Time Service Facility Native C++ PSM Specification

Document WINNF-TS-3004-App01

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Table of Contents

TERMS, CONDITIONS & NOTICES ............................................................................................ i
Table of Contents ............................................................................................................................ ii
List of Figures ................................................................................................................................ iii
List of Tables .................................................................................................................................. iii
Contributors .................................................................................................................................... iv
Time Service Facility Native C++ PSM Specification ................................................................. 1
1 Introduction ................................................................................................................................. 1
  1.1 Reference definitions ........................................................................................................ 1
  1.2 Conformance ..................................................................................................................... 2
    1.2.1 Radio platform items ................................................................................................. 2
    1.2.2 Radio application items ............................................................................................. 2
  1.3 Document structure ............................................................................................................. 2
2 Native C++ PSM classes ............................................................................................................ 3
  2.1 Provide and Use Services Interfaces ................................................................................ 3
  2.2 Facade class ...................................................................................................................... 3
3 Native C++ PSM header files ..................................................................................................... 5
  3.1 <cstdint> (stdint.h) ............................................................................................................ 5
  3.2 TsfFacade.hpp ................................................................................................................... 6
  3.3 TsfPlatformProviderAdaptations.hpp ............................................................................... 6
  3.4 TsfTypes.hpp .................................................................................................................... 8
  3.5 TsfServices.hpp ............................................................................................................... 10
  3.6 TsfExplicitServicesAccess.hpp ...................................................................................... 12
  3.7 TsfGenericServicesAccess.hpp ...................................................................................... 13
  3.8 TsfExceptions.hpp .......................................................................................................... 14
4 References ................................................................................................................................. 16
  4.1 Referenced documents ..................................................................................................... 16
END OF THE DOCUMENT ........................................................................................................ 17
List of Figures

Figure 1 Interfaces addressed by *Time Service Facility native C++ PSM specification* 1
Figure 2 Class diagram of Native C++ Facade 4

List of Tables

Table 1 Definitions from *Time Service Facility PIM Specification* 1
Table 2 Definitions from *Principles for WInnForum Facility Standards* 2
Table 3 Definitions from Native C++ section of *WInnForum Facilities PSMs Mapping Rules* 2
Table 4 Provide services mapping 3
Table 5 Use services mapping 3
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Time Service Facility Native C++ PSM Specification

1 Introduction

This document WINNF-TS-3004-App01 is the native C++ PSM specification of the WInnForum Time Service Facility V1.1.0.

It derives from the Time Service Facility PIM Specification [Ref1] in accordance with Principles for WInnForum Facility Standards [Ref2].

It addresses the Native C++ programming paradigm, applying the mapping rules of the Native C++ section of WInnForum Facilities PSMs Mapping Rules [Ref3] and specifically reporting any deviation to those rules.

The following figure positions the interfaces addressed by the native C++ PSM specification:

![Diagram showing interfaces addressed by native C++ PSM specification]

As depicted, the native C++ PSM specification addresses the native C++ PSM interfaces of time services, positioned, within a native C++ node, between the native C++ application components of radio applications and native C++ façades of native C++ time services.

The native C++ PSM specification addresses two versions of the C++ language:
- C++03, specified by [Ref4], typically applicable for DSP (Digital Signal Processors) processing nodes where compilers do not support recent C++ language versions,
- C++11, specified by [Ref5], suited to state-of-the-art programming environments.

It uses the abbreviation “tsf” to identify Time Service Facility in formal identifiers.

1.1 Reference definitions

The Time Service Facility native C++ PSM specification applies the following definitions from Time Service Facility PIM Specification [Ref1]:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Used definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time service concepts</td>
<td>time service, Time Service Facility</td>
</tr>
</tbody>
</table>

Table 1 Definitions from Time Service Facility PIM Specification
The *Time Service Facility native C++ PSM specification* applies the following definitions from *Principles for WiNnForum Facility Standards* [Ref2]:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Used definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base concepts</td>
<td>radio application, radio platform</td>
</tr>
<tr>
<td>Architecture concepts</td>
<td>application component, processing node, façade</td>
</tr>
<tr>
<td>WiNnForum facility</td>
<td>facility, PIM specification, PSM specification</td>
</tr>
<tr>
<td>Services</td>
<td>service, service interface, provide service, use service, services group</td>
</tr>
<tr>
<td>Primitives</td>
<td>primitive, parameter, type, exception</td>
</tr>
<tr>
<td>Attributes</td>
<td>attribute, property</td>
</tr>
</tbody>
</table>

Table 2  Definitions from Principles for WiNnForum Facility Standards

The *Time Service Facility native C++ PSM specification* applies the following definitions from the Native C++ section of *WiNnForum Facilities PSMs Mapping Rules* [Ref3]:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Used definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification purpose</td>
<td>native C++ PSM specification, native C++ PSM interface</td>
</tr>
<tr>
<td>Software architecture</td>
<td>native C++ application component, native C++ node, native C++ façade</td>
</tr>
</tbody>
</table>

Table 3  Definitions from Native C++ section of WiNnForum Facilities PSMs Mapping Rules

The term “unspecified” indicates an aspect explicitly left to implementer’s decisions.

### 1.2 Conformance

#### 1.2.1 Radio platform items

A *native C++ façade* of a *time service* implementation **is conformant with** the *Time Service Facility native C++ PSM specification* if it provides an implementation of the *Facade* class and its related service interfaces.

A *native C++ time service* **is defined as** a *time service* implementation with all of its *native C++ façades* being conformant with the *native C++ PSM specification*.

#### 1.2.2 Radio application items

A *native C++ application component* **is conformant with** the *Time Service Facility native C++ PSM specification* if it can use *native C++ façades* conformant with the *native C++ PSM specification*, without using any non-standard service interface for the *time service*.

### 1.3 Document structure

Section 2 specifies the normative classes for the *native C++ PSM interfaces*.

Section 3 specifies the header files to be used by *native C++ time services*.
2 Native C++ PSM classes

This normative section specifies the C++ classes for native C++ PSM interfaces.

2.1 Provide and Use Services Interfaces

The service interfaces for the provide services of the native C++ PSM interfaces are specified by the following table:

<table>
<thead>
<tr>
<th>PIM service interface (in TimeService::)</th>
<th>PIM section</th>
<th>Native C++ PSM service interface (in WInnF_Cpp::TimeService::)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TerminalTime::TerminalTimeAccess</td>
<td>3.1.2</td>
<td>TerminalTime::TerminalTimeAccess</td>
</tr>
<tr>
<td>SystemTime::SystemTimeAccess</td>
<td>3.1.3</td>
<td>SystemTime::SystemTimeAccess</td>
</tr>
<tr>
<td>SystemTime::StandardTimeProvision</td>
<td>3.1.4</td>
<td>SystemTime::StandardTimeProvision</td>
</tr>
<tr>
<td>SpecificTimes::SpecificTimeHandling</td>
<td>3.1.6</td>
<td>SpecificTimes::SpecificTimeHandling</td>
</tr>
</tbody>
</table>

Table 4 Provide services mapping

The service interfaces for the use services of the native C++ PSM interfaces are specified by the following table:

<table>
<thead>
<tr>
<th>PIM service interface (in TimeService::)</th>
<th>PIM section</th>
<th>Native C++ PSM service interface (in WInnF_Cpp::TimeService::)</th>
</tr>
</thead>
<tbody>
<tr>
<td>StandardTimes::ReferencesNotification</td>
<td>3.1.5</td>
<td>StandardTimes::ReferencesNotification</td>
</tr>
<tr>
<td>SpecificTimes::SettingsNotification</td>
<td>3.1.7</td>
<td>SpecificTimes::SettingsNotification</td>
</tr>
</tbody>
</table>

Table 5 Use services mapping

2.2 Facade class

The WInnF_Cpp::TimeService::Facade class is specified as the class derived from the Facade class of the Native C++ section of WinForum Facilities PSMs Mapping Rules [Ref3].

Since a time service does not feature a CONFIGURED state, the Facade class does not feature the methods activeServicesInitialized() and activeServicesReleased().

Two classes are available for active services access, as specified by [Ref3]:

- ExplicitServicesAccess,
- GenericServicesAccess.

Usage of those classes by façades is controlled by the preprocessing variables EXPLICIT_SERVICES_ACCESS and GENERIC_SERVICES_ACCESS.

A façade may implement the two possibilities, in which case the two preprocessing variables are set.
Typical possibilities for the **Facade** class are represented by the following class diagram:

![Class diagram of Native C++ Facade](image.jpg)

The lifecycle of a **Facade** instance is greater than the lifecycle of the *application component* using the *time service*. Other aspects are unspecified.
3 Native C++ PSM header files

This normative section specifies the standard C++ header files (.hpp) to be used by conformant (see section 1.2) native C++ façades and native C++ application components.

Conformant native C++ façades and native C++ application components have only to include TsfFacade.hpp.

TsfPlatformProviderAdaptations.hpp captures the adaptations decided by native C++ time services implementers.

The supported C++ versions are C++03 and C++11. The standard macro __cplusplus indicates the supported C++ version.

The specified header files have been successfully compiled using:

- GCC 4.8.5 and 7.5.0 for C++ 98, C++ 11, C++14 and C++17.

The used code formatting rules are specified by the Native C++ section of WInnForum Facilities PSMs Mapping Rules [Ref3].

3.1 <cstdint> (stdint.h)

The <cstdint> (stdint.h) library is used for C++ standard declarations for basic types.
### 3.2 TsfFacade.hpp

The `TsfFacade.hpp` file is specified as the header file that declares the `Facade` class. The content of `TsfFacade.hpp` is specified as:

```cpp
#ifndef TSF_FACADE
#define TSF_FACADE

#include "TsfPlatformProviderAdaptations.hpp"
#include "TsfServices.hpp"

#ifdef EXPLICIT_SERVICES_ACCESS
#include "TsfExplicitServicesAccess.hpp"
#endif

#ifdef GENERIC_SERVICES_ACCESS
#include "TsfGenericServicesAccess.hpp"
#endif

namespace WInnF_Cpp
{
    namespace TimeService
    {
        // Facade (section 2.2 of [PSM])
        class Facade
        {
            public:
            #ifdef EXPLICIT_SERVICES_ACCESS
            virtual ActiveServicesAccess::ExplicitServicesAccess *
            getExplicitServicesAccess() NOEXCEPT = 0;
            #endif

            #ifdef GENERIC_SERVICES_ACCESS
            virtual ActiveServicesAccess::GenericServicesAccess *
            getGenericServicesAccess() NOEXCEPT = 0;
            #endif

            virtual ~Facade() NOEXCEPT {};
        } // // namespace TimeService
    } // namespace WInnF_Cpp

    #endif // ifndef TSF_FACADE

} // namespace WInnF_Cpp
```

### 3.3 TsfPlatformProviderAdaptations.hpp

The `TsfPlatformProviderAdaptations.hpp` file is specified as the header file specifying the `ActiveServicesAccess` property, specified by section 2.2. `TsfPlatformProviderAdaptations.hpp` has to be adapted by platform providers only in areas marked with *** PROVIDER-ADAPTATION ***.
The content of `TsfPlatformProviderAdaptations.hpp` is specified as:

```c++
#ifndef TSF_PLATFORM_PROVIDER_ADAPTATIONS
#define TSF_PLATFORM_PROVIDER_ADAPTATIONS

// ActiveServicesAccess
// *** PROVIDER-ADAPTATION ***
#define EXPLICIT_SERVICES_ACCESS // comment if EXPLICIT is not supported
#define GENERIC_SERVICES_ACCESS // comment if GENERIC is not supported
#define EXCEPTIONS_SUPPORT // comment if EXCEPTIONS is not supported

#endif // #ifndef TSF_PLATFORM_PROVIDER_ADAPTATIONS
```
3.4 TsfTypes.hpp

The TsfTypes.hpp file is specified as the header file that declares the API types specified by section 3.4 of the Time Service Facility PIM Specification [Ref1].

The int type for SpecificTimeId in the PIM specification (not a valid IDL type) maps to unsigned 16-bit.

The int type for SourceId in the PIM specification (not a valid IDL type) maps to unsigned 8-bit.

The content of TsfTypes.hpp is specified as:

```
#ifndef TSF_TYPES
#define TSF_TYPES

#include <cstdint>
#include <cstddef>
#include <cstdint.h>
#endif

#include "TsfPlatformProviderAdaptations.hpp"
// Support of exceptions (section 3.8 of [PIM])
#ifdef EXCEPTIONS_SUPPORT
    #include "TsfExceptions.hpp"
#else
    // If exceptions are not supported, make sure NOEXCEPT is defined
    #ifndef NOEXCEPT
        #if __cplusplus < 201103L
            #define NOEXCEPT
        #else
            #define NOEXCEPT noexcept
        #endif
    #endif
#endif

namespace WInnF_Cpp
{
    namespace TimeService
    {
        // SourceId (signed int in the [PIM], no dedicated type)
        typedef uint8_t SourceId;

        // SpecificTimeId (signed int in the [PIM], no dedicated type)
        typedef uint16_t SpecificTimeId;

        // TimeValue (section 3.4.1 of [PIM])
        struct TimeValue
        {
            uint32_t seconds;     // in seconds
            uint32_t nanoseconds; // in nanoseconds (<1.000.000.000)
        };
        const TimeValue UndefinedTime = {0xFFFFFFFF, 0xFFFFFFFF};

        // TimeUncertainty (section 3.4.2 of [PIM])
        typedef int32_t TimeUncertainty;
    }
}
```
const TimeUncertainty Beyond2SecTimeUncertainty = 0xFFFFFFFF0;
const TimeUncertainty Beyond4SecTimeUncertainty = 0xFFFFFFFF1;
const TimeUncertainty Beyond8SecTimeUncertainty = 0xFFFFFFFF2;
const TimeUncertainty Beyond16SecTimeUncertainty = 0xFFFFFFFF3;
const TimeUncertainty Beyond32SecTimeUncertainty = 0xFFFFFFFF4;
const TimeUncertainty Beyond64SecTimeUncertainty = 0xFFFFFFFF5;
const TimeUncertainty Beyond128SecTimeUncertainty = 0xFFFFFFFF6;
const TimeUncertainty Beyond256SecTimeUncertainty = 0xFFFFFFFF7;
const TimeUncertainty Beyond512SecTimeUncertainty = 0xFFFFFFFF8;
const TimeUncertainty Beyond1024SecTimeUncertainty = 0xFFFFFFFF9;
const TimeUncertainty Beyond2048SecTimeUncertainty = 0xFFFFFFFA;
const TimeUncertainty Beyond4096SecTimeUncertainty = 0xFFFFFFFB;
const TimeUncertainty Beyond8192SecTimeUncertainty = 0xFFFFFFFC;
const TimeUncertainty Beyond16384SecTimeUncertainty = 0xFFFFFFF0;
const TimeUncertainty UnknownTimeUncertainty = 0xFFFFFFFE;
const TimeUncertainty UndefinedTimeUncertainty = 0xFFFFFFFF;

// RateUncertainty (section 3.4.3 of [PIM])
typedef int32_t RateUncertainty;
const RateUncertainty UnknownRateUncertainty = 0xFFFFFFFF;

} // namespace TimeService
} // namespace WInnF_Cpp
#endif // ifndef TSF_TYPES
### 3.5 TsfServices.hpp

The **TsfServices.hpp** file is specified as the header file that declares the service interfaces specified by section 3.1 of the *Time Service Facility PIM Specification* [Ref1].

It declares **TSF_PIM_VERSION** in accordance with section “Referenced PIM version” of the Native C++ section of *WinnForum Facilities PSMs Mapping Rules* [Ref3].

The content of **TsfServices.hpp** is specified as:

```cpp
#ifndef TSF_SERVICES
#define TSF_SERVICES

#if __cplusplus < 199711L
    #error C++ version must be C++98 or later
#endif

// TSF_PIM_VERSION property
#define TSF_PIM_VERSION 0x010100L // For V1.1.0

#include "TsfTypes.hpp"

namespace WInnF_Cpp
{
    namespace TimeService
    {
        namespace TerminalTime
        {
            // TerminalTime::TerminalTimeAccess (section 3.1.2 of [PIM])
            class TerminalTimeAccess
            {
                public:
                    virtual void getTerminalTime(TimeValue *terminalTime) const NOEXCEPT = 0;
                    virtual void getTerminalTimeRateUncertainty(RateUncertainty *terminalTimeRateUncertainty) const NOEXCEPT = 0;
                    virtual ~TerminalTimeAccess() NOEXCEPT {}
            } // namespace TerminalTime
        } // namespace TerminalTime
    } // namespace TimeService

    namespace SystemTime
    {
        // SystemTime::SystemTimeAccess (section 3.1.3 of [PIM])
        class SystemTimeAccess
        {
            public:
                virtual void getCurrentTAI(TimeValue *currentTAI, TimeValue *timeStamp, TimeUncertainty *timeUncertainty) const NOEXCEPT = 0;
                virtual void getCurrentUTC(TimeValue *currentUTC, TimeValue *timeStamp, TimeUncertainty *timeUncertainty) const NOEXCEPT = 0;
                virtual void getLastUpdateTAI(TimeValue *lastUpdateTAI, TimeValue *timeStamp, TimeUncertainty *timeUncertainty) const NOEXCEPT = 0;
                virtual void getLastUpdateUTC(TimeValue *lastUpdateUTC, TimeValue *timeStamp, TimeUncertainty *timeUncertainty) const NOEXCEPT = 0;
        } // namespace SystemTime
    } // namespace SystemTime
}
```

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Time Service C++ PSM
WINNF-TS-3004-App01-V1.1.1

TimeValue * timeStamp,
TimeUncertainty *timeUncertainty) const NOEXCEPT = 0;

virtual ~SystemTimeAccess() NOEXCEPT {}

};

// SystemTime::StandardTimeProvision (section 3.1.4 of [PIM])
class StandardTimeProvision
{
public:
    virtual void provideTAI(TimeValue providedTAI,
                           TimeValue timeStamp,
                           TimeUncertainty timeUncertainty,
                           SourceId sourceId) = 0;

    virtual void provideUTC(TimeValue providedUTC,
                            TimeValue timeStamp,
                            TimeUncertainty timeUncertainty,
                            SourceId sourceId) = 0;

    virtual ~StandardTimeProvision() NOEXCEPT {}

};

// namespace SystemTime

namespace StandardTimes
{
    // StandardTimes::ReferencesNotification (section 3.1.5 of [PIM])
class ReferencesNotification
    {
public:
    virtual void notifyStandardTimeReference(
        TimeValue referenceTAI,
        TimeValue referenceUTC,
        TimeValue timeStamp,
        TimeUncertainty timeUncertainty,
        SourceId sourceId) NOEXCEPT = 0;

    virtual ~ReferencesNotification() NOEXCEPT {}

    };

};

// namespace StandardTimes

namespace SpecificTimes
{
    // SpecificTimes::SpecificTimeHandling (section 3.1.6 of [PIM])
class SpecificTimeHandling
    {
public:
    virtual void setSpecificTime(SpecificTimeId specificTimeId,
                                 TimeValue specificTime,
                                 TimeValue timeStamp,
                                 TimeUncertainty timeUncertainty) = 0;

    virtual void getSpecificTime(
        SpecificTimeId specificTimeId,
        TimeValue * specificTime,
        TimeValue * timeStamp,
        TimeUncertainty *timeUncertainty) const = 0;

    virtual ~SpecificTimeHandling() NOEXCEPT {}

    };

    // SpecificTimes::SettingsNotification (section 3.1.7 of [PIM])
class SettingsNotification
    {
public:
    virtual void notifySpecificTimeSetting(
        SpecificTimeId specificTimeId,
        TimeValue * specificTime,
        TimeValue * specificTimeId,
        TimeValue * timeUncertainty) const = 0;

    virtual ~SettingsNotification() NOEXCEPT {}

    };
```cpp
TimeValue       specificTime,
TimeValue       timeStamp,
TimeUncertainty timeUncertainty) NOEXCEPT = 0;
virtual ~SettingsNotification() NOEXCEPT {};
} // namespace SpecificTimes
} // namespace TimeService
} // namespace WInnF_Cpp
#endif // ifndef TSF_SERVICES
```

3.6 TsfExplicitServicesAccess.hpp

The content of `TsfExplicitServicesAccess.hpp` is specified as:

```cpp
#ifndef TSF_EXPLICIT_SERVICES_ACCESS
#define TSF_EXPLICIT_SERVICES_ACCESS
namespace WInnF_Cpp
{
    namespace TimeService
    {
        namespace ActiveServicesAccess
        {
            // Access to specific active services
            class ExplicitServicesAccess
            {
                public:
                // Provide services instances
                // TerminalTime services group
                virtual TerminalTime::TerminalTimeAccess *getTerminalTimeAccess() = 0;

                // SystemTime services group
                virtual SystemTime::SystemTimeAccess *getSystemTimeAccess() = 0;
                virtual SystemTime::StandardTimeProvision *
                getStandardTimeProvision() = 0;

                // SpecificTimes services group
                virtual SpecificTimes::SpecificTimeHandling *
                getSpecificTimeHandling() = 0;

                // Use services
                // StandardTimes services group
                virtual void setReferencesNotification(
                    StandardTimes::ReferencesNotification *reference) = 0;

                // SpecificTimes services group
                virtual void setSettingsNotification(
                    SpecificTimes::SettingsNotification *reference) = 0;

                virtual ~ExplicitServicesAccess() NOEXCEPT {};
            } // namespace ActiveServicesAccess
        } // namespace TimeService
    } // namespace WInnF_Cpp
} // ifndef TSF_EXPLICIT_SERVICES_ACCESS
```
3.7 TsfGenericServicesAccess.hpp

The content of `TsfGenericServicesAccess.hpp` is specified as:

```cpp
#ifndef TSF_GENERIC_SERVICES_ACCESS
#define TSF_GENERIC_SERVICES_ACCESS

#include "TsfTypes.hpp"

namespace WinnFCpp
{
    namespace TimeService
    {
        namespace ActiveServicesAccess
        {
            class Object
            {
                public:
                    virtual ~Object() NOEXCEPT {}
            };
            
            class GenericServicesAccess
            {
                public:
                    // Access to active provide services
                    virtual Object *getProvideService(
                        const char *serviceName) = 0;

                    // Access to active use services
                    virtual void setUseService(const char *serviceName,
                        Object *    useService) = 0;

                    virtual ~GenericServicesAccess() NOEXCEPT {}
            };
        } // namespace ActiveServicesAccess
    } // namespace TimeService
} // namespace WinnFCpp
#endif // ifndef TSF_GENERIC_SERVICES_ACCESS
```
3.8 TsfExceptions.hpp

The TsfExceptions.hpp file is specified as the header file that declares all useable exceptions. TsfExceptions.hpp is used if EXCEPTION_USE is equal to true.

The content of TsfExceptions.hpp is specified as:

```cpp
#ifndef TSF_EXCEPTIONS
#define TSF_EXCEPTIONS
#include <stdexcept>
#ifndef NOEXCEPT
#if __cplusplus < 201103L
#define NOEXCEPT
#else
#define NOEXCEPT noexcept
#endif
#endif

// Exceptions identifiers (section 3.2 of [PIM])
namespace WInnF_Cpp
{
    namespace TimeService
    {
        // General exceptions
        class FutureTimeStampException : public std::invalid_argument
        {
            public:
                FutureTimeStampException(char const *msg = "") NOEXCEPT :
                    ::std::invalid_argument(msg)
                {
                }
                FutureTimeStampException(::std::string const &msg) NOEXCEPT :
                    ::std::invalid_argument(msg)
                {
                }
            }
        // Range exceptions
        class InvalidSpecificTimeId : public std::range_error
        {
            public:
                InvalidSpecificTimeId(char const *msg = "") NOEXCEPT :
                    ::std::range_error(msg)
                {
                }
                InvalidSpecificTimeId(::std::string const &msg) NOEXCEPT :
                    ::std::range_error(msg)
                {
                }
            }
        // Services access exceptions – specified by Native C++ Mapping Rules
        class UnavailableServiceException : public std::runtime_error
        {
            public:
                UnavailableServiceException(char const *msg = "") NOEXCEPT :
                    ::std::runtime_error(msg)
                {
                }
            }
    }
}
#endif
```
UnavailableServiceException(::std::string const &msg) NOEXCEPT
  : ::std::runtime_error(msg)
{
}
};

class InvalidReferenceException : public std::runtime_error
{
public:
  InvalidReferenceException(char const *msg = "") NOEXCEPT
    : ::std::runtime_error(msg)
  {
  }
  InvalidReferenceException(::std::string const &msg) NOEXCEPT
    : ::std::runtime_error(msg)
  {
  }
};

} // namespace TimeService
} // namespace WInnF_Cpp

#endif // ifndef TSF_EXCEPTIONS
4 References

4.1 Referenced documents

https://sds.wirelessinnovation.org/specifications-and-recommendations
https://winnf.memberclicks.net/assets/work_products/Specifications/WINNF-TS-3004-V1.1.1.pdf

https://sds.wirelessinnovation.org/specifications-and-recommendations

https://sds.wirelessinnovation.org/specifications-and-recommendations
https://winnf.memberclicks.net/assets/work_products/Reports/WINNF-TR-2008-V1.0.1.pdf

http://www.cplusplus.com/

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