Principles for WInnForum Facility Standards

Document WINNF-TR-2007

Version V1.0.0

13 October 2020
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Contributors

The following individuals and their organization of affiliation are credited as Contributors to development of the specification, for having been involved in the work group that developed the draft then approved by WINnForum member organizations:

- Marc Adrat, FKIE,
- Jean-Philippe Delahaye, DGA,
- Guillaume Delbarre, DGA,
- David Hagood, VIAVI Solutions,
- Olivier Kirsch, KEREVAL,
- Francois Levesque, NordiaSoft,
- Chuck Linn, L3Harris,
- David Murotake, HKE,
- Eric Nicollet, Thales Communications & Security,
- Kevin Richardson, MITRE,
- Robert Sklut, JTNC.
Principles for WInnForum Facility Standards

1 Introduction
This document specifies principles aimed to be applied by WInnForum “facility” specifications.

1.1 WInnForum Facilities overview

A WInnForum facility is defined as a WInnForum specification that applies the “Principles for WInnForum Facility Standards”.

A facility is specified in observance of the following tenets:
- Addresses functional support capabilities (e.g., transceiver, timing service, audio),
- Service-oriented approach,
- OMG Model Driven Architecture (MDA) paradigm,
- Specification of one PIM and several PSMs,
- Specification of services, associated API and attributes,
- Flexibility and scalability thanks to formalized optionality model.

The following figure provides an overview of the WInnForum facility principles:

![Diagram](image)

Figure 1 WInnForum facility overview

1.2 Field of application

The content of this report if applied by time service facility (WINNF-TS-3004).
2 General principles

2.1 Software defined radio

The following figure introduces the concepts defined in the remainder of this section:

![Diagram showing relationships between radio capability, software defined radio, radio application, and radio platform.]

**Figure 2 Base concepts**

### D02 A radio capability is defined as**
a capability available on a radio product based on over-the-air radio operation (transmit-receive, transmit-only or receive-only).

**Illustration**

One can consider the following examples of radio capabilities:

- Duplex: communications, waveforms, radar…
- Tx-only: broadcast emission, jamming…
- Rx-only: broadcast reception, direction finding, GNSS reception…

### D03 A software defined radio is defined as**
a radio that implements radio capabilities through execution of software applications.

### D04 A radio application is defined as**
a software application instance that implements a radio capability within a software defined radio.

Note, this definition of a radio application does not correspond to the SCA definition of an “application”, which refers to an installed application and not to any of its instances.

### D05 A radio platform is defined as**
the hardware and software environment provided by a software defined radio for execution of radio applications.

2.2 Benefits of SDR Standards

### D06 The portability concept is defined as**, for a radio application, the level of reduction of effort in having an existing radio application running on new radio platform.

### D07 The hospitality concept is defined as**, for a radio platform, the level of reduction of effort in having a radio application running on that radio platform.
The expected benefits of SDR Standards are improvements of *portability* of radio applications and *hospitality* of radio platforms.

### 3 SDR technical principles

#### 3.1 Architecture concepts

3.1.1 Applications components and processing nodes

*D08* An *application component is defined as* a software component of a *radio application*.

*D09* A *processing node is defined as* a processor of the *radio platform* capable to execute application components.

Examples of *processing nodes* are:
- GPP,
- DSP,
- FPGA.

Any *application component* executes on a particular *processing node* of a *software defined radio*.

3.1.2 Software support

The following figure introduces the concepts defined in the remainder of this section:

![Diagram with processing nodes and software environments]

**Figure 3 Software support**

*D10* The *software support is defined as* the capabilities of a *radio platform* that enable execution of *application components* throughout the available *processing nodes*.

*D11* A *software environment is defined as* the capabilities of a given *processing node* that enable execution of *application components*.

*Software support* and *software environment* result from real-time and embedded software engineering design decision.
Examples of *software support* and *software environment* constituents:

- Scheduling, provided by real-time operating system (e.g. POSIX),
- Connectivity, provided by middleware or transport services (e.g. CORBA),
- Components handling, provided by components management frameworks (e.g. SCA CF).

### 3.1.3 Functional support

The following figure introduces the concepts defined in the remainder of this section:

![Functional Support Diagram](image)

**Figure 4 Functional support**

D12 The *functional support* is defined as the capabilities of a *radio platform* that provide functionalities specific to the radio domain in support of *application components*.

D13 A *functional support capability* is defined as one elementary capability of the *functional support*.

A *functional support capability* is generally implemented in conjunction with “hardware parts” external to the *processing node*.

Examples of *functional support capabilities* are:

- Transceiver,
- Time service,
- GNSS,
- Audio port,
- Serial port,
- Pseudo-random noise generator.

D14 A *façade* is defined as the software segment of a *functional support capability* implementation that executes on a given *processing node*.

D15 An *access paradigm* is defined as the software mechanisms enabling an *application component* to access to a *façade* within the concerned *processing node*.
Examples of access paradigms are:
- Component-based: SCA, UCM, etc.,
- Native languages: native C, native C++, etc.,
- Programmable logic: RTL, VHDL, Verilog, etc.

3.2 Service-oriented functional support

3.2.1 Services

A service is defined as one elementary capability provided by a functional support capability to radio applications.

A service name is defined as the name of a service.

A services group name is based on a verb that reflects the duties assigned to the provider of the service.

A service implementation is defined as an implementation of a particular service by a particular facade.

A service interface is defined as the software interface presented by a service to the radio application(s) employing it.

A PIM service interface bears the same name as the service it relates to.
3.2.2 Provide and use services

The following figure introduces the concepts defined in the remainder of this section:

![Diagram showing the concepts of provide and use services]

**Figure 6 Services orientation**

| D20 | A **provide service** is defined as a service whose **service interface** is used by **radio applications** and provided by a **functional support capability**. |
| D21 | A **use service** is defined as a service whose **service interface** is used by a **functional support capability** and provided by **radio applications**. |

3.2.3 Services groups

| D22 | A **services group** is defined as a consistent set of **use services** and **provide services** of a **functional support capability** that answers to a common use case. |
| D23 | A **services group name** is defined as the name of a **services group**. |

A **services group name** is based on a noun and reflects the attached use case.

3.2.4 Primitives

Like in UML or IDL, a **service interface** is composed of one to several primitives.

| D24 | A **primitive** is defined as one of the primitives composing a **service interface**. |
| D25 | A **primitive implementation** is defined as an implementation of a particular **primitive** within a **service implementation**. |
The following software engineering concepts are attached to primitives:

- **D26** signature,
- **D27** parameter,
- **D28** direction ("in", "out", "inout" indicator),
- **D29** semantics of:
  - **parameters** (meaning and behaviors attached to parameters),
  - **primitives**,
- **D30** type,
- **D31** exception.

The previous concepts, being widespread in the software engineering domain, are listed with no formal definition to allow usage in PIM specifications and most PSM specifications.

As an illustrative reference, see [Ref1] for the UML definition of those concepts.

### 3.2.5 Real-time concepts

The following figure introduces the concepts defined in the remainder of this section:

**Figure 7 Services primitives call and return time**

**D32** The **call time** of a primitive implementation is defined as the instant when it is called. 

\( \text{t}_{\text{call}} \) denotes the call time of a primitive implementation.

**D33** The **return time** of a primitive implementation is defined as the instant when it returns. 

\( \text{t}_{\text{return}} \) denotes the return time of a primitive implementation.

**D34** The **worst-case execution time** (WCET) of a primitive implementation of a provide service is defined as the maximum time taken by the implementation between its call time and return time.

**D35** The **worst-case external execution time** (WCEET) of a primitive implementation of a use service is defined as the maximum time supported by the implementation between \( \text{t}_{\text{call}} \) and \( \text{t}_{\text{return}} \).

WCET excludes any transport time, while WCEET encompasses transport time.

WCEET is influenced by extrinsic factors such as the execution time of the called primitive implementation, the eventual transport time between the functional support capability and the
radio application, or the number of radio applications to which the functional support capability is connected to.

A WCEET is therefore difficult to verify and will often be left unspecified.

3.3 Facility attributes

3.3.1 Main concept

A facility attribute is defined as an object-oriented attribute of a functional support capability that conditions its correct joint execution with a radio application.

See [Ref1] for further considerations related to object-oriented attributes.

The concept of facility attribute fills a gap in existing SDR standards, since specification of APIs is insufficient to conduct engineering of correct operation of a radio application on top of a radio platform, especially in front of configurable functional support capabilities or standards with options.

Examples of possible facility attributes:

- A behavioral option, that needs to be consistent with what is assumed by the radio application,
- A transfer function for a signal-capturing capability (transceiver, audio port...), that needs to be consistent with the performance expectations of the radio application,
- The set of supported services, that need to be consistent with the set of services required by the radio application,
- A real-time performance value, that need to be consistent with the real-time performance of the radio application software.

Examples of concepts unlikely to be facility attributes:

- SWaP of the functional support capability implementation,
- Any platform-specific performance features which do not impact the radio application.

Within the context of a facility specification, a facility attribute is denoted “attribute”.

3.3.2 Categories

Depending on assumptions related to the period of time during which they are constant, three categories of facility attributes are defined.

A capability is defined as a facility attribute constant over the lifetime of a functional support capability implementation.

A property is defined as a facility attribute constant over the configured state of a functional support capability implementation.

A variable is defined as a facility attribute of a functional support capability implementation that is not meant to be constant.
4 Specification principles

4.1 Model Driven Architecture (MDA)

A facility is composed of a PIM (Platform-Independent Model) specification completed by derived PSM (Platform-Specific Model) specifications.

This structure is inspired by the Object Management Group (OMG) Model Driven Architecture (MDA) approach (see “The Fast Guide to Model Driven Architecture” [Ref2]) to real-time processing engineering of software-defined radio (SDR) systems.

4.2 PIM specification

A PIM specification is defined as a specification that answers to the definition of a PIM provided by [Ref2]: “A PIM exhibits a sufficient degree of independence so as to enable its mapping to one or more platforms. This is commonly achieved by defining a set of services in a way that abstracts out technical details. Other models then specify a realization of these services in a platform specific manner.”.

A PIM specification uses the WInnForum “IDL Profiles for Platform-Independent Modeling of SDR Applications” [Ref3] to specify the service interfaces of the functional support capability.

This is consistent with usage of SCA 4.1 Appendix E-1 “Application Interface Definition Language Platform Independent Model Profiles” (see [Ref4]).

Each PIM specification needs to identify if it uses the Full or the Ultra-Lightweight (ULw) profile.

4.3 PSM specifications

A PSM specification is defined as a specification that answer to the definition of a PSM provided by [Ref2]: “A PSM combines the specifications in the PIM with the details required to stipulate how a system uses a particular type of platform. If the PSM does not include all of the details necessary to produce an implementation of that platform it is considered abstract (meaning that it relies on other explicit or implicit models which do contain the necessary details).”.

A PSM specification complements the PIM specification with aspects specific to the access paradigm for which it is applicable.

To the minimum, a PSM specification specifies the software interfaces derived in a consistent way from the service interfaces specified by the PIM specification.

Such interface derivation is based on mapping rules applicable for the concerned access paradigm, being preferably standard mapping rules.

Derogations to the mapping rules need to be justified.
Referenced documents

http://www.omg.org/spec/UML/2.5


http://www.wirelessinnovation.org/assets/work_products/Specifications/winnf-14-s-0016-v1.0.0%20-%20pim%20idl%20profiles.zip

[Ref4]  *Application Interface Definition Language Platform Independent Model Profiles, SCA 4.1 Appendix E-1*, Joint Tactical Networking Center, 20 August 2015  

The provided URLs were successfully accessed at the release date of the specification.