Document number:	P0319R0
Date:	2016-05-22
Project:	ISO/IEC JTC1 SC22 WG21 Programming Language C++
Audience:	Library Evolution Working Group / Concurrency Working Group
Reply-to:	Vicente J. Botet Escribá <vicente.botet@nokia.com>

Adding Emplace functions for `promise<T>/future<T>`

Abstract

This paper proposes the addition of emplace factories for `future<T>` and emplace functions for `promise<T>` as we have proposed for of `any` and `optional` in P0032R2.

Table of Contents

Introduction

This paper proposes the addition of emplace factories for `future<T>` and emplace functions for `promise<T>` as we have proposed for of `any` and `optional` in P0032R2.

Motivation

While we have added the `future<T>` factories `make_ready_future` and `make_exceptional_future` into P0159R0, we don't have emplace factories as we have for `shared_ptr` and `unique_ptr` and we could have for `any` and `optional` if P0032R2 is accepted.

The C++ standard should be coherent for features that behave the same way on different types and complete, that is, don't miss features that could make the user code more efficient.

Proposal

We propose to:

- Add `promise<T>::set_exception(E)` member function that sets a promise `exception_ptr` from an exception.
- Add `promise<T>::emplace(Args...)` member function that emplaces the value instead of setting it.
- Add `future<T>` emplace factory `emplace_ready_future<T>(Args...)` / `make_ready_future<T>(Args...)`.
- Add `future<T>` emplace factory `emplace_exceptional_future<T,E>(Args...)/make_exceptional_future<T,E>(Args...)`.

Emplace assignment for promises

Some times a promise setter function must construct the promise value type and possibly the exception, that is the value or the exceptions are not yet built.

Before

```
void promiseSetter(promise<X>& p, bool cnd) {
  if (cnd)
    p.set_value(X(a, b, c));
  else
    p.set_exception(make_exception_ptr(MyException(__FILE_, __LINE__)));
}
```

Note that we need to repeat `X`.

With this proposal we can just emplace either the value or the exception.

```
void producer(promise<int>& p) {
  if (cnd) p.set_value(a, b, c);
  else p.set_exception(MyException(__FILE_, __LINE__));
}
```

Note that not only the code can be more efficient, it is also clearer and more robust as we don't repeat neither `X` ..

Emplace factory for futures

Some future producer functions may know how to build the value at the point of construction and possibly the exception. However, when the value type is not available it must be constructed explicitly before making a ready future. The same applies for a possible exception that must be built.

Before

```
future<X> futureProducer(bool cnd1, bool cnd2) {
  if (cnd1)
    return make_ready_future(X(a, b, c));
  if (cnd2)
    return make_exceptional_future<X>(MyException(__FILE_, __LINE__));
  else
    return somethingElse();
}
```

The same reasoning than the previous section applies here. With this proposal we can just write less code and have more (as possible more efficient).

```
future<int> futureProducer(bool cnd1, bool cnd2) {
      if (cnd1)
        return make_ready_future<X>(a, b, c);
      if (cnd2)
        return make_exceptional_future<X>(MyException(__FILE_, __LINE__));
      else
        return somethingElse();
    }
```

Design rationale

Why should we provide some kind of emplacement for

`future` / `promise` ?

Wrapping and type-erasure classes should all provide some kind of emplacement as it is more efficient to emplace than to construct the wrapped/type-erased type and then copy or assign it.

The current standard and the TS provide already a lot of such emplace operations, either in place constructors, emplace factories, emplace assignments.

Why emplace factories instead of in_place constructors?

`std::experimental::optional` provides in place constructors and it could provide emplace factory if P0032R0 is adopted.

This proposal just extends the current future factories to emplace factories.

Should we provide a future `in_place` constructor? For coherency purposes and in order to be generic, yes, we should. However we should also provide a constructor from a `T` which doesn't exists neither. This paper doesn't proposes this yet.

Promise emplace assignments

`std::experimental::optional` provides emplace assignments via `optional::emplace()` and it could provide emplace factory if P0032R0 is accepted.

We believe that `promise<T>` should provide and similar interface. However, a promise accepts to be set only once, and so the function name should be different for the authors.

Impact on the standard

These changes are entirely based on library extensions and do not require any language features beyond what is available in C++ 14.

Proposed wording

The wording is relative to P0159R0.

The current wording make use of `decay_unwrap_t` as proposed in P0318R0, but if this is not accepted the wording can be changed without too much troubles.

Thread library

X.Y Header `<experimental/future>` synopsis

Replace the makereadyfuture declaration in [header.future.synop] by

```
namespace std {
namespace experimental {
inline namespace concurrency_v2 {

template <int=0, int ..., class T>
future<decay_unwrap_t<T>> make_ready_future(T&& x) noexcept;
template <class T>
future<T> make_ready_future(remove_reference<T> const& x) noexcept;
template <class T>
future<T> make_ready_future(remove_reference<T> && x) noexcept;
template <class T, class ...Args>
future<T> make_ready_future(Args&& ...args) noexcept;
}}
}
```

X.Y Class template `promise`

`Add [futures.promise] the following in the synopsis`

```
template <class ...Args>
void promise::set_value(Args&& ...args);
template <class U, class... Args>
void promise::set_value(initializer_list<U> il, Args&&... args);
```

`Add the following`

```
template <class ...Args>
void promise::set_value(Args&& ...args);
```

Requires: `is_constructible<R, Args&&...>`

Effects: atomically initializes the stored value as if direct-non-list-initializing an object of type `R` with the arguments `forward<Args>(args)...)` in the shared state and makes that state ready.

Postconditions: this contains a value.

`[NDLR] Throws and Error conditions as before`

```
template <class U, class... Args>
void promise::set_value(initializer_list<U> il, Args&&... args);
```

Requires: `is_constructible<R, initializer_list<U>&, Args&&...>`

Effects: atomically initializes the stored value as if direct-non-list-initializing an object of type `R` with the arguments `il, forward<Args>(args)...)` in the shared state and makes that state ready.

Postconditions: this contains a value.

`[NDLR] Throws and Error conditions as before`

Function template make*ready*future

`[NDLR] Add to [futures.make_ready_future] the following`

```
template <class T>
future<T> make_ready_future(remove_reference<T> const& v) noexcept;
template <class T>
future<T> make_ready_future(remove_reference<T> && r) noexcept;
template <class T, class ...Args>
future<T> make_ready_future(Args&& ...args) noexcept;
```

Effects: The function creates a shared state immediately ready emplacing the `T` with `x` for the first overload, `forward<T>(r)` for the second and `T{args...}` for the third.

Returns: A future associated with that shared state.

Postconditions: The returned future contains a value.

Implementability

Boost.Thread contains an implementation of the emplace value functions.

Open Points

The authors would like to have an answer to the following points if there is at all an interest in this proposal. Most of them are bike-shedding about the name of the proposed functions:

`emplace_` versus `make_` factories

`shared_ptr` and `unique_ptr` factories `make_shared` and `make_unique` emplace already the underlying type and are prefixed by `make_`. For coherency purposes the function emplacing future should use also `make_` prefix.

`promise::emplace` versus `promise::set_value`

`promise<R>` has a `set_value` member function that accepts a

```
void promise::set_value(const R& r);
void promise::set_value(R&& r);
void promise<R&>::set_value(R& r);
void promise<void>::set_value();
```

There is no reason for constructing an additional `R` to set the value, we can emplace it

```
template <typename ...Args>
void promise::set_value(Args&& as);
```

`optional` names this member function `emplace`. However, a promise accepts to be set only once, and so the function name should be different. Should we add a new member `emplace` function to `promise<T>` or overload `set_value` ?

Future work

In addition to emplace value functions we could also have emplace exceptions functions. This would need to update also `exception_ptr` emplace factories. While this cases can perform better, the exceptional case need less optimizations.

Acknowledgements

Thanks to Jonathan Wakely for his suggestion to limit the proposal to the emplace value cases which should be more consensual.

References

- [N4480](http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2015/n4480.html) N4480 - Working Draft, C++ Extensions for Library Fundamentals

  http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2015/n4480.html

- P0032R0 P0032 - Homogeneous interface for variant, any and optional http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2015/p0032r0.pdf

* P0032R2 P0032 - Homogeneous interface for variant, any and optional - Revision 1

  http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0032r2.pdf

* P0159R0 P0159 - Draft of Technical Specification for C++ Extensions for Concurrency

  http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2015/p0159r0.html

* P0318R0 `decay_unwrap` and `unwrap_reference`

  http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0318r0.pdf

* P0338R0 - C++ generic factories

  http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0338r0.pdf

* make.impl C++ generic factory - Implementation

  https://github.com/viboes/std-make/blob/master/include/experimental/std*make*v1/make.hpp

* Boost.Thread http://www.boost.org/doc/libs/1*60*0/doc/html/thread.html