



Time Service Facility Native C++ PSM Specification

Document WINNF-TS-3004-App01

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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*:

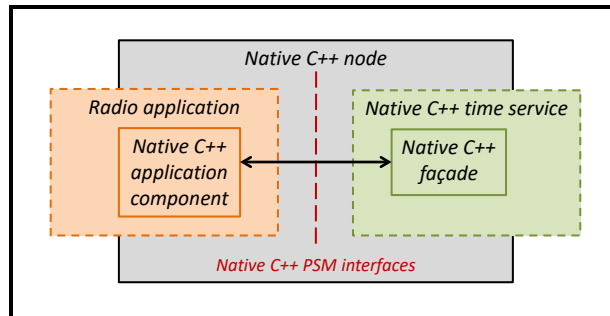


Figure 1 Interfaces addressed by *Time Service Facility native C++ PSM specification*

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]:

Topic	Used definitions
Time service concepts	<i>time service</i> , <i>Time Service Facility</i>

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]:

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

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]:

Topic	Used definitions
Specification purpose	<i>native C++ PSM specification, native C++ PSM interface</i>
Software architecture	<i>native C++ application component, native C++ node, native C++ façade</i>

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:

PIM service interface (in <code>TimeService::</code>)	PIM section	Native C++ PSM service interface (in <code>WinnF_Cpp::TimeService::</code>)
<code>TerminalTime::TerminalTimeAccess</code>	3.1.2	<code>TerminalTime::TerminalTimeAccess</code>
<code>SystemTime::SystemTimeAccess</code>	3.1.3	<code>SystemTime::SystemTimeAccess</code>
<code>SystemTime::StandardTimeProvision</code>	3.1.4	<code>SystemTime::StandardTimeProvision</code>
<code>SpecificTimes::SpecificTimeHandling</code>	3.1.6	<code>SpecificTimes::SpecificTimeHandling</code>

Table 4 Provide services mapping

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

PIM service interface (in <code>TimeService::</code>)	PIM section	Native C++ PSM service interface (in <code>WinnF_Cpp::TimeService::</code>)
<code>StandardTimes::ReferencesNotification</code>	3.1.5	<code>StandardTimes::ReferencesNotification</code>
<code>SpecificTimes::SettingsNotification</code>	3.1.7	<code>SpecificTimes::SettingsNotification</code>

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 *WinnForum 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:

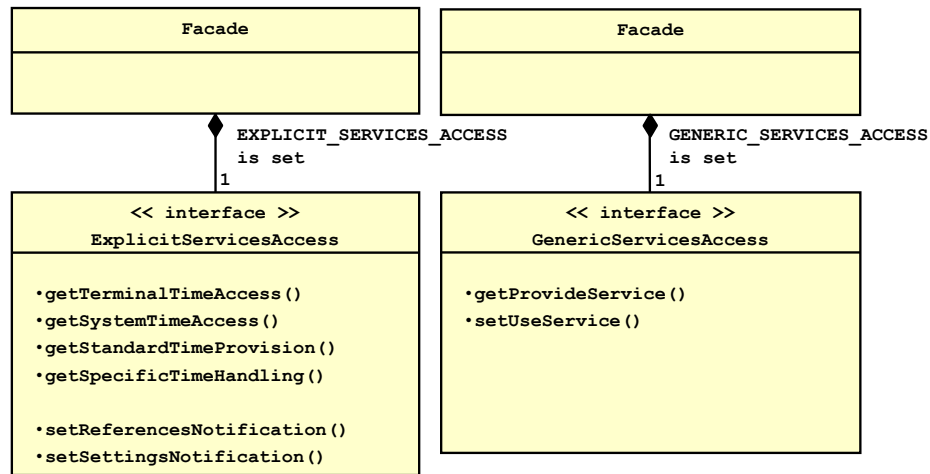


Figure 2 Class diagram of Native C++ Facade

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:

```
#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
```

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:

```
// Specifies PlatformProvider-adaptations:
//  ActiveServicesAccess property, specified by section 2.3 of [PSM]

#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

#if __cplusplus >= 201103L // C++2011
#include <cstdint>
#else
#include <stdint.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 = 0xFFFFFFF10;
const TimeUncertainty Beyond4096SecTimeUncertainty = 0xFFFFFFF11;
const TimeUncertainty Beyond8192SecTimeUncertainty = 0xFFFFFFF12;
const TimeUncertainty Beyond16384SecTimeUncertainty = 0xFFFFFFF13;

const TimeUncertainty UnknownTimeUncertainty = 0xFFFFFFFFE;
const TimeUncertainty UndefinedTimeUncertainty = 0xFFFFFFFFF;

// RateUncertainty (section 3.4.3 of [PIM])
typedef int32_t RateUncertainty;

const RateUncertainty UnknownRateUncertainty = 0xFFFFFFFFF;
} // 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:

```
#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 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;
    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      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:

```

#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

#endif // ifndef TSF_EXPLICIT_SERVICES_ACCESS

```

3.7 TsfGenericServicesAccess.hpp

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

```
#ifndef TSF_GENERIC_SERVICES_ACCESS
#define TSF_GENERIC_SERVICES_ACCESS

#include "TsfTypes.hpp"

namespace WinNF_Cpp
{
    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 WinNF_Cpp
#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:

```
#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)
            {
            }
        };
    }
}
```

```

        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

- [Ref1] *Time Service Facility PIM Specification*, The Wireless Innovation Forum, WINNF-TS-3004, V1.1.0, 18 January 2022
<https://sds.wirelessinnovation.org/specifications-and-recommendations>
https://winnf.memberclicks.net/assets/work_products/Specifications/WINNF-TS-3004-V1.1.0.pdf
- [Ref2] *Principles for WinInnForum Facility Standards*, The Wireless Innovation Forum, WINNF-TR-2007, V1.0.0, 13 October 2020
<https://sds.wirelessinnovation.org/specifications-and-recommendations>
https://winnf.memberclicks.net/assets/work_products/Reports/WINNF-TR-2007-V1.0.0.pdf
- [Ref3] *WinInnForum Facilities PSMs Mapping Rules*, The Wireless Innovation Forum, WINNF-TR-2008, V1.0.1, 18 January 2022
<https://sds.wirelessinnovation.org/specifications-and-recommendations>
https://winnf.memberclicks.net/assets/work_products/Reports/WINNF-TR-2008-V1.0.1.pdf
- [Ref4] *Information technology – Programming languages – C++*, ISO/IEC 14882:2003
<http://www.cplusplus.com/>
- [Ref5] *Information technology – Programming languages – C++*, ISO/IEC 14882:2011
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