

Transceiver Facility Native C++ PSM specification

Transceiver Facility
where software defines the radio



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Transceiver Facility Native C++ PSM specification

1 Introduction

This document WINNF-TS-0008-App01 is the *native C++ PSM specification* of the *Transceiver Facility V2.1.0*.

It derives from the *Transceiver 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*:

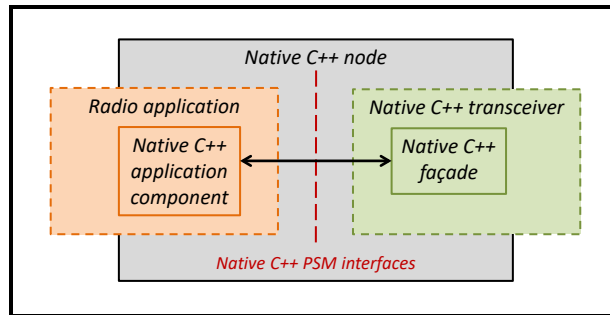


Figure 1 Positioning of *native C++ PSM interfaces*

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

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 “xvcr” to identify *Transceiver Facility* in formal identifiers.

1.1 Reference definitions

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

Topic	Used definitions
Transceiver technical concepts	<i>transceiver</i> , <i>Transceiver Facility</i> , <i>Tx channel</i> , <i>Rx channel</i>

Table 1 Definitions from *Transceiver Facility PIM Specification*

The *Transceiver Facility native C++ PSM specification* applies the following definitions from *Principles for WinnForum Facility Standards* [Ref2]:

Topic	Applied 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 *Transceiver 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

1.1.1 Radio platform items

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

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

1.1.2 Radio application items

A *native C++ application component* **is conformant with** the *Transceiver 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 *transceiver*.

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++ transceivers*.

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>Transceiver::</code>)	PIM section	Native C++ PSM service interface (in <code>WInnF_Cpp::Transceiver::</code>)
<code>Management::Reset</code>	2.4.1.1	<code>Management::Reset</code>
<code>Management::RadioSilence</code>	2.4.1.2	<code>Management::RadioSilence</code>
<code>BurstControl::DirectCreation</code>	2.4.2.1	<code>BurstControl::DirectCreation</code>
<code>BurstControl::RelativeCreation</code>	2.4.2.2	<code>BurstControl::RelativeCreation</code>
<code>BurstControl::AbsoluteCreation</code>	2.4.2.3	<code>BurstControl::AbsoluteCreation</code>
<code>BurstControl::StrobedCreation</code>	2.4.2.4	<code>BurstControl::StrobedCreation</code>
<code>BurstControl::Termination</code>	2.4.2.5	<code>BurstControl::Termination</code>
<code>BasebandSignal::SamplesTransmission</code>	2.4.3.2	<code>BasebandSignal::SamplesTransmission</code>
<code>BasebandSignal::RxPacketsLengthControl</code>	2.4.3.3	<code>BasebandSignal::RxPacketsLengthControl</code>
<code>Tuning::InitialTuning</code>	2.4.4.1	<code>Tuning::InitialTuning</code>
<code>Tuning::Retuning</code>	2.4.4.2	<code>Tuning::Retuning</code>
<code>GainControl::GainLocking</code>	2.4.6.2	<code>GainControl::GainLocking</code>
<code>TransceiverTime::TimeAccess</code>	2.4.7.1	<code>TransceiverTime::TimeAccess</code>
<code>Strobing::ApplicationStrobe</code>	2.4.8.1	<code>Strobing::ApplicationStrobe</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>Transceiver::</code>)	PIM section	Native C++ PSM service interface (in <code>WInnF_Cpp::Transceiver::</code>)
<code>BasebandSignal::SamplesReception</code>	2.4.3.1	<code>BasebandSignal::SamplesReception</code>
<code>Notifications::Events</code>	2.4.5.1	<code>Notifications::Events</code>
<code>Notifications::Errors</code>	2.4.5.2	<code>Notifications::Errors</code>
<code>GainControl::GainChanges</code>	2.4.6.1	<code>GainControl::GainChanges</code>

Table 5 Use services mapping

2.2 Facade classes

The `WInnF_Cpp::Transceiver::TxFacade` class is specified as the class dedicated to *Tx channels*, derived from the `Facade` class of the Native C++ section of *WInnForum Facilities PSMs Mapping Rules* [Ref3].

The `WinnF_Cpp::Transceiver::RxFacade` class is specified as the class dedicated to *Rx channels*, derived from the `Facade` class of the Native C++ section of *WinnForum Facilities PSMs Mapping Rules* [Ref3].

Since a *transceiver* features a `CONFIGURED` state, the `Facade` class features 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 `TxFacade` and `RxFacade` classes are represented by the following class diagram:

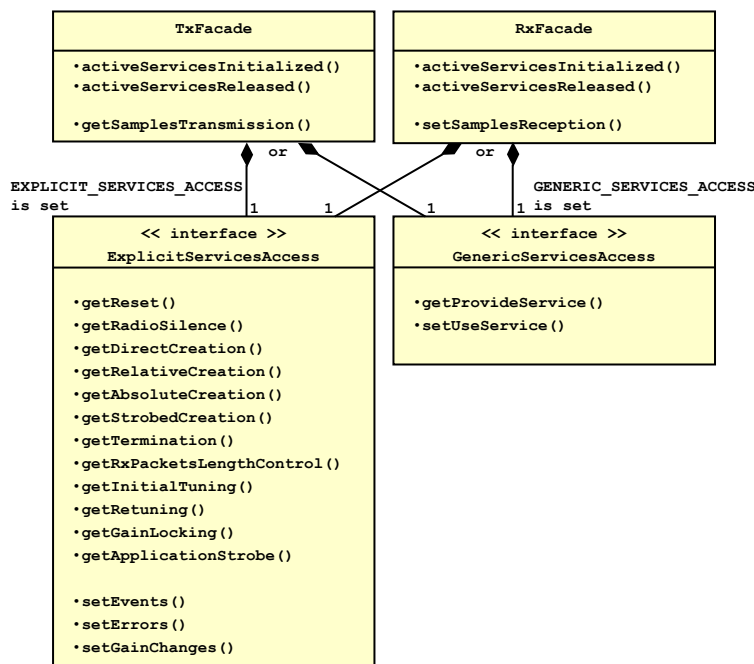


Figure 2 Class diagram of Native C++ Facades

The lifecycle of a `Façade` instance is greater than the lifecycle of the *application component* using the *transceiver*. Other aspects are *unspecified*.

2.2.1 TxFacade

`TxFacade` owns the *transceiver*-specific `getSamplesTransmission()` primitive.

2.2.1.1 *getSamplesTransmission* method

2.2.1.1.1 Overview

getSamplesTransmission() returns a pointer referencing the instance of **SamplesTransmission** interface implemented by the *native C++ façade* for the required *Tx channel*.

2.2.1.1.2 Associated properties

Not applicable.

2.2.1.1.3 Declaration

The C++ signature of the method is specified as:

```
Transceiver::BasebandSignal::SamplesTransmission* getSamplesTransmission(
    uint16_t channelNumber);
```

2.2.1.1.4 Parameters

Name	Type	Description
<i>channelNumber</i>	<i>uint16_t</i>	Number of the required <i>Tx channel</i> .

Table 6 *getSamplesTransmission()* parameters

The parameters validity ranges are:

- For *channelNumber*: 1 to **TX_CHANNELS**.

2.2.1.1.5 Returned value

If an instance is available, the method returns a **Transceiver::BasebandSignal::SamplesTransmission*** pointer to the *service interface* for the required *Tx channel*.

Otherwise, the function returns **NULL**.

2.2.1.1.6 Originator

Native C++ application component.

2.2.1.1.7 Exceptions

The *exceptions* (see section 2.2.3) of the method **are specified as:**

- **MaxChannelNumberException,**
- **UnavailableServiceException.**

2.2.1.1.8 Behavior requirements

A *native C++ façade* needs to, on a call to *getSamplesTransmission()*:

- If no instance of the **SamplesTransmission** *provide service* is available:
 - If *exceptions* are supported, throw **UnavailableServiceException,**
 - If *exceptions* are not supported, set the return value to **NULL,**
- If the **SamplesTransmission** *provide service* is available, set the return value with a reference to its *service interface,*
- Return the call,
- Keep the *provide service* active at least until the instance of the *transceiver* implementation has exited the **CONFIGURED** state.

2.2.2 RxFacade

RxFacade owns the *transceiver-specific* *setSamplesReception()* primitive.

2.2.2.1 setSamplesReception method

2.2.2.1.1 Overview

setSamplesReception() passes a pointer used by the *façade* to reference the instance of **SamplesReception** implemented by the *native C++ application component* for the required *Rx channel.*

2.2.2.1.2 Associated properties

Not applicable.

2.2.2.1.3 Declaration

The C++ signature of the method **is specified as:**

```
void setSamplesReception(
    Transceiver::BasebandSignal::SamplesReception* reference,
    uint16_t channelNumber);
```

2.2.2.1.4 Parameters

Name	Type	Description
<i>reference</i>	<code>Transceiver::BasebandSignal::SamplesReception*</code>	Reference of a <code>SamplesReception</code> service interface implemented by the application component.
<i>channelNumber</i>	<code>uint16_t</code>	Number of the required Rx channel.

Table 7 Specification of `setSamplesReception()` parameters

The parameters validity ranges are:

- For *channelNumber*: 1 to `RX_CHANNELS`.

2.2.2.1.5 Returned value

None.

2.2.2.1.6 Originator

Native C++ application component.

2.2.2.1.7 Exceptions

The exceptions (see section 2.2.3) of the method are specified as:

- `MaxChannelNumberException`,
- `UnavailableServiceException`.

2.2.2.1.8 Behavior requirements

A native C++ façade needs to, on a call to a `setSamplesReception()`:

- If no instance of the `SamplesReception` use service is available:
 - If exceptions are supported, throw `UnavailableServiceException`.
- If the `SamplesReception` use service is available, use *reference* to set a pointer of the native C++ façade to reference the service interface implemented by the native C++ application component,
- Return the call,
- Use the referenced service interface until the instance of the transceiver exits the `CONFIGURED` state.

Note: this implies that the `SamplesReception` use service of the native C++ application component remains valid until the transceiver exits the `CONFIGURED` state.

2.2.3 Facade exceptions

The exceptions associated to native C++ *façades* are specified by the following table:

Exception	Standard C++ parent	Condition
<code>MaxChannelNumberException</code>	<code>std::range_error</code>	The value of <i>channelNumber</i> parameter exceeds <code>TX_CHANNELS</code> or <code>RX_CHANNELS</code> .
<code>UnavailableServiceException</code>	<code>std::range_error</code>	The accessed <i>service</i> is not available.

Table 8 *Façades* exceptions

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++ transceivers* and *native C++ application components*.

Conformant *native C++ façades* and *native C++ application components* have only to include `XcvrFacades.hpp`.

`XcvrPlatformProviderAdaptations.hpp` captures the adaptations decided by *native C++ transceivers* 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 `XcvrFacades.hpp`

The `XcvrFacades.hpp` file is specified as the header file that declares the `Facade` classes.

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

```
#ifndef XCVR_FACADES
#define XCVR_FACADES

#include "XcvrPlatformProviderAdaptations.hpp"
#include "XcvrServices.hpp"

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

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

namespace WinnF_Cpp
{
namespace Transceiver
{

// TxFacade (section 2.2.1 of [PSM])
class TxFacade
{
public:
#ifdef EXPLICIT_SERVICES_ACCESS
virtual ActiveServicesAccess::ExplicitServicesAccess *
getExplicitServicesAccess() NOEXCEPT = 0;
#endif

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

virtual void activeServicesInitialized()= 0;
virtual void activeServicesReleased()= 0;

virtual void getSamplesTransmission(
uint16_t channelNumber) NOEXCEPT = 0;
virtual ~TxFacade() NOEXCEPT {}
};

// RxFacade (section 2.2.1 of [PSM])
class RxFacade
{
public:
#ifdef EXPLICIT_SERVICES_ACCESS
virtual ActiveServicesAccess::ExplicitServicesAccess *
getExplicitServicesAccess() NOEXCEPT = 0;
#endif

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

virtual void activeServicesInitialized()= 0;
virtual void activeServicesReleased()= 0;

virtual void setSamplesReception(
Transceiver::BasebandSignal::SamplesReception* const reference,
uint16_t channelNumber) NOEXCEPT = 0;
virtual ~RxFacade() NOEXCEPT {}
};
};
```

```

} // namespace Transceiver
} // namespace WinNF_Cpp

#endif // ifndef XCVR_FACADES

```

3.3 XcvrPlatformProviderAdaptations.hpp

The `XcvrPlatformProviderAdaptations.hpp` file is specified as the header file specifying all user adaptations:

- *Interface declaration properties*, specified by section 4.5 of the *Transceiver Facility PIM Specification* [Ref1],
- Tx or Rx metadata, if needed,
- Preprocessing variables for *active services access*.

`XcvrPlatformProviderAdaptations.hpp` has to be used with user adaptations at areas marked with `*** PROVIDER-ADAPTATION ***`.

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

```
// Specifies user-adaptations

#ifndef XCVR_USER_ADAPTATIONS
#define XCVR_USER_ADAPTATIONS

// Active Services Access and Exceptions Support
// *** 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

// Interface declaration properties
namespace WinnF_Cpp
{
    namespace Transceiver
    {
        // PIM enumerated identifiers : int16, int32, int64, float32
        // Datatype_prefix for disambiguation vs. <stdint> types
        enum{ Datatype_int16, Datatype_int32, Datatype_int64, Datatype_float32};

        // *** PROVIDER-ADAPTATION *** CARRIER_FREQ_TYPE value
        const int XCVR_CARRIER_FREQ_TYPE = Datatype_int32; // Specify
        "Datatype_int32" or "Datatype_int64"

        // *** PROVIDER-ADAPTATION *** DELAY_TYPE value
        const int XCVR_DELAY_TYPE = Datatype_int32; // Specify "Datatype_int32"
        or "Datatype_int64"

        // *** PROVIDER-ADAPTATION *** IQ_TYPE value
        const int XCVR_IQ_TYPE = Datatype_int32; // Specify "Datatype_int16",
        "Datatype_int32" or "Datatype_float32"
    }
}

// TX_META_DATA and RX_META_DATA values
// *** PROVIDER-ADAPTATION *** XCVR_TX_META_DATA value
// #define XCVR_TX_META_DATA FALSE // Uncomment if FALSE
#if XCVR_TX_META_DATA == TRUE
namespace WinnF_Cpp
{
    namespace Transceiver
    {
        {
            typedef struct TxMetaData
            {
                // *** PROVIDER-ADAPTATION ***
                // Specify declaration of Tx metadata fields
            };
        }
    }
}
#endif // #if XCVR_TX_META_DATA == TRUE
```

```
// *** PROVIDER-ADAPTION *** XCVR_RX_META_DATA value
// #define XCVR_RX_META_DATA FALSE // Uncomment if FALSE
#if XCVR_RX_META_DATA == TRUE
namespace WinnF_Cpp
{
    namespace Transceiver
    {
        typedef struct RxMetaData
        {
            // *** USER-ADAPTATION ***
            // Specify declaration of Rx metadata fields
        };
    }
}
#endif // #if XCVR_RX_META_DATA == TRUE

#endif // #ifndef XCVR_USER_ADAPTATIONS
```

3.4 XcvrTypes.hpp

The **XcvrTypes.hpp** file is specified as the header file that declares the *API types* specified by section 3.4 of the *Transceiver Facility PIM Specification* [Ref1].

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

```
#ifndef XCVR_TYPES
#define XCVR_TYPES

#if __cplusplus >= 201103L // C++2011
#include <cstdint>
#else
#include <stdint.h>
#endif

#include "XcvrPlatformProviderAdaptations.hpp"

#if __cplusplus >= 201103L // C++2011
#include <vector>
#endif // #if __cplusplus >= 201103L

// Support of exceptions (section 3.2 of [PIM])
#ifdef EXCEPTIONS_SUPPORT
#include "XcvrExceptions.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 Transceiver
{
// Optional types templated declarations
template<int I> struct OptionalTypes{};
template<> struct OptionalTypes<Datatype_int16>
{
typedef uint16_t IQ;
};
template<> struct OptionalTypes<Datatype_int32>
{
typedef uint32_t IQ;
typedef uint32_t Delay;
typedef uint32_t CarrierFreq;
};
template<> struct OptionalTypes<Datatype_int64>
{
typedef uint64_t Delay;
typedef uint64_t CarrierFreq;
};
template<> struct OptionalTypes<Datatype_float32>
{
typedef float IQ;
};

// IQ (section 3.4.11 of [PIM])
typedef OptionalTypes<XCVR_IQ_TYPE>::IQ IQ;

// BasebandSample (section 3.4.4 of [PIM])
struct BasebandSample {IQ valueI; IQ valueQ;};

```

```

// BasebandPacket (section 3.4.2 of [PIM])
#if __cplusplus == 199711L // C++1998/2003
// IDL to C++ mapping of "typedef sequence <BasebandSample>
BasebandPacket;"
class BasebandPacket
{
public:
BasebandPacket();
BasebandPacket( uint32_t max);
BasebandPacket( uint32_t max, uint32_t length, BasebandSample *bbs,
bool release = false);
~ BasebandPacket();
BasebandPacket &operator =(const BasebandPacket &);
uint32_t maximum() const;
void length( uint32_t);
uint32_t length() const;
BasebandSample &operator []( uint32_t index);
const BasebandSample &operator []( uint32_t index) const;
bool release() const;
void replace( uint32_t max, uint32_t length, BasebandSample *bbs, bool
release = false);
BasebandSample *get_buffer( bool orphan = false);
const BasebandSample *get_buffer() const;
static BasebandSample *allocbuff( uint32_t nelems);
static void freebuff(BasebandSample *);
};
#elif __cplusplus>= 201103L // C++2011
typedef std::vector<BasebandSample> BasebandPacket;
#endif // #if __cplusplus == 199711L // C++1998/2003

// BlockLength (section 3.4.3 of [PIM])
typedef uint32_t BlockLength;
const BlockLength UndefinedBlockLength = 0xFFFFFFFF;

// BurstNumber (section 3.4.5 of [PIM])
typedef uint32_t BurstNumber;

// CarrierFreq (section 3.4.6 of [PIM]), in Hz
typedef OptionalTypes<XCVR_CARRIER_FREQ_TYPE>::CarrierFreq CarrierFreq;

#if XCVR_CARRIER_FREQ_TYPE == int32
const CarrierFreq UndefinedCarrierFreq = 0xFFFFFFFF;
#elif XCVR_CARRIER_FREQ_TYPE == int64
const CarrierFreq UndefinedCarrierFreq = 0x7FFFFFFFFFFFFFFF;
#else
#error const XCVR_CARRIER_FREQ_TYPE must be equal to "int32" or "int64"
#endif // #if XCVR_CARRIER_FREQ_TYPE == int32

// Delay (section 3.4.7 of [PIM]), in ns
typedef OptionalTypes<XCVR_DELAY_TYPE>::Delay Delay;

#if XCVR_DELAY_TYPE == int32
const Delay UndefinedDelay = 0xFFFFFFFF;
#elif XCVR_DELAY_TYPE == int64
const Delay UndefinedDelay = 0x7FFFFFFFFFFFFFFF;
#else
#error cont XCVR_DELAY_TYPE must be equal to "int32" or "int64"
#endif // #if XCVR_DELAY_TYPE == int32

// Error (section 3.4.8 of [PIM])
#if __cplusplus == 199711L // C++1998/2003
enum Error
{

```

```
#elif __cplusplus >= 201103L // C++2011
enum class Error
{
#endif // #if __cplusplus == 199711L // C++1998/2003
    DelayedTuningError,
    TuningTimeoutError,
    DelayedFirstSampleError,
    FirstSampleTimeoutError,
    TransmissionUnderflowError,
    ReceptionOverflowError,
    ShorterTransmittedBlockError,
    LongerTransmittedBlockError,
    DelayedTuning,
    TuningTimeout,
    DelayedFirstSample,
    FirstSampleTimeout,
    TransmissionUnderflow,
    ReceptionOverflow,
    ShorterTransmittedBlock,
    LongerTransmittedBlock
};

// Event (section 3.4.9 of [PIM])
#if __cplusplus == 199711L // C++1998/2003
enum Event
{
#elif __cplusplus >= 201103L // C++2011
enum class Event
{
#endif // #if __cplusplus == 199711L // C++1998/2003
    ProcessingStartEvent,
    ProcessingStopEvent,
    SilenceStartEvent,
    SilenceStopEvent
};

// Gain (section 3.4.10 of [PIM]), in 1/10 dB
typedef int16_t Gain;
const Gain UndefinedGain = 0xFFFF;

// MetaData (section 3.4.12 of [PIM])
// Declared in XcvrUserAdaptations.hpp

// PacketLength (section 3.4.13 of [PIM])
typedef uint32_t PacketLength;

// SampleNumber (section 3.4.14 of [PIM])
typedef uint32_t SampleNumber;

// StrobeSource (section 3.4.15 of [PIM])
enum StrobeSource
{
    ApplicationStrobe,
    TimeRef_PPS,
    GNSS_PPS,
    UserStrobe1,
    UserStrobe2,
    UserStrobe3,
    UserStrobe4
};

// TimeSpec (section 3.4.16 of [PIM])
struct TimeSpec
```

```
{
    uint32_t seconds;           // in seconds
    uint32_t nanoseconds;
}; // in nanoseconds (<1.000.000.000)
const TimeSpec UndefinedTimeSpec = {0xFFFFFFFF, 0xFFFFFFFF};

// TuningPreset (section 3.4.17 of [PIM])
typedef uint16_t TuningPreset;
const TuningPreset UndefinedTuningPreset = 0xFFFF;
}

#endif // #ifndef XCVR_TYPES
```

3.5 XcvrServices.hpp

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

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

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

```
#ifndef XCVR_SERVICES
#define XCVR_SERVICES

#if __cplusplus < 199711L
  #error C++ version must be C++98/2003 or later
#endif

// XCVR_PIM_VERSION property
#define XCVR_PIM_VERSION 0x020100L // For V2.1.0

#include "XcvrTypes.hpp"

namespace WInnF_Cpp
{
  namespace Transceiver
  {
    namespace Management
    {
      // Management::Reset (section 2.4.1.1 of [PIM])
      class Reset
      {
      public:
        virtual void reset() = 0;
        virtual ~Reset() NOEXCEPT {}
      };

      // Management::RadioSilence (section 2.4.1.2 of [PIM])
      class RadioSilence
      {
      public:
        virtual void startRadioSilence() = 0;
        virtual void stopRadioSilence() = 0;
        virtual ~RadioSilence() NOEXCEPT {}
      };
    }

    namespace BurstControl
    {
      // BurstControl::DirectCreation (section 2.4.2.1 of [PIM])
      class DirectCreation
      {
      public:
        virtual void startBurst(
          BlockLength requestedLength) = 0;
        virtual ~DirectCreation() NOEXCEPT {}
      };

      // BurstControl::RelativeCreation (section 2.4.2.2 of [PIM])
      class RelativeCreation
      {
      public:
        virtual void scheduleRelativeBurst(
```

```

        bool requestedAlternate,
        Delay requestedDelay,
        BlockLength requestedLength) = 0;
    virtual ~RelativeCreation() NOEXCEPT {}
};

// BurstControl::AbsoluteCreation (section 2.4.2.3 of [PIM])
class AbsoluteCreation
{
public:
    virtual void scheduleAbsoluteBurst(
        TimeSpec requestedStartTime,
        BlockLength requestedLength) = 0;
    virtual ~AbsoluteCreation() NOEXCEPT {}
};

// BurstControl::StrobedCreation (section 2.4.2.4 of [PIM])
class StrobedCreation
{
public:
    virtual void scheduleStrobedBurst(
        StrobeSource requestedStrobeSource,
        Delay requestedDelay,
        BlockLength requestedLength) = 0;
    virtual ~StrobedCreation() NOEXCEPT {}
};

// BurstControl::Termination (section 2.4.2.5 of [PIM])
class Termination
{
public:
    virtual void setBlockLength(
        BlockLength requestedLength) = 0;
    virtual void stopBurst() = 0;
    virtual ~Termination() NOEXCEPT {}
};
}

namespace BasebandSignal
{
// BasebandSignal::SamplesReception (section 2.4.3.1 of [PIM])
class SamplesReception
{
public:
#ifdef XCVR_RX_META_DATA == TRUE
    virtual void pushRxPacket(
        BasebandPacket rxPacket,
        bool endOfBlock,
        RxMetaData rxMetaData) = 0;
#else
    virtual void pushRxPacket(
        BasebandPacket rxPacket,
        bool endOfBlock) = 0;
#endif // #if XCVR_TX_META_DATA == TRUE
    virtual ~SamplesReception() NOEXCEPT {}
};
};

```



```

// BasebandSignal::SamplesTransmission (section 2.4.3.2 of [PIM])
class SamplesTransmission
{
public:
#if TX_META_DATA == TRUE
    virtual void pushTxPacket(
        BasebandPacket txPacket,
        bool endOfBlock,
        TxMetaData txMetaData) = 0;
#else
    virtual void pushTxPacket(
        BasebandPacket txPacket,
        bool endOfBlock) = 0;
#endif // #if TX_META_DATA == TRUE
    virtual ~SamplesTransmission() NOEXCEPT {}
};

// BasebandSignal::RxPacketsLengthControl (section 2.4.3.3 of [PIM])
class RxPacketsLengthControl
{
public:
    virtual void setRxPacketsLength(
        PacketLength requestedLength) = 0;
    virtual ~RxPacketsLengthControl() NOEXCEPT {}
};

namespace Tuning
{
// Tuning::InitialTuning (section 2.4.4.1 of [PIM])
class InitialTuning
{
public:
    virtual void setTuning(
        TuningPreset requestedPreset,
        CarrierFreq requestedFrequency,
        Gain requestedGain,
        BurstNumber requestedBurstNumber) = 0;
    virtual ~InitialTuning() NOEXCEPT {}
};

// Tuning::Retuning (section 2.4.4.2 of [PIM])
class Retuning
{
public:
    virtual void retune(
        CarrierFreq requestedFrequency,
        Gain requestedGain,
        Delay requestedDelay) = 0;
    virtual ~Retuning() NOEXCEPT {}
};
}

```

```

namespace Notifications
{
    // Notifications::Events (section 2.4.5.1 of [PIM])
    class Events
    {
    public:
        virtual void notifyEvent(
            Event notifiedEvent) = 0;
        virtual ~Events() NOEXCEPT {}
    };

    // Notifications::Errors (section 2.4.5.2 of [PIM])
    class Errors
    {
    public:
        virtual void notifyError(
            Error notifiedError) = 0;
        virtual ~Errors() NOEXCEPT {}
    };
}

namespace GainControl
{
    // GainControl::GainChanges (section 2.4.6.1 of [PIM])
    class GainChanges
    {
    public:
        virtual void indicateGain(
            Gain newGain,
            SampleNumber firstValidSample) = 0;
        virtual ~GainChanges() NOEXCEPT {}
    };

    // GainControl::GainLocking (section 2.4.6.2 of [PIM])
    class GainLocking
    {
    public:
        virtual void lockGain() = 0;
        virtual void unlockGain() = 0;
        virtual ~GainLocking() NOEXCEPT {}
    };
}

namespace TransceiverTime
{
    // TransceiverTime::TimeAccess (section 2.4.7.1 of [PIM])
    class TimeAccess
    {
    public:
        virtual void getCurrentTime(
            TimeSpec* currentTime) const = 0;
        virtual void getLastStartTime(
            TimeSpec* lastStartTime,
            BurstNumber* lastBurstNumber) const = 0;
        virtual ~TimeAccess() NOEXCEPT {}
    };
}

```

```

namespace Strobing
{
    // Strobing::ApplicationStrobe (section 2.4.8.1 of [PIM])
    class ApplicationStrobe
    {
    public:
        virtual void triggerStrobe(void);
        virtual ~ApplicationStrobe() NOEXCEPT {}
    };
}
}
}

#endif // ifndef XCVR_SERVICES

```

3.6 XcvrExplicitServicesAccess.hpp

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

```

#ifndef XCVR_EXPLICIT_SERVICES_ACCESS
#define XCVR_EXPLICIT_SERVICES_ACCESS

namespace WinnF_Cpp
{
    namespace Transceiver
    {
        namespace ActiveServicesAccess
        {
            // Access to specific active services
            class ExplicitServicesAccess
            {
            public:
                // Provide services
                // Management services group
                virtual Transceiver::Management::Reset* getReset() = 0;
                virtual Transceiver::Management::RadioSilence* getRadioSilence() =
0;

                // BurstControl services group
                virtual Transceiver::BurstControl::DirectCreation*
getDirectCreation()
                    = 0;
                virtual Transceiver::BurstControl::RelativeCreation*
getRelativeCreation() = 0;
                virtual Transceiver::BurstControl::AbsoluteCreation*
getAbsoluteCreation() = 0;
                virtual Transceiver::BurstControl::StrobedCreation*
getStrobedCreation() = 0;
                virtual Transceiver::BurstControl::Termination* getTermination() =
0;

                // BasebandSignal services group
                virtual Transceiver::BasebandSignal::RxPacketsLengthControl*
getRxPacketsLengthControl() = 0;

                // Tuning services group
                virtual Transceiver::Tuning::InitialTuning* getInitialTuning() = 0;
                virtual Transceiver::Tuning::Retuning* getRetuning() = 0;

                // GainControl services group
                virtual Transceiver::GainControl::GainLocking* getGainLocking() = 0;
            };
        };
    };
}

```

```

        // Strobing services group
        virtual Transceiver::Strobing::ApplicationStrobe*
        getApplicationStrobe() = 0;

        // Use services
        // Notifications services group
        virtual void setEvents( Transceiver::Notifications::Events*
        reference)
        = 0;
        virtual void setErrors( Transceiver::Notifications::Errors*
        reference)
        = 0;

        // GainControl services group
        virtual void setGainChanges( Transceiver::GainControl::GainChanges*
        reference) = 0;
        virtual ~ExplicitServicesAccess() NOEXCEPT {}
    };
} // namespace ActiveServicesAccess
} // namespace Transceiver
} // namespace WINNF_Cpp
#endif // ifndef XCVR_EXPLICIT_SERVICES_ACCESS

```

3.7 XcvrGenericServicesAccess.hpp

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

```

#ifndef XCVR_GENERIC_SERVICES_ACCESS
#define XCVR_GENERIC_SERVICES_ACCESS

#include "XcvrTypes.hpp"

namespace WINNF_Cpp
{
    namespace Transceiver
    {
        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 * provider) = 0;

                virtual ~GenericServicesAccess() NOEXCEPT {}
            };
        } // namespace ActiveServicesAccess
    } // namespace Transceiver
} // namespace WINNF_Cpp
#endif // ifndef XCVR_GENERIC_SERVICES_ACCESS

```

3.8 XcvrExceptions.hpp

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

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

```
#ifndef XCVR_EXCEPTIONS
#define XCVR_EXCEPTIONS

#include <stdexcept>

#ifndef NOEXCEPT
#if __cplusplus < 201103L
#define NOEXCEPT
#else
#define NOEXCEPT noexcept
#endif
#endif

// Exceptions identifiers (section 3.1.19 of [PIM])
namespace WinnF_Cpp
{
    namespace Transceiver
    {
        // General exceptions
        class NoAlternateReferencingException: public std::invalid_argument
        {
        public:
            NoAlternateReferencingException (char const *msg = "") NOEXCEPT
                : ::std::invalid_argument(msg)
            {
            }
            NoAlternateReferencingException(::std::string const &msg) NOEXCEPT
                : ::std::invalid_argument(msg)
            {
            }
        };

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

        class StrobeSourceException: public std::invalid_argument
        {
        public:
            StrobeSourceException(char const *msg = "") NOEXCEPT
                : ::std::invalid_argument(msg)
            {
            }
            StrobeSourceException(::std::string const &msg) NOEXCEPT
                : ::std::invalid_argument(msg)
            {
            }
        };
    }
}
```

```

    }
};

// Range exceptions
class MinBlockLengthException: public std::range_error
{
public:
    MinBlockLengthException(char const *msg = "") NOEXCEPT
        : ::std::range_error(msg)
    {
    }
    MinBlockLengthException(::std::string const &msg) NOEXCEPT
        : ::std::range_error(msg)
    {
    }
};

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

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

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

class MinFromOngoingException: public std::range_error
{
public:
    MinFromOngoingException(char const *msg = "") NOEXCEPT
        : ::std::range_error(msg)
    {
    }
};

```

```

    MinFromOngoingException(::std::string const &msg) NOEXCEPT
        : ::std::range_error(msg)
    {
    }
};

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

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

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

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

class MaxFromStrobeException: public std::range_error
{
public:
    MaxFromStrobeException(char const *msg = "") NOEXCEPT
        : ::std::range_error(msg)

```

```

    {
    }
    MaxFromStrobeException(::std::string const &msg) NOEXCEPT
        : ::std::range_error(msg)
    {
    }
};

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

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

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

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

class MaxTuningPresetException: public std::range_error    {
public:
    MaxTuningPresetException(char const *msg = "") NOEXCEPT

```



```

        : ::std::range_error(msg)
    {
    }
    MaxTuningPresetException(::std::string const &msg) NOEXCEPT
        : ::std::range_error(msg)
    {
    }
};

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

// MILT exceptions
class AbsoluteMILTException: public std::runtime_error
{
public:
    AbsoluteMILTException(char const *msg = "") NOEXCEPT
        : ::std::runtime_error(msg)
    {
    }
    AbsoluteMILTException(::std::string const &msg) NOEXCEPT
        : ::std::runtime_error(msg)
    {
    }
};

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

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

class Tuning_MILTException: public std::runtime_error

```

```

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

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

// Services access exceptions
class AlreadyConfiguredException: public std::runtime_error
{
    public:
        AlreadyConfiguredException(char const *msg = "") NOEXCEPT
            : ::std::runtime_error(msg)
        {
        }
        AlreadyConfiguredException(::std::string const &msg) NOEXCEPT
            : ::std::runtime_error(msg)
        {
        }
};

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

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 Transceiver
} // namespace WinNF_Cpp

#endif // ifndef XCVR_EXCEPTIONS
```

4 References

4.1 Referenced documents

- [Ref1] *Transceiver Facility PIM Specification*, The Wireless Innovation Forum, WINNF-TS-0008 V2.1.1.1, 20 January 2022
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https://winnf.memberclicks.net/assets/work_products/Specifications/WINNF-TS-0008-V2.1.1.pdf
- [Ref2] *Principles for WinnForum 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] *WinnForum Facilities PSMs Mapping Rules*, The Wireless Innovation Forum, WINNF-TR-2008, V1.0.1, 18 January 2022
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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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END OF THE DOCUMENT