

Construction Rules for enum class Values

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Abstract

This paper suggests a simple adjustment to the existing rules governing conversion from the underlying type of a scoped enumeration to said enumeration, if the latter is defined with no associated enumerator. This effectively supports programming styles that rely on defining of new distinct integral types based out of existing integer types, without the complexity of anarchic integer conversions, while retaining all the ABI characteristics and benefits of the integer types, especially for system programming.

1 INTRODUCTION

There is an incredibly useful technique for introducing a new integer type that is almost an exact copy, yet distinct type in modern C++11 programs: an `enum class` with an explicitly specified underlying type. Example:

```
enum class Index : uint32_t { };    // Note: no enumerator.
```

One can use `Index` as a new distinct integer type, it has no implicit conversion to anything (good!) This technique is especially useful when one wants to avoid the anarchic implicit conversions C++ inherited from C. For all practical purposes, `Index` acts like a "strong typedef" in C++11.

There is however, one inconvenience: to construct a value of type `Index`, the current language spec generally requires the use a cast -- either a `static_cast` or a functional notation cast. This is both conceptually wrong and practically a serious impediment. Constructing an `Index` value out of `uint32_t` is not a cast, no more than we consider

```
struct ClassIndex { uint32_t val; };  
  
ClassIndex idx { 42 };
```

a cast. It is a simple construction of a value of type `ClassIndex`, with no narrowing conversion. I claim the current rule for scoped enumeration is too strict. For instance, we should be able to write

```
int f(Index);  
auto a = f({42});
```

This proposal suggests we allow an implicit/non-narrowing conversion from a scoped enumeration's underlying type to the enumeration itself, when its definition introduces no enumerator and the source uses a list-initialization syntax. This is safe and support very useful programming techniques. For example, you could introduce new integer types (e.g. SafeInt) that **enjoy the same existing calling conventions as its underlying integer type**, even on ABIs expressly designed to penalize passing/returning structures by value. This supports a zero-overhead abstraction technique. It has been found very popular in practice by system programmers and application programmers.

Strictly speaking, this change could be detected by SFINAE tricks; however, the benefit is much greater -- and the SFINAE trick detection is more useful in the *other* direction, which I am not proposing to change.

2 WORDING

Modify paragraph 7.2/8 as follows

For an enumeration whose underlying type is fixed, the values of the enumeration are the values of the underlying type. **A scoped enumeration with a fixed underlying type is called an *integer class* if its *enumerator-list* is empty.** [...]

Add a bullet between (3.8) and (3.9) to paragraph 8.5.4/3 as follows:

Otherwise, if T is an integer class (7.2) with underlying type E, the initializer list shall be either empty or of the form { v } and the conversion from v to E (if any) shall not involve a narrowing conversion. In either case, the object is initialized with T() if the initializer list was empty, or the functional cast expression T(v). [Example:

```
enum byte : unsigned char { };

byte b { 42 };                // OK

byte c = { 42 };             // OK; same value as b

byte d = byte{ 42 };         // OK; same value as b

void f(byte);

f({ 42 });                   // OK; same as f(T(42))

f({ -43 });                  // error

f(43);                       // error

--end example]
```

3 ACKNOWLEDGMENT

This proposal formalizes the TINY suggestion made on EWG reflector [1]. It benefited from feedback from various people, in particular Richard Smith and Jens Maurer. After the draft of this paper was completed, I was made aware of the paper authored by Walter Brown reviving the suggestion of “opaque typedef” [2]. The current suggestion is not incompatible with Walter’s proposal, nor is it a replacement or a competing proposal. An integer class is still an enumeration and follows every other rule governing scope enumerations. This proposal is more of a completion of Oleg Smolsky’s proposal [3], but for enumerations.

4 REFERENCES

- [1] Gabriel Dos Reis, *[TINY] enum class conversion and conversion from underlying type when no enumerator is introduced*, 2015. Reflector message c++std-ext-16296 posted on January 7, 2015.
- [2] Walter Brown, "Function Aliases + Extended Inheritance = Opaque Typedefs," ISO/IEC JTC1/SC22/WG21, 2015. Document number P0109R0
- [3] Oleg Smolsky, "Extension to aggregate initialization," ISO/IEC JTC1/SC22/WG21, 2015. Document number P0017R0