Response to AFLCMC ORCA RFI
Attachment A

WINNF-17-R-0023

Version V1.0.0

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References

[Ref1] *A Technical Review of SCA Based Software Defined Radios: Vision, Reality and Current Status*, Lee Pucker and al., 5-Oct-2016, Springer's Journal of Signal Processign Systems.

[Ref2] *SCA Standards for Defense Communications: Global Adoption, Proven Performance*, The Wireless Innovation Forum.
http://www.wirelessinnovation.org/assets/Collateral_and_Supporting_Docs/sca%20sell%20sheet%20march%202015.pdf (accessed 17-jan-2017)

[Ref3] *Transceiver Facility PIM Specification*, Transceiver Next project contributors, V1.3.37, Jan-2017.

Response to AFLCMC ORCA RFI
Attachments A

1 Introduction

This document provides the *Attachments A* to WINNF-17-R-0023-V1.0.0, WInnF *Response to AFLCMC ORCA RFI Core*.

2 Attachment A.1 – About the SCA

2.1 Overview

The SCA was developed with the goal of:

- Increase operational flexibility and interoperability of globally deployed systems,
- Reduce supportability costs,
- Improve upgradeability in terms of easy technology insertion and capability upgrades,
- Reduce system acquisition and operation cost.

The SCA has been structured to:

- Provide for portability of applications software between different SCA implementations,
- Leverage commercial standards to reduce development cost,
- Reduce development time of new waveforms through the ability to reuse design modules,
- Build on evolving commercial frameworks and architectures.

The fundamental paradigm of the SCA is its Component Based Design (CBD) approach agnostic of the operating environment. The SCA enables the development of embedded systems (including communications systems) composed of different processors, operating systems, programming languages, compilers. It also enables the plug-and-play assembly of heterogeneous components into single systems.

Hardware (both digital and RF) and software components can be obtained from different vendors and integrated into a radio system via a common set of set of rules and behavior for the core management, deployment, configuration, and control of applications and peripherals on the radio platform.

The SCA encourages competition and innovation and allows companies to focus on specific areas of improvements rather than complete redesigns.

2.2 A proven framework

With over 400,000 radio units deployed on the battlefield worldwide, the SCA set of standards has proven its benefits in the deployment of military communications systems. It has been adopted not only in US radio replacement programs but also in Europe (namely: ESSOR and SVFuA programs).

A stated in the conclusion of [Ref1], a collective article written by WInnF stakeholders elaborating along the previous lines:

> "*SDR is a dominant technology in defense communications, bringing multiple benefits to radio manufacturers and their customers world-wide. The SCA is a proven framework supporting these SDRs with over 400,000 SCA enabled radios currently in deployment. This success has also made the SCA attractive for applications beyond the military radio market, with the SCA 4.1 specification specifically referencing use in commercial communications terminals, electronic warfare applications, and test and measurement instruments. With its component-based design approach, the SCA has considerably changed the way radios are developed, enabling a higher degree of deployment flexibility and leading to cost reduction when supporting multiple missions. From an original US DoD vision of a standard military radio development software architecture, the SCA, with version 4.1, has moved forward as an international specification, with government and industry collaborating to leverage the technologies the SCA combines to advance radio communications as a defense capability.*".

The following figure (extracted from [Ref2]) shows a number of international programs that have elected the SCA as the basis for the development of the radio systems:

Figure 1 International adoption of SCA-based standards

The SCA standards have been developed with the support of the international community and in part via the WInnF which served as the meeting place for discussion and evolution of the specification. Inputs from radio manufacturers, government labs, software tool vendors and hardware components vendors have made the SCA a stable framework for the development of SDR following a Component Based Development approach. The WInnF has made itself the reference group for the evolution of the specification and for innovative solutions for the development of SDR.

The WInnF members have collaborated extensively on the evolution of the SCA Core Framework specification from its debut to the latest version of SCAv4.1. The members have also developed a number of APIs to facilitate the decoupling of digital and RF hardware. Amongst them, as noted in Table 2 are the International Radio Security Supplement API (used for crypto drivers) and the Transceiver API (used for the RF head).

3 Attachment A.2 – About Transceiver Next Project

3.1 Context and positioning statement

The following is a quote of the "Context" part of the Transceiver Next project proposal:

> *"The WINNF Transceiver Facility is providing a unique Transceiver API for SDR Applications to access the Transceiver sub-system, supporting portability of SDR Applications and openness of SDR Platforms at the core of radio base-band processing.*
>
> *Since its publication in 2009, the specification has been reported to be used in many contexts, and a number of suggestions of improvement have already been reported. Besides, interest is growing for a number of additional features to be included in the standard.*
>
> *The WINNF Transceiver Facility is now managed as a WINNF CC SCA Standard, in accordance with CC SCA Policy 006. This namely implies the Issues submission form available from CC SCA section of the WINNF web site enable any user of the specification to report issues and suggestions of improvements for the specification to be improved by WINNF members.*
>
> *The Transceiver Next project is proposed to be a WINNF Project aiming at development of next version of WINNF Transceiver Facility. The preparation of the project was initiated by 3 WInnF members at the end of November 2014 (see the initial call for participation), and several other WInnF members joined the early initiators to prepare this project.*".

The following is a quote of the "Positioning statement" part of the Transceiver Next project proposal:

> *"**For** the international community of SDR products developers*
>
> ***Who** are seeking openly available, free to access and free to use internationally elaborated standard API for portable SDR Applications and multi-applications SDR Transceivers*
>
> ***The** [Transceiver Next] project will produce an updated release of the WINNF Transceiver Facility, based on the V1 published in 2009*
>
> ***That** will improve the V1 content based on years of implementation experience and will expand the addressed capabilities to expand the application range of the standard.*
>
> ***Unlike** all known existing Transceiver related API standards that are related to implementation architecture of the Transceiver (such as OBSAI, DigRF, OBISS, MHAL RF Chain Coordinator…),*
>
> ***This product** features implementation-abstract standard APIs that enable to reach a high degree of portability for SDR Applications while enabling SDR Transceivers to host a large variety of SDR Applications.*
>
> ***Unlike** previous version of the Transceiver Facility that was driven by requirements of Waveform Applications,*
>
> ***This product** will broaden applicability of the specification to other categories of SDR Applications such as Test and Measurement, Dynamic Spectrum Allocation or Sensing.*"

3.2 Happenings digest

3.2.1 Participation

The participation in the projects has been way beyond initial expectations: from an initial set of 3 committed contributors, the level of participation has doubled in average.

Participants from industry are: Thales, NordiaSoft, Cobham, Rohde & Schwarz, Rockwell-Collins, Hitachi Kokusai Electric, Harris Corp, Leonardo.

Participants from governments are: JTNC Standards, DGA (French MoD), FKIE (appointed by German MoD).

Participants from academia are: ENSTA (France).

More than 10 regular participants are recorded, with an estimate of more the 3500 man-hours of efforts cumulated effort by end 2016.

3.2.2 Progress snapshot

As per date of publication of this *response* (Mid-January 2017), Transceiver Next is nearing completion of its core volume, the *PIM specification*.

The entry in the approval process is expected before the end of January 2017.

The core specification draft has 96 pages of core matter plus 9 pages of front matter.

The remainder of the activities once the *PIM specification* is approved will consist in developing the PIM specification appendices for C, C++, VHDL and SCA.

Complete publication of Transceiver Facility V2 is expected by middle of 2017.

4 Attachment A.3 – Preview of the Transceiver Facility V2 PIM

Information provided in the section is extracted from content of the latest available draft of the specification available when the *response* was developed (37th draft) (see [Ref3]).

4.1 Overall modelling

The Transmissions phases of the transceiver are viewed as follows:

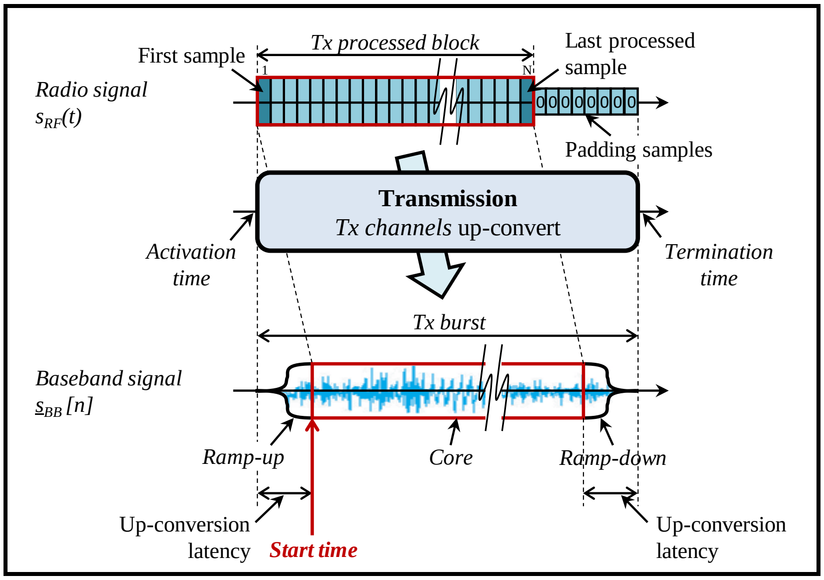

Figure 2 Principle of transmission processing phase

The *up-conversion* performed by a *Tx channel* obeys to the *up-conversion formula*:

$$\boxed{\dot{\underline{s}}_{RF}(f+f_c) = \underline{H}_{Tx}(f).\dot{\underline{s}}_{BB}(f),\ f \in [-F_S^{BB}/2\,;+F_S^{BB}/2]}.$$

The Reception phases of the transceiver are viewed as follows:

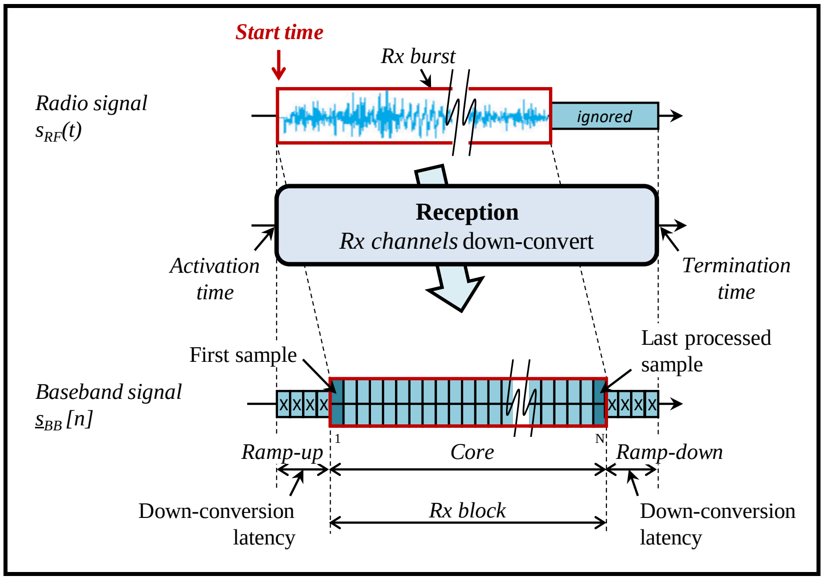

Figure 3 Principle of reception processing phase

The *down-conversion* performed by a *Rx channel* obeys to the *up-conversion formula*:

$$\boxed{\dot{\underline{s}}_{BB}(f) = \underline{H}_{Rx}(f).\dot{\underline{s}}_{RF}(f - f_c),\ f \in [-F_S^{BB}/2\,;+F_S^{BB}/2]}.$$

4.2 Main sate machine

The *Rx channels* and *Tx channels* composing a *transceiver* obey to the following state machine:

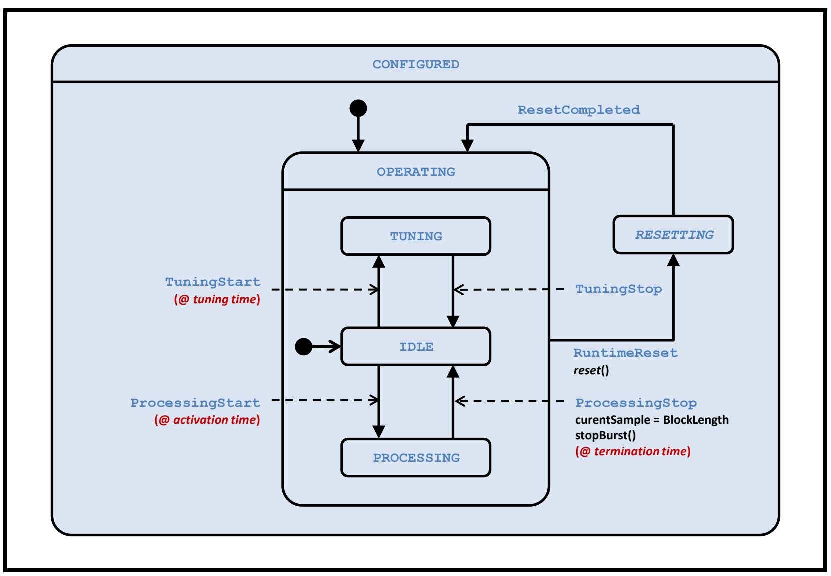

Figure 4 Main state machine of Rx channels and Tx channels

4.3 Services of the API

4.3.1 Provide services

The following table lists the *provide services* of the API (used by a *radio application* and provided by a *transceiver instance*):

Services groups / Namespaces	Services / Interfaces	Primitives
Management	::Management::Reset	*reset()*
	::Management::RadioSilence	*startRadioSilence()* *stopRadioSilence()*
BurstControl	::BurstControl::DirectCreation	*startBurst()*
	::BurstControl::RelativeCreation	*scheduleRelativeBurst()*
	::BurstControl::AbsoluteCreation	*scheduleAbsoluteBurst()*
	::BurstControl::StrobedCreation	*scheduleStrobedBurst()*
	::BurstControl::Termination	*setBlockLength()* *stopBurst()*
BasebandSignal	::BasebandSignal::SamplesTransmission	*pushTxPacket()*
	::BasebandSignal::RxPacketsLengthControl	*setRxPacketsLength()*
Tuning	::Tuning::InitialTuning	*setTuning()*
	::Tuning::Retuning	*retune()*
TransceiverTime	::TransceiverTime::TimeAccess	*getCurrentTime()* *getLastStartTime()*
Strobing	::Strobing::ApplicationStrobe	*triggerStrobe()*

Table 1 Provide services of Transceiver API

4.3.2 Use services

The following table lists the *use services* of the API (provided by a *radio application* and used by a *transceiver instance*):

Services groups	Service / Interface	Primitives
BasebandSignal	::BasebandSignal::SamplesReception	*pushRxPacket()*
Notifications	::Notifications::Events	*notifyEvent()*
	::Notifications::Errors	*notifyError()*
GainControl	::GainControl::GainChanges	*indicateGain()*

Table 2 Use services of Transceiver API

4.4 Properties

The specified Transceiver Properties are (list provided to give an overall idea of the specified content):

- Structure: **TX_CHANNELS**, **RX_CHANNELS**, **DUPLEX**, **TX_SHAPING**, **TX_SERVICES**, **RX_SERVICES**, **TIME_COUPLING**,
- Behavior: **TUNING_ASSOCIATION**, **TUNING_TIMEOUT**, **1ST_SAMPLE_TIMEOUT**,
- Notifications: **EXCEPTIONS**, **EVENTS**, **ERRORS**,
- Interfaces declarations: **CARRIER_FREQ_TYPE**, **DELAY_TYPE**, **IQ_TYPE**, **TX_META_DATA**, **RX_META_DATA**,
- Initialization: **INIT_RX_PACKETS_LENGTH**, **INIT_CARRIER_FREQ**, **INIT_GAIN**,
- Parameters validity: **MIN/MAX_BLOCK_LENGTH**, **ALTERNATE_REFERENCING**, **MINMAX_FROM_PREVIOUS**, **STROBE_SOURCES**, **MIN/MAX_FROM_STROBE**, **MAX_PACKETS_LENGTH**, **MAX_TUNING_PRESET**, **MIN/MAX_CARRIER_FREQ**, **MIN/MAX_GAIN**, **MIN/MAX_FROM_ONGOING**,
- Rapidity: **INTER-PROCESSING**, **TUNING_DURATION**, **RETUNING_DURATION**,
- Storage: **CREATION_STORAGE**, **TUNING_STORAGE**, **TX_BASEBAND_STORAGE**,
- Channelization: **CHANNEL_MASK**, **SAMPLING_FREQ_ACC**, **CARRIER_FREQ_ACC**, **GAIN_ACC**,
- Temporal accuracy: **START_TIME_ACC**, **CURRENT_TIME_ACC**, **LAST_START_TIME_ACC**,
- Invocation lead time: **RELATIVE_MILT**, **ABSOLUTE_MILT**, **STROBED_MILT**, **TX_PACKET_MILT**, **BLOCK_LENGTH_MILT**, **TUNING_MILT**, **RETUNING_MILT**,
- Processing time (provide services): **RESET_MPT**, **START_SILENCE_MPT**, **STOP_SILENCE_MPT**, **DIRECT_MPT**, **RELATIVE_MPT**, **ABSOLUTE_MPT**, **STROBED_MPT**, **TX_PACKET_MPT**, **BLOCK_LENGTH_MPT**, **RX_PACKETS_LENGTH_MPT**, **TUNING_MPT**, **RETUNING_MPT**, **CURRENT_TIME_MPT**, **LAST_START_TIME_MPT**, **TRIGGER_STROBE_MPT**.
- Processing time (use services): **RX_PACKET_MPT**, **EVENTS_MPT**, **ERRORS_MPT**, **GAIN_CHANGE_MPT**.

The following figure illustrates the fields of **CHANNEL_MASK**:

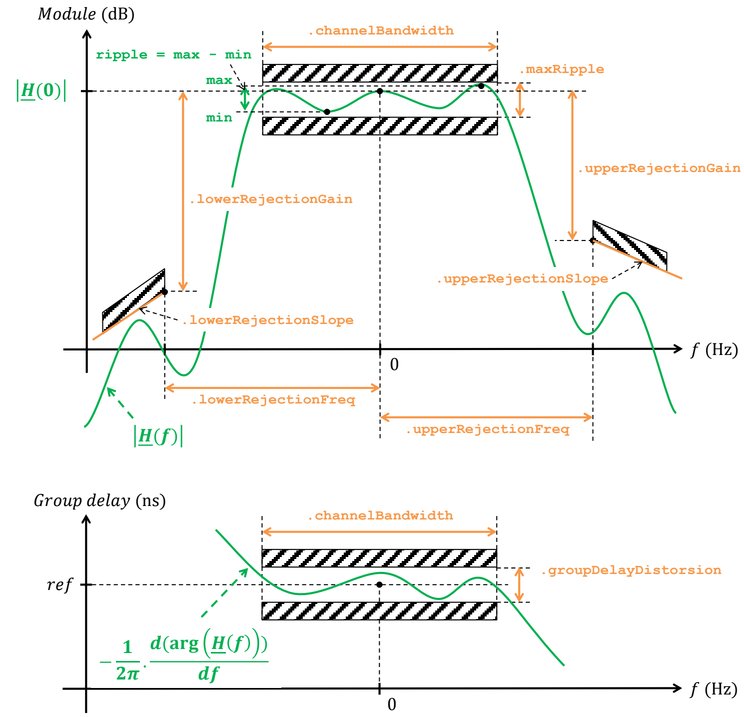

Figure 5 Illustration of the fields of channel masks

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