

std::function move operations should be noexcept

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Introduction

The move constructor and move assignment operator for `std::function` should be `noexcept`.

Motivation and Scope

It is highly desirable to have `noexcept` move operations, especially when it does not impose an undue burden on implementers or a high cost for users.

The other type-erased standard libraries `any` and `shared_ptr` already require this. `function` is very similar to `any` in that both encourage the small object optimization.

It appears that `function` is required to use the small object optimization, at least to hold a `reference_wrapper` object or function pointer [\[func.wrap.func.con#4\]](#), and this proposal is compatible with that.

Both `libstdc++` and `libc++` already implement this.

Impact on the Standard

Impact on the standard is minor. The declarations for the move constructor and move assignment operator for `function` have to have `noexcept` added, and the `throws` clause for the move constructor has to be deleted.

Design Decisions

A possible implementation technique: if the object either is too big to fit inside the small object optimization space inside `function` or the object has a `noexcept(false)` move constructor or `noexcept(false)` assignment operator, then store it in the heap; otherwise, store it in the small object optimization space.

Because default construction and `swap` are already `noexcept`, it is very likely that a currently conforming implementation of `function` already does something like this under the covers, even if they don't declare their move constructor and move assignment operator as `noexcept`.

Technical Specifications

Changes relative to [n4687](#):

[func.wrap.func]

```
function() noexcept;
function(nullptr_t) noexcept;
function(const function&);
function(function&&) noexcept;
template<class F> function(F);

function& operator=(const function&);
function& operator=(function&&) noexcept;
function& operator=(nullptr_t) noexcept;
template<class F> function& operator=(F&&);
template<class F> function& operator=(reference_wrapper<F>) noexcept;
~function();
```

[func.wrap.func.con]

```
function(function&& f) noexcept;
Postconditions: If !f, *this has no target; otherwise, the target of *this is equivalent to the target of f before the construction, and f is in a valid state with an unspecified value.
Throws: Shall not throw exceptions if f's target is a specialization of reference_wrapper or a function pointer. Otherwise, may throw bad_alloc or any exception thrown by the copy or move constructor of the stored callable object. [ Note: Implementations should avoid the use of dynamically allocated memory for small callable objects, for example, where f's target is an object holding only a pointer or reference to an object and a member function pointer. —end note ]
```

```
function& operator=(function&& f) noexcept;
Effects: Replaces the target of *this with the target of f.
Returns: *this.
```

Acknowledgements

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References

[n4687](#) - Working Draft, Standard for Programming Language C++, Richard Smith

[std_function.h](#), libstdc++ (gcc)

[functional](#) – libc++ (clang)