansion will be 0 if the attribute is unknown or unsupported, and
will return nonzero if the attribute is supported for that build configuration. Standards-based attributes
will return the latest date of modification to the standard for that attribute (e.g., 201811L if an attribute
was voted into the standard in Nov 2018) in order to allow more fine-grained feature testing capabilities
should an attribute evolve over time. For example, imagining a hypothetical situation in which the
deprecated attribute was standardized as not taking a string argument until Nov 2018:

```c
#if __has_c_attribute(deprecated) >= 201811L
#define DEPRECATED(MSG) [[deprecated(MSG)]]
#else
#define DEPRECATED(MSG) [[deprecated]]
#endif /* Fallback implementation; perhaps use an alternative impl. */
```

C++ lists attribute feature test macro values alongside a list of other, non-attribute feature testing
macros. Given that C does not have a similar list serving the same purpose, this document proposes
adding the feature testing macro value for standards-based attributes as a normative paragraph
attached to each attribute.

C++ based the behavior of `__has_cpp_attribute` on the defined preprocessor token, where it is
only available for use within a conditional inclusion expression. This proposal is consistent with the C++
treatment and does not propose adding this as a predefined macro available outside of the
preprocessor. It is valuable for C to follow suit because restricting the usage to only preprocessor
conditionals does not interfere with any intended use cases; runtime branching based on the existence
of an attribute is not intended to be easily supported.

Proposed Wording
The wording proposed is a diff from ISO/IEC 9899-2018. Green text is new text, while red text is deleted
text.

Modify 6.10.1p1, splitting it into two paragraphs:
The expression that controls conditional inclusion shall be an integer constant expression except that: identifiers (including those lexically identical to keywords) are interpreted as described below.\(^{167}\)

The conditional inclusion expression may contain unary operator expressions of the form

\[
\text{defined}(\text{identifier})
\]

or

\[
\text{defined}(\text{identifier})
\]

which evaluate to 1 if the identifier is currently defined as a macro name (that is, if it is predefined or if it has been the subject of a \#define preprocessing directive without an intervening \#undef directive with the same subject identifier), 0 if it is not.

Add a third paragraph to the Constraints section after the new 2\(^{\text{nd}}\) paragraph from above:

The conditional inclusion expression may contain unary operator expressions of the form

\[
\_\text{has}\_\text{c}_\text{attribute}(\text{pp-tokens})
\]

which are replaced by a nonzero pp-number matching the form of an integer-constant if the implementation supports an attribute with the name specified by interpreting the pp-tokens as an attribute-token, and by 0 otherwise. The pp-tokens shall match the form of an attribute-token.

Add a fourth paragraph as the initial paragraph in the Semantics section:

The \#ifdef and \#ifndef directives, and the defined conditional inclusion operator, shall treat \_\text{has}\_\text{c}_\text{attribute} as if it was the name of a defined macro. The identifier \_\text{has}\_\text{c}_\text{attribute} shall not appear in any context not mentioned in this subclause.

Modify 6.10.1p4 (as originally numbered):

Drafting note: I do not think we need to make it explicitly undefined to generate \_\text{has}\_\text{c}_\text{attribute} through macro replacement because of the “shall not appear in any context” above. The C++ standard has similar words in [cpp.cond]p10 but they do not mention \_\text{has}\_\text{c}_\text{attribute} in that paragraph.

4 Prior to evaluation, macro invocations in the list of preprocessing tokens that will become the controlling constant expression are replaced (except for those macro names modified by the defined unary operator), just as in normal text. If the token defined is generated as a result of this replacement process or use of the defined unary operator does not match one of the two specified forms prior to macro replacement, the behavior is undefined. After all replacements due to macro expansion and evaluations of the defined and \_\text{has}\_\text{c}_\text{attribute} unary operators have been performed, all remaining identifiers (including those lexically identical to keywords) are replaced with the pp-number 0, and then each preprocessing token is converted into a token. The resulting tokens compose the controlling constant expression which is evaluated according to the rules of 6.6. For the purposes of this token conversion and evaluation, all signed integer types and all unsigned integer types act as if they have the same representation as, respectively, the types intmax_t and uintmax_t defined in the header <cstdint.h>.\(^{168}\) This includes interpreting character constants, which may involve converting escape sequences into execution character set members. Whether the numeric value for these character constants matches the value obtained when an identical character constant occurs in an
expression (other than within a \#if or \#elif directive) is implementation-defined.\[^{169}\] Also, whether a single-character character constant may have a negative value is implementation-defined.

Add new paragraphs after 6.10.1p6:

8 EXAMPLE

```c
/* Fallback for compilers not yet implementing this feature. */
#ifndef __has_c_attribute
#define __has_c_attribute(x) 0
#endif /* __has_c_attribute */

#if __has_c_attribute(fallthrough)
/* Standard attribute is available, use it. */
#define FALLTHROUGH [[fallthrough]]
#else
/* Fallback implementation. */
#define FALLTHROUGH[[vendor::fallthrough]]
#endif
```

Modify 6.10.8p2:

Drafting note: This is intended to continue to allow the common coding pattern:

```c
#ifndef __has_c_attribute
#define __has_c_attribute(x) 0
#endif
```

because 6.10.1p4 allows \__has_c_attribute to appear in the \#ifndef. The prohibition added here prevents subversion of \__has_c_attribute behavior when the feature is supported by an implementation while still allowing useful idioms in practice when an implementation does not yet support \__has_c_attribute.

2 None of these macro names, nor the identifiers defined or \__has_c_attribute, shall be the subject of a \#define or a \#undef preprocessing directive. Any other predefined macro names shall begin with a leading underscore followed by an uppercase letter or a second underscore.

Add a new paragraph after 6.7.11.1p3, to be applied only if the deprecated attribute is adopted. The editors are expected to replace the given value with the appropriate date of adoption for the attribute:

4 The \__has_c_attribute conditional inclusion expression (6.10.1) shall return the value 20YYMM when given deprecated as the pp-tokens operand.

Add a new paragraph after 6.7.11.2p1, to be applied only if the fallthrough attribute is adopted. The editors are expected to replace the given value with the appropriate date of adoption for the attribute:

2 The \__has_c_attribute conditional inclusion expression (6.10.1) shall return the value 201904L when given fallthrough as the pp-tokens operand.

Add a new paragraph after 6.7.11.3p2, to be applied only if the maybe_unused attribute is adopted. The editors are expected to replace the given value with the appropriate date of adoption for the attribute:
3 The `__has_c_attribute` conditional inclusion expression (6.10.1) shall return the value 201904L when given `maybe_unused` as the `pp-tokens` operand.

Add a new paragraph after 6.7.11.4p1, to be applied only if the `nodiscard` attribute is adopted. The editors are expected to replace the given value with the appropriate date of adoption for the attribute:

2 The `__has_c_attribute` conditional inclusion expression (6.10.1) shall return the value 201904L when given `nodiscard` as the `pp-tokens` operand.

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References

[P0941R2]

[N2269]