Principles for WInnForum Facility Standards

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Principles for WInnForum Facility Standards

1 Introduction

This document specifies principles aimed to be applied by WInnForum "*facility*" specifications.

1.1 WInnForum Facilities overview

D01 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:

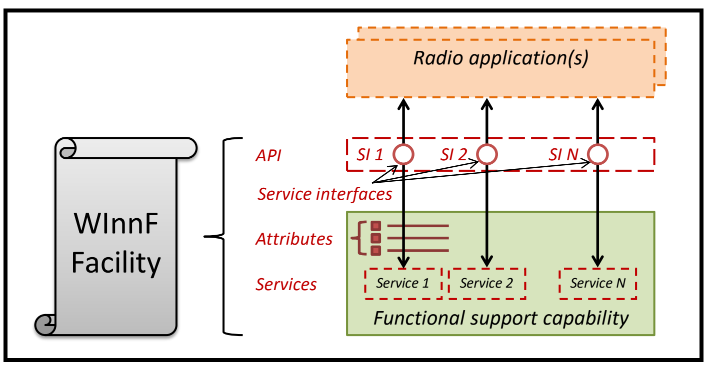

Figure 1 WInnForum facility overview

1.2 Field of application

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

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2 General principles

2.1 Software defined radio

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

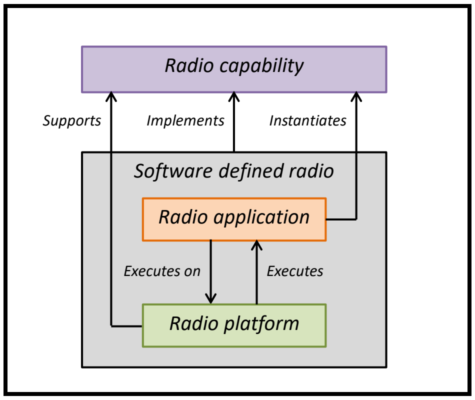

Figure 2 Base concepts

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*.

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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:

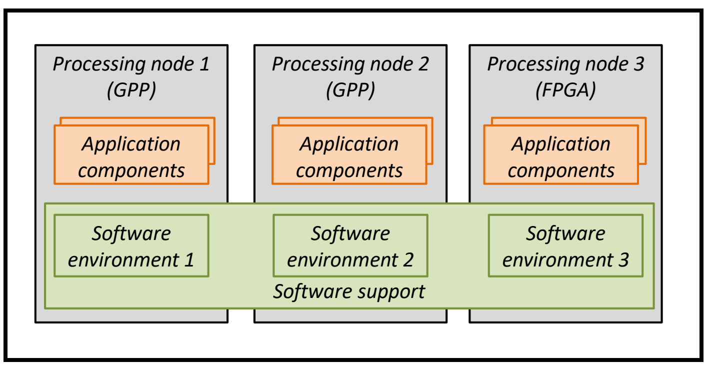

Figure 3 Software support

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.

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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:

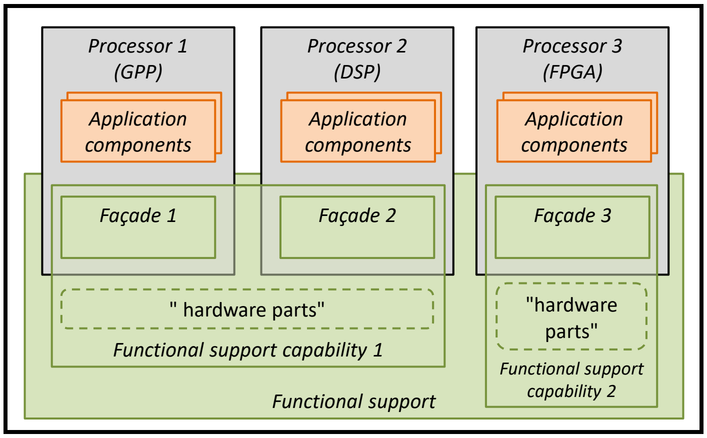

Figure 4 Functional support

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*.

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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

D16 A *service* **is defined as** one elementary capability provided by a *functional support capability* to *radio applications*.

D17 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.

D18 A *service implementation* **is defined as** an implementation of a particular *service* by a particular *façade*.

D19 A *service interface* **is defined as** the software interface presented by a *service* to the *radio application(s)* employing it.

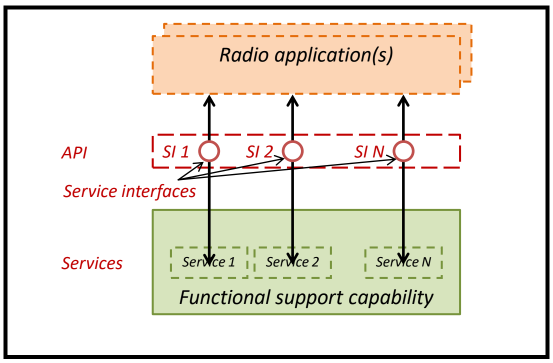

Figure 5 Services

A PIM *service interface* bears the same name as the *service* it relates to.

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3.2.2 Provide and use services

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

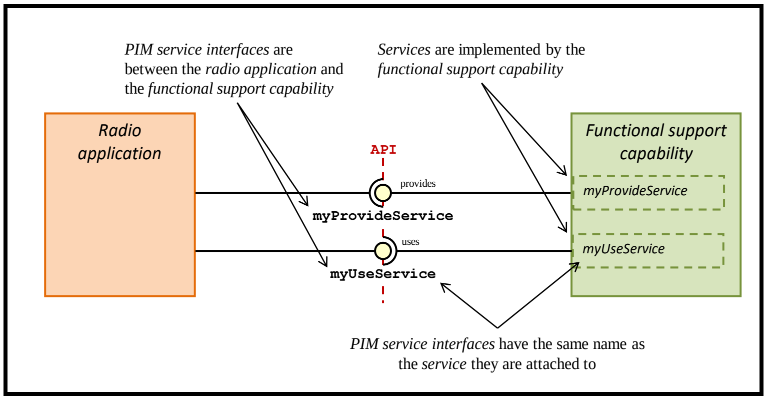

Figure 6 Services orientation

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*.

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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:

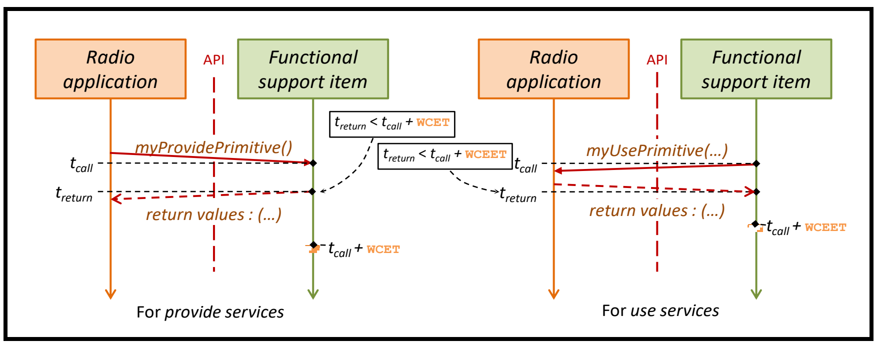

Figure 7 Services primitives call and return time

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

t_{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.

t_{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 t_{call} and t_{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

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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

D36 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.

D37 A *capability* **is defined as** a *facility attribute* constant over the lifetime of a *functional support capability* implementation.

D38 A *property* **is defined as** a *facility attribute* constant over the configured state of a *functional support capability* implementation.

D39 A *variable* **is defined as** a *facility attribute* of a *functional support capability* implementation that is not meant to be constant.

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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

D40 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

D41 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.

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Referenced documents

[Ref1] *OMG Unified Modeling Language (OMG UML)*, The Object Management Group, formal/2015-03-01, Version 2.5, March 2015
http://www.omg.org/spec/UML/2.5

[Ref2] *The Fast Guide to Model Driven Architecture*, Cephas Consulting Corp, 2006
http://www.omg.org/mda/mda_files/Cephas_MDA_Fast_Guide.pdf

[Ref3] *IDL Profiles for Platform-Independent Modeling of SDR Applications*, The Wireless Innovation Forum, WINNF-14-S-0016, Version 2.0.1, 12 June 2015
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
https://www.jtnc.mil/Resources-Catalog/Resource-Catalog-Article-View/Article/2083328/sca-41-appendix-e-1-application-idl-pim-profiles/

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