

p0408r0 - Efficient Access to `basic_stringbuf`'s Buffer

Peter Sommerlad

2016-07-01

Document Number: p0408r0	
Date:	2016-07-01
Project:	Programming Language C++
Audience:	LWG/LEWG

1 Motivation

Streams have been the oldest part of the C++ standard library and their specification doesn't take into account many things introduced since C++11. One of the oversights is that there is no non-copying access to the internal buffer of a `basic_stringbuf` which makes at least the obtaining of the output results from an `ostreamstream` inefficient, because a copy is always made. I personally speculate that this was also the reason why `basic_strbuf` took so long to get deprecated with its `char *` access.

With move semantics and `basic_string_view` there is no longer a reason to keep this pessimisation alive on `basic_stringbuf`.

2 Introduction

This paper proposes to adjust the API of `basic_stringbuf` and the corresponding stream class templates to allow accessing the underlying string more efficiently.

C++17 and library TS have `basic_string_view` allowing an efficient read-only access to a contiguous sequence of characters which I believe `basic_stringbuf` has to guarantee about its internal buffer, even if it is not implemented using `basic_string` obtaining a `basic_string_view` on the internal buffer should work sidestepping the copy overhead of calling `str()`.

On the other hand, there is no means to construct a `basic_string` and move from it into a `basic_stringbuf` via a constructor or a move-enabled overload of `str(basic_string &&)`.

3 Acknowledgements

- Daniel Krüger encouraged me to pursue this track.

4 Impact on the Standard

This is an extension to the API of `basic_stringbuf`, `basic_stringstream`, `basic_istreamstream`, and `basic_ostringstream` class templates.

5 Design Decisions

After experimentation I decided that substituting the `(basic_string<charT, traits, Allocator const &)` constructors in favor of passing a `basic_string_view` would lead to ambiguities with the new move-from-string constructors.

5.1 Open Issues to be Discussed by LEWG / LWG

- Is the name of the `str_view()` member function ok?
- Should the `str()&&` overload be provided for move-out?
- Should `str()&&` empty the character sequence or leave it in an unspecified but valid state?

6 Technical Specifications

The following is relative to n4594.

6.1 27.8.2 Adjust synopsis of `basic_stringbuf` [`stringbuf`]

Add a new constructor overload:

```
explicit basic_stringbuf(
    basic_string<charT, traits, Allocator>&& s,
    ios_base::openmode which = ios_base::in | ios_base::out);
```

Change the `const`-overload of `str()` member function to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT, traits, Allocator> str() const &;
```

Add two overloads of the `str()` member function and add the `str_view()` member function:

```
void str(basic_string<charT, traits, Allocator>&& s);
basic_string<charT, traits, Allocator> str() &&;
basic_string_view<charT, traits> str_view() const;
```

6.1.1 27.8.2.1 `basic_stringbuf` constructors [stringbuf.cons]

Add the following constructor specification:

```
explicit basic_stringbuf(
    basic_string<charT, traits, Allocator>&& s,
    ios_base::openmode which = ios_base::in | ios_base::out);
```

- ¹ *Effects:* Constructs an object of class `basic_stringbuf`, initializing the base class with `basic_streambuf()` (27.6.3.1), and initializing mode with `which`. Then calls `str(std::move(s))`.

6.1.2 27.8.2.3 Member functions [stringbuf.members]

Change the `const`-overload of `str()` member function specification to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT,traits,Allocator> str() const &;
```

Change p1 to use plural for "`str(basic_string)` member functions":

- ¹ *Returns:* A `basic_string` object whose content is equal to the `basic_stringbuf` underlying character sequence. If the `basic_stringbuf` was created only in input mode, the resultant `basic_string` contains the character sequence in the range `[eback(), egptr())`. If the `basic_stringbuf` was created with `which & ios_base::out` being true then the resultant `basic_string` contains the character sequence in the range `[pbase(), high_mark)`, where `high_mark` represents the position one past the highest initialized character in the buffer. Characters can be initialized by writing to the stream, by constructing the `basic_stringbuf` with a `basic_string`, or by calling one of the `str(basic_string)` member functions. In the case of calling one of the `str(basic_string)` member functions, all characters initialized prior to the call are now considered uninitialized (except for those characters re-initialized by the new `basic_string`). Otherwise the `basic_stringbuf` has been created in neither input nor output mode and a zero length `basic_string` is returned.

Add the following specifications and adjust the wording of `str() const &` according to the wording given for `str_view() const` member function.:

```
void str(basic_string<charT, traits, Allocator>&& s);
```

- ² *Effects:* Moves the content of `s` into the `basic_stringbuf` underlying character sequence and initializes the input and output sequences according to mode.
- ³ *Postconditions:* Let `size` denote the original value of `s.size()` before the move. If mode `& ios_base::out` is true, `pbase()` points to the first underlying character and `eptr() >= pbase() + size` holds; in addition, if mode `& ios_base::ate`

is true, `pptr() == pbase() + size` holds, otherwise `pptr() == pbase()` is true. If `mode & ios_base::in` is true, `eback()` points to the first underlying character, and both `gptr() == eback()` and `egptr() == eback() + size` hold.

```
basic_string<charT, traits, Allocator> str() &&;
```

- 4 *Returns:* A `basic_string` object moved from the `basic_stringbuf` underlying character sequence. If the `basic_stringbuf` was created only in input mode, `basic_string(eback(), egptr()-eback())`. If the `basic_stringbuf` was created with `which & ios_base::out` being true then `basic_string(pbase(), high_mark-pbase())`, where `high_mark` represents the position one past the highest initialized character in the buffer. Characters can be initialized by writing to the stream, by constructing the `basic_stringbuf` with a `basic_string`, or by calling one of the `str(basic_string)` member functions. In the case of calling one of the `str(basic_string)` member functions, all characters initialized prior to the call are now considered uninitialized (except for those characters re-initialized by the new `basic_string`). Otherwise the `basic_stringbuf` has been created in neither input nor output mode and an empty `basic_string` is returned.

- 5 *Postcondition:* The underlying character sequence is empty.

```
basic_string_view<charT, traits> str_view() const;
```

- 6 *Returns:* A `basic_string_view` object referring to the `basic_stringbuf` underlying character sequence. If the `basic_stringbuf` was created only in input mode, `basic_string_view(eback(), egptr()-eback())`. If the `basic_stringbuf` was created with `which & ios_base::out` being true then `basic_string_view(pbase(), high_mark-pbase())`, where `high_mark` represents the position one past the highest initialized character in the buffer. Characters can be initialized by writing to the stream, by constructing the `basic_stringbuf` with a `basic_string`, or by calling one of the `str(basic_string)` member functions. In the case of calling one of the `str(basic_string)` member functions, all characters initialized prior to the call are now considered uninitialized (except for those characters re-initialized by the new `basic_string`). Otherwise the `basic_stringbuf` has been created in neither input nor output mode and a `basic_string_view` referring to an empty range is returned.

- 7 [*Note:* Using the returned object after destruction or any modification of `*this`, such as output on the holding stream, will cause undefined behavior, because the internal string referred by the return value might have changed or re-allocated. — *end note*]

6.2 27.8.3 Adjust synopsis of `basic_istreamstream` [`istreamstream`]

Add a new constructor overload:

```
explicit basic_istreamstream(
    basic_string<charT, traits, Allocator>&& str,
    ios_base::openmode which = ios_base::in);
```

Change the `const`-overload of `str()` member function to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT, traits, Allocator> str() const &;
```

Add an overload of the `str()` member function and add the `str_view()` member function:

```
void str(basic_string<charT, traits, Allocator>&& s);
basic_string<charT, traits, Allocator> str() &&;
basic_string_view<charT, traits> str_view() const;
```

6.2.1 27.8.3.1 `basic_istreamstream` constructors [`istreamstream.cons`]

Add the following constructor specification:

```
explicit basic_istreamstream(
    const basic_string<charT, traits, Allocator>&& str,
    ios_base::openmode which = ios_base::in);
```

- ¹ *Effects:* Constructs an object of class `basic_istreamstream<charT, traits>`, initializing the base class with `basic_istream(&sb)` and initializing `sb` with `basic_stringbuf<charT, traits, Allocator>(std::move(str), which | ios_base::in)` (27.8.2.1).

6.2.2 27.8.3.3 Member functions [`istreamstream.members`]

Change the `const`-overload of `str()` member function specification to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT, traits, Allocator> str() const &;
```

Add the following specifications and adjust the wording of `str() const` according to the wording given for `str_view() const` member function.:

```
void str(basic_string<charT, traits, Allocator>&& s);
```

- ¹ *Effects:* `rdbuf()->str(std::move(s))`.

```
basic_string<charT, traits, Allocator> str() &&;
```

2 *Returns:* `std::move(*rdbuf()).str()`.

```
basic_string_view<charT, traits> str_view() const;
```

3 *Returns:* `rdbuf()->str_view()`.

6.3 27.8.4 Adjust synopsis of `basic_ostringstream` [`ostringstream`]

Add a new constructor overload:

```
explicit basic_ostringstream(
    basic_string<charT, traits, Allocator>&& str,
    ios_base::openmode which = ios_base::out);
```

Change the `const`-overload of `str()` member function to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT, traits, Allocator> str() const &;
```

Add an overload of the `str()` member function and add the `str_view()` member function:

```
void str(basic_string<charT, traits, Allocator>&& s);
basic_string<charT, traits, Allocator> str() &&;
basic_string_view<charT, traits> str_view() const;
```

6.3.1 27.8.4.1 `basic_ostringstream` constructors [`ostringstream.cons`]

Add the following constructor specification:

```
explicit basic_ostringstream(
    const basic_string<charT, traits, Allocator>&& str,
    ios_base::openmode which = ios_base::out);
```

1 *Effects:* Constructs an object of class `basic_ostringstream<charT, traits>`, initializing the base class with `basic_ostream(&sb)` and initializing `sb` with `basic_stringbuf<charT, traits, Allocator>(std::move(str), which | ios_base::out)` (27.8.2.1).

6.3.2 27.8.4.3 Member functions [`ostringstream.members`]

Change the `const`-overload of `str()` member function specification to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT, traits, Allocator> str() const &;
```

Add the following specifications and adjust the wording of `str()` `const` according to the wording given for `str_view()` `const` member function.:

```
void str(basic_string<charT, traits, Allocator>&& s);
```

1 *Effects:* `rdbuf()->str(std::move(s)).`

```
basic_string<charT,traits,Allocator> str() &&;
```

2 *Returns:* `std::move(*rdbuf()).str().`

```
basic_string_view<charT, traits> str_view() const;
```

3 *Returns:* `rdbuf()->str_view().`

6.4 27.8.5 Adjust synopsis of `basic_stringstream` [`stringstream`]

Add a new constructor overload:

```
explicit basic_stringstream(
    basic_string<charT, traits, Allocator>&& str,
    ios_base::openmode which = ios_base::in | ios_base::out);
```

Change the `const`-overload of `str()` member function to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT,traits,Allocator> str() const &;
```

Add an overload of the `str()` member function and add the `str_view()` member function:

```
void str(basic_string<charT, traits, Allocator>&& s);
basic_string<charT,traits,Allocator> str() &&;
basic_string_view<charT, traits> str_view() const;
```

6.4.1 27.8.4.1 `basic_stringstream` constructors [`stringstream.cons`]

Add the following constructor specification:

```
explicit basic_stringstream(
    const basic_string<charT, traits, Allocator>&& str,
    ios_base::openmode which = ios_base::in | ios_base::out);
```

1 *Effects:* Constructs an object of class `basic_stringstream<charT, traits>`, initializing the base class with `basic_stream(&sb)` and initializing `sb` with `basic_stringbuf<charT, traits, Allocator>(std::move(str), which)` (27.8.2.1).

6.4.2 27.8.4.3 Member functions [stringstream.members]

Change the `const`-overload of `str()` member function specification to add a reference qualification. This avoids ambiguities with the rvalue-ref overload of `str()`.

```
basic_string<charT,traits,Allocator> str() const &;
```

Add the following specifications and adjust the wording of `str() const` according to the wording given for `str_view() const` member function.:

```
void str(basic_string<charT, traits, Allocator>&& s);
```

1 *Effects:* `rdbuf()->str(std::move(s)).`

```
basic_string<charT,traits,Allocator> str() &&;
```

2 *Returns:* `std::move(*rdbuf()).str().`

```
basic_string_view<charT, traits> str_view() const;
```

3 *Returns:* `rdbuf()->str_view().`

7 Appendix: Example Implementations

The given specification has been implemented within a recent version of the `sstream` header of `gcc6`. Modified version of the headers and some tests are available at

https://github.com/PeterSommerlad/SC22WG21_Papers/tree/master/workspace/Test-basic_stringbuf_efficient/src.

Here are some definitions taken from there:

```
// basic_stringbuf:
explicit
basic_stringbuf(__string_type&& __str,
                ios_base::openmode __mode = ios_base::in | ios_base::out)
: __streambuf_type(), _M_mode(), _M_string(std::move(__str))
{ _M_stringbuf_init(__mode); }
using __string_view_type=experimental::basic_string_view<_CharT,_Traits>;

__string_view_type str_view() const {
    __string_view_type __ret{};
    if ( this->pptr() ) {
        // The current egptr() may not be the actual string end.
        if (this->pptr() > this->egptr())
            __ret = __string_view_type(this->pbase(), this->pptr()-this->pbase());
        else
            __ret = __string_view_type(this->pbase(), this->egptr()-this->pbase());
    }
}
```



```

        else {
            __ret = _M_string;
        }
        return __ret;
    }
void
str(__string_type&& __s)
{
    _M_string.assign(std::move(__s));
    _M_stringbuf_init(_M_mode);
}

//basic_istream
explicit
basic_istream(__string_type&& __str,
               ios_base::openmode __mode = ios_base::in)
: __istream_type(), _M_stringbuf(std::move(__str), __mode | ios_base::in)
{ this->init(&_M_stringbuf); }
    using __string_view_type=experimental::basic_string_view<_CharT,_Traits>;
__string_view_type
str_view() const
{ return _M_stringbuf.str_view(); }
void
str( __string_type&& __s)
{ _M_stringbuf.str(std::move(__s)); }

//basic_ostringstream
explicit
basic_ostringstream(__string_type&& __str,
                    ios_base::openmode __mode = ios_base::out)
: __ostream_type(), _M_stringbuf(std::move(__str), __mode | ios_base::out)
{ this->init(&_M_stringbuf); }
    using __string_view_type=experimental::basic_string_view<_CharT,_Traits>;
__string_view_type
str_view() const
{ return _M_stringbuf.str_view(); }
void
str( __string_type&& __s)
{ _M_stringbuf.str(std::move(__s)); }

//basic_stringstream
explicit
basic_stringstream( __string_type&& __str,
                    ios_base::openmode __m = ios_base::out | ios_base::in)
: __iostream_type(), _M_stringbuf(std::move(__str), __m)
{ this->init(&_M_stringbuf); }
    using __string_view_type=experimental::basic_string_view<_CharT,_Traits>;
__string_view_type
str_view() const

```

```
{ return _M_stringbuf.str_view(); }  
void  
str( __string_type&& __s)  
{ _M_stringbuf.str(std::move(__s)); }
```