Response to AFLCMC ORCA RFI
Main body

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Response to AFLCMC ORCA RFI
Main Body

1 Introduction

The Wireless Innovation Forum (WInnF) is pleased to provide answers to the questions raised in the AFLACMC Open Radio Communication Architecture (ORCA) RFI.

The Forum is an international non-profit organization dedicated to advancing technologies supporting the innovative utilization of spectrum and the development of wireless communications systems, including essential or critical communications systems. Its membership comprises an international group of equipment vendors, subsystem vendors, software developers, technology developers, communication service providers, research and engineering organizations, academic institutions, government users, regulators.

Through events, committee projects and initiatives, the Forum acts as the premier venue for its members to collaborate openly in defining and promoting emergence of consensus-based recommendations and standards for software-defined radios, providing opportunities to network with customers, partners and competitors, educate decision makers, develop and expand markets and advance relevant technologies.

1.1 Motivations

1.1.1 Why a WInnF answer?

A strong motivation of the WInnF membership is focused on *portability* of waveform applications, as reflected by the first of the WInnF Top Ten Most Wanted Innovations: "*Techniques for Efficient Porting of Waveform Applications Between Embedded Heterogeneous Platforms*" (see [Ref1]).

This directly corresponds to the general motivations expressed on the first page of the RFI ("*(…) regarding modular, software-defined radio architectures and frameworks based on commercial and/or popular standards, and which might incentivize competition among potential off-the-shelf component providers.*").

1.1.2 WInnF CC SCA

Stakeholders working within the WInnF along the aforementioned lines, mainly those involved with military communications systems, have formed a dedicated committee, the *Coordinating Committee on International SCA-based Standards* (CC SCA) (see [Ref2]), which hosts – as its name captures – all WInnF activities related to international SCA-based standards.

A *Steering Group* of 9 members oversees the planning and execution of the Committee's works, in collaboration of an *Advisory Council* of 14 members affiliated with governmental organizations active in the development of international SDR standards.

An essential pillar of the Committee's activities is the relationship developed over the years with the US DoD JTNC, materialized by an MoU known to be in place between the JTNC and WInnF

since November 2014 (see [Ref3]), demonstrating joint recognition of a collaborative effort to bridge a number of hard-to-overcome barriers traditionally present among USG and Industry.

A similar arrangement is also known to be established since February 2016 with the European *Organisation Conjointe de Coopération en matière d'ARmement* (OCCAR), contracting authority of the the *European Secure Software Defined Radio* (ESSOR) program (see [Ref4]).

The Committee's members have delivered, over years, several valued contributions in support of emergence of standards supporting portability.

1.1.3 WInnF and SCA

The historical and primary standard of interest for the WInnF is the *Software Communications Architecture* (SCA) (see [Ref5]), from its inception to the recent SCA 4.1. See [Ref6] for an exhaustive summary of the long track record of WInnF activities related to the SCA.

For more on SCA see Attachment A.1, *About SCA*.

Among WInnF members, many radio manufacturers reporting usage of SCA in their products (e.g. Harris, Indra, Leonardo, Radmor, Raytheon, Rockwell-Collins, Rohde & Schwarz, Thales), and Cobham reports usage of the SCA for development of its radio test instruments.

1.1.4 WInnF-developed SDR Standards

WInnF activities are not limited to the SCA specification.

The WInnF CC SCA namely developed SDR Standards of its own, complementing the SCA and JTRS published APIs. Those are:

- *International Radio Security Services (IRSS) API* (see [Ref7]),
- *Transceiver Facility* (V1 published in 2009) (see [Ref8]),
- *IDL Profiles for Platform-Independent Modelling of SDR Applications* (see [Ref9]),
- *Lw and ULw POSIX AEPs for Resource Constrained Processors* (see [Ref10]).

1.1.5 WInnF expectation

It is the WInnF expectation that the information delivered in this response to the RFI will provide the basis for follow-up discussions to explore how a reference venue could be established, allowing the WInnF to support the AFLCMC, in a fashion similar to the relationship existing between WInnF and JTNC (see [Ref3]).

1.2 The WInnF Transceiver Facility

From the set of SDR standards listed above, WInnF's **Transceiver Facility** specifically relates to the point of interest of the RFI, as namely stated by this quote: "*(…) main preoccupation of the RFI authors actually focus around the relationship between modem software and RF capabilities*".

1.2.1 Motivation

The Transceiver Facility fundamentally aims to bridge an important gap in the set of APIs available for *functional support*: having an API suitable to harness the radio head.

The *Transceiver Facility* standardizes a service-oriented *Transceiver Application Programming Interface* (*Transceiver API*) and associated *Transceiver Properties*, in support of portability of *radio applications* and openness of reconfigurable *transceiver* implementations.

The *transceiver* is the processing stage situated between the antenna and the radio physical layer baseband processing. Its I/O signals are the *baseband signal* and the *radio signal*, as depicted in following figure:

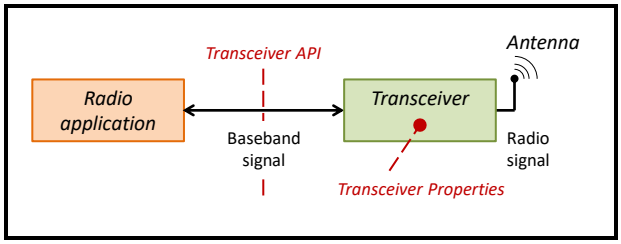

Figure 1 Overview of Transceiver Facility

1.2.2 The WInnF Transceiver Facility V1

The Transceiver Facility V1 (see [Ref8]) aimed to bridge the aforementioned gap, and was developed in 2007-2008 within the WInnF.

The main contributors were from Thales, Indra and Rohde & Schwarz, with a specification approved for a publication in 2009.

The document was structured around the OMG Model Driven Architecture (MDA) principles, and defined the essential principles for design of standard Transceiver artifacts, including an API defined in a platform-independent model (PIM) then declined into platform specific models (PSM) for various programming languages.

The essential contributions were prepared in the frame of the European program E²R 2 (End-to-End Reconfigurability 2 – 2007-2008), based on former achievements of the French PEA AL program (2003-2006), where a very first flavor of a Transceiver API was developed and successfully used for porting of 2 waveforms across 2 different platforms.

The overall TRL of the Transceiver Facility V1 is estimated around 4-5.

1.2.3 Reported product uses of WInnF Transceiver Facility V1

The ESSOR program, a multinational SDR program of the Italian, Finnish, French, Polish, Spanish and Swedish MoDs (see [Ref11]), developed the **ESSOR Transceiver API** as part of the ESSOR SDR Architecture (see [Ref12]). An acknowledged reference was made by ESSOR stakeholders that the Transceiver Facility V1 was used as a reference starting point for development of the **ESSOR Transceiver API**.

Access to ESSOR Architecture is contingent to specific authorization from ESSOR MoDs.

The SVFuA program, a national SDR program of the German MoD (see [Ref13]), developed a **SVFuA Transceiver API** which positioning within the system is comparable to the WInnF Transceiver Facility V1.

1.2.4 Transceiver Next: towards Transceiver Facility V2

Transceiver Next is a WInnF project that was initiated as a revision project of the **Transceiver Facility V1**. See Attachment A.2 for details regarding the context and positioning statement of the project.

Transceiver Next revealed to be strongly supported by actively contributing members with diverging initial views, yielding to a global shift in scope for the benefit of better than initially expected result. See Attachment A.2 for details regarding happenings of the project.

Main input contributions were inspired from **ESSOR Transceiver API** content and **SFVuA Transceiver API**.

Transceiver Next is now nearing completion of its core *PIM Specification*, which outstanding aspects are reflected in Attachment A.3

Transceiver Facility Core Specification specifies a total of 17 services and 20 primitives for the **Transceiver API** part, and a total 75 **Transceiver Properties** that exhaustively cover the needs for engineering of *radio application* portability.

The overall TRL of the Transceiver Facility V2 is estimated around 7-8.

1.2.5 High match with RFI expectations

The **WInnF Transceiver Facility**, from its very inception, is largely aligned with the motivations expressed in the RFI.

The **Transceiver Facility V2** under finalization by WInnF is to deliver key answers to the RFI expectations, grounded on implementation experience of contributors and extensive standard development effort.

Most of the answers provided to the specific RFI points are therefore structured around a *Transceiver Facility focus* section, completed by a *broader perspective* section.

2 Answers to specific RFI points

This section provides an answer to each of the *specific RFI points* (bullets of the bullet list of the second page of the RFI).

2.1 Knowledge of a standardized decoupled framework

RFI quote: "*Knowledge of a standardized, decoupled framework to enable procurement of RF and digital components from different sources, e.g. standard interfaces between decoupled apertures, transceivers, modems, signal processing, crypto, etc. Show how the building blocks fit together, contain a set of tools, provide a common vocabulary, and include a list of recommended standards".*

2.1.1 SCA-based standards

The WInnF recognizes a set of SCA-based standards library (see [Ref14]) that serve better portability of *radio applications* across *radio platforms*, an essential objective of the international military communications community.

This corresponds to one "*standardized, decoupled framework to enable procurement of RF and digital components from different sources*".

Common practices and vocabulary emerged from usage of the framework, shared not only across US stakeholders but successfully influencing the international community, as established by [Ref15] that summarizes the breadth of successful usage of SCA-based standards.

The library is based on JTNC standards, and is completed by WInnF-developed standards (listed in section 1.1.2).

Most JTNC standards are reported by JTNC as being referenced as "mandated standards" by the *Department of Defense Information Technology Standards Registry* (DISR) (see [Ref16]).

The building blocks of the standards library either belong to *execution support* or *functional support*.

Execution support is defined as the set of software capabilities that support execution of real-time embedded applications. It is not specific to radio communications domain and can be used in other radio domains such as electronic warfare, electronic intelligence or radar, or even in non-radio domains such as robotics or transportation signaling.

The following table provides a list of key standards for *execution support*:

Execution support capability	Related standard building block (see [Ref14])
Configuration framework	SCA Core Specification (of an SCA "Core Framework") (see [Ref5])
(RT)OS access	GPP: SCA Full POSIX AEP (see [Ref5]) DSP: WInnF Lw and ULw POSIX AEP (see [Ref10])
Connectivity	GPP: CORBA (*) DSP: CORBA (*), MOCB or MHAL Communication Service
Application-specific interfaces declaration	WInnF IDL Profiles for PIM specification of Application-Specific Interfaces (see [Ref9])

Table 1 Key standards for execution support

(*) Standardized as a platform specific model (PSM) by SCA 4.1.

Functional support is defined as the set of capabilities related to the domain of interest, here the radio domain.

The following table provides a list of key standards for the *functional support*:

Functional support capability	Related standard building block (see [Ref14])
Transceiver	WInnF Transceiver Facility ESSOR Transceiver API
Security services	WInnF IRSS API
Serial I/O	JTNC Serial Device API
GNSS	JTNC GPS Device API
Timing	JTNC Timing Service API

Table 2 Key standards for functional support

2.1.2 Building blocks consistency

The following figure depicts how the standards building blocks fit together:

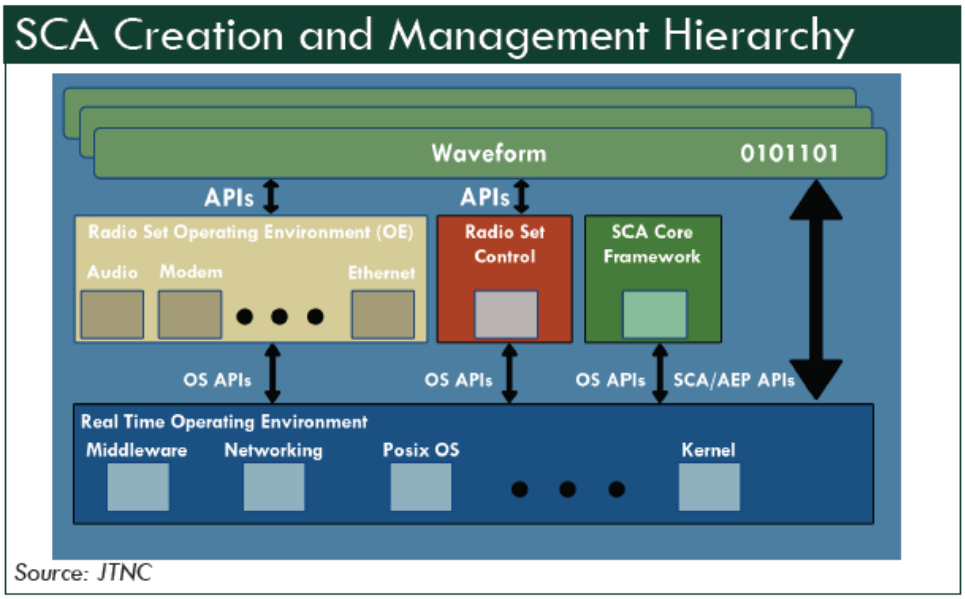

Figure 2 How SCA-based standards fit together

The *waveform* in the figure represents whichever radio domain software application developed for portability on top of SDR standards (for communications, radar, EW, etc.).

The *waveform* executes as a software application based on the Real-Time Operating Environment of the figure, and is deployed within the radio system by the *SCA Core Framework*. Those altogether correspond to the *execution support* standards of [Ref14], partly listed in section 2.1.1.

The *waveform* does not directly connect with the hardware, but relies on the set of APIs listed as the Radio Set Operating Environment (OE) and Radio Set Control of the figure, which correspond to the *functional support* standards of [Ref14], partly listed in section 2.1.1.

The **Transceiver Facility** belongs to this set.

The building blocks of the SCA-based standards library largely cover set of needs of the SDR eco-system.

2.2 Easy hardware refresh

RFI quote: "*Experience in hardware refresh without major software rewrites, i.e. decouple hardware and software/firmware upgrades. In addition, enable modem software portability across hardware platforms and from third party vendors*".

2.2.1 Transceiver Facility focus

The **WInnF Transceiver Facility** is designed to decouple the *radio application* from the underlying hardware thanks to the specified service-oriented abstract API.

A hardware upgrade is therefore made functionally transparent to the *radio application* (integration with the new platform and non-regression testing remains needed), focusing the redevelopment effort in the software part of the *radio platform* that presents the API services for usage by the *radio application*.

WInnF member Thales reported that a hardware refresh impacting the baseband processing board and a change of power amplifier in one of its SDR solution running the **ESSOR Transceiver API** (close to the **WInnF Transceiver Facility**) caused a software rewrite of only a couple of man-months, focused within FPGA low-level adaptation to drivers and BSP.

2.2.2 Broader perspective

NordiaSoft, a WInnF member, reported that its SCA core framework works without source code modifications on multiple radio manufacturers platforms, from small form factors to large high data rate long range systems. They have also developed a number of demonstration waveforms that can run on multiple platforms (military and commercial) without modifications.

2.3 Reuse across domains

RFI quote: "*Experience in the reuse of RF components and infrastructure across communication, Electronic Intelligence, Electronic Warfare (EW) and other domains*".

2.3.1 Transceiver Facility focus

The **WInnF Transceiver Facility** is developed to address all radio domains, beyond its radio communications inception, as established by the second "Unlike" statement of its positioning statement: "***This product*** *will broaden applicability of the specification to other categories of SDR Applications such as Test and Measurement, Dynamic Spectrum Allocation or Sensing.".*

The WInnF would most certainly welcome any contributions devoted to the development evolutions of the **WInnF Transceiver Facility** to suit the needs of other radio domains. Formation of ad hoc projects would be considered based on contributor's proposals.

2.3.2 Broader perspective

The development of the SCA standards by the JTRS / JTNC program and the WInnF members has been done to ensure a high level of application domain independence.

The *execution support* standards identified above are domain independent. The *functional support* standards, on the other hand, are domain specific as they tie the domain specific peripheral hardware to the signal processing hardware.

The JTRS program and the WInnF have developed a series of functional support standards for the radio communications domain. For other domains, additional standards or fully new sets could be developed.

The WInnF member Cobham has reported using the SCA and functional support standards to develop test instrumentation and generic development environment for military radios, EW, ELINT or radar.

2.4 Portability across platforms

RFI quote: "*Experience in enabling component hardware and software portability across multiple form-factors and platforms and from third party vendors*".

2.4.1 Transceiver Facility focus

The **WInnF Transceiver Facility** is designed to facilitate porting of *radio application* from one hardware platform to another based on availability of requested services of the **Transceiver API** with satisfaction of the **Transceiver Properties** values required by the *radio application*.

The ESSOR program reported a successful porting of the ESSOR HDR WF across platforms from five different providers, each of them exhibiting the **ESSOR Transceiver API**.

The national platforms from Finland, France, Italy, Poland and Spain had quite different form factors (2 tactical radios, 1 prototype, 2 lab systems) and the **ESSOR Transceiver API** was an enabler of such a success directly inside the PHY layer processing.

The SVFuA program reported successful hosting of different waveforms, from different providers, running within a common open radio platform structured around the **SVFuA Transceiver API**.

Being built from contributions derived from the **ESSOR Transceiver API** and **SVFuA Transceiver API**, the **WInnF Transceiver Facility V2** will leverage this experience and bring the standard to a further maturity step thanks to the extensive portability-related discussions that took place in the course of the **WInnF Transceiver Facility V2** development (*Transceiver Next* project).

2.4.2 Broader perspective

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.

Utilizing the SCA and related API standards, WInnF member Harris Corp reported that it has ported numerous waveforms, including SRW, WNW and MUOS from the JTRS Information

Repository onto different form factors, including single channel and multi-channel manpack radios, hand held radios and small form factor personal soldier radios. These radios contain disparate digital and RF sections but through the abstraction concepts provided by the SCA and related API's support a common set of WF application implementations across them.

2.5 Software Development Kit

RFI quote: "*Indicate how a Software Development Kit (SDK) may be provided to allow mixed vendor integration inside the framework, i.e. one vendor producing the modems while another develops the signal processing modules*".

2.5.1 Transceiver Facility focus

The **WInnF Transceiver Facility** primarily specifies a service-oriented **WInnF Transceiver API**.

The structure of the **WInnF Transceiver API** is inspired by the OMG MDA paradigm, resulting in a *platform-independent model (PIM) specification* completed by a number of *platform specific model (PSM) appendices*.

The *PIM specification* delivers an exhaustive and accurate set of programming-choice agnostic assumptions regarding the API software services and signatures defining the boundary between the radio application domain and the platform domain.

The *PSM specifications* then specify requirements to compliant SDK depending on the usage context. For instance:

- The VHDL PSM will enable development of FPGA-suited IPs exhibiting the Transceiver behavior for direct usage by waveform-specific blocks using the IP,
- The C++ Native PSM will enable development of statically linkable libraries to be used in the DSP projects of waveform applications,
- The SCA PSM will enable delivery of SCA models and configuration plugins integrated into high-level SCA models of the platform.

The set of PSM specifications is fully expandable to additional possible programming paradigms based on contributions to improvement of the **WInnF Transceiver Facility**.

2.5.2 Broader perspective

Within the WInnF membership a complete eco-system for the development of SDR products has been created. The mixed vendor integration is facilitated by both the execution standards and functional standard identified in the first question answered above. Using a common framework for the development of signal processing components and a common set of APIs for the interaction with the hardware makes the integration much easier.

Over the years, industry has created their own set of SDK to facilitate their development. Today in addition, commercial off the shelf SDK is available.

For example, NordiaSoft's SDK generates source code that run, as is, on a very large number of operating systems and processors. NordiaSoft also provides an implementation of all the JTNC

devices and services. The NordiaSoft Suite has been used not only for military radio systems but also for test instruments.

2.6 Enterprise capabilities and eco-system broadening

RFI quote: "*Develop enterprise capabilities instead of point solutions. Define a multi-function RF infrastructure to be reused for multiple functions and waveforms. In addition, enable third party software, and hardware for re use across multiple platforms*".

2.6.1 Transceiver Facility focus

The **WInnF Transceiver Facility**, from its inception, aims to support the needs of multiple radio applications.

From that perspective, not only standardizing the service-oriented **WInnF Transceiver API**, it specifies standard **WInnF Transceiver Properties** that enable efficient and optimal engineering of the portability of the waveform applications across different platforms in a shared, common vocabulary.

The developed standard is therefore particularly suited to enable hosting of third party *radio application* on a radio platform complying with the standard.

2.6.2 Broader perspective

The WInnF is recognized as the central organization for the development of standards for SDR promoting software reuse over heterogeneous platforms that can be changed via hardware upgrades or obtained from multiple vendors.

The Forum members cooperate to define an international set of standards that can be used across the industry to develop a wide range of products from small handheld radios to large high data ones.

The commercial eco-system supported by the WInnF members has enabled an eco-system of third party vendors to emerge.

For example, NordiaSoft provides a complete software development environment for SCA based SDR systems; Cobham and SSPI offer digital and RF platforms; GateHouse offers waveforms applications.

As a whole, the Forum is the meeting place to ensure the development of far-looking, future-proof enterprise capability rather than short-term, point solutions. The Forum would welcome the opportunity to extend its activity to support the AFLCMC requirements for ORCA. It has the complete infrastructure in terms of process for the development of new or extended standards.

The Forum has also shown in the past that it can work on standards they don't formally own (the SCA is the perfect example) and provide input to the owner.

2.7 Certification matters

RFI quote: "*Standardized, componentized, and/or virtualized, cyber security and flight worthiness, and associated certification, authorization, and accreditation in context with objectives described above*".

2.7.1 Transceiver Facility focus

The **WInnF Transceiver Facility** is seen by its developers as the starting point of a broader set of WInnF specifications that will encompass standard conformity evaluation procedures and conformity certification process.

Launching of projects aimed at development of such artifacts was considered by stakeholders involved in the *Transceiver Next* project, of would be certainly welcomed by CC SCA Steering Group would a credible project proposal aiming at this direction be submitted in the future.

2.7.2 Broader perspective

One strategic pillar of the WInnF is to enable emergence of certifications, as established by the following quote of its 2013-2017 strategic plan (see [Ref17], section 3): "***Commercialization*** – *Through this pillar, the members of the Forum will facilitate the transition of advanced wireless technologies from the research labs into deployed systems. The Forum and its members will do this by promoting industry convergence on open specifications and standards supporting relevant technologies and by enabling certifications that promote interoperability.*".

3 Conclusion

As the answers to specific RFI points establish, the **WInnF Transceiver Facility** is seen as a solution that should play a privileged role in satisfaction of RFI author's objectives. The WInnF Transceiver Facility leverages the experiences and lessons learned of successful SDR programs (ESSOR and SVFuA) to deliver a specification that supports portability of waveform applications across disparate HW platform implementations.

Beyond the modem / radio focus, the suite of **SCA-based International SDR Standards** managed by the WInnF CC SCA provides a holistic framework for SDR solutions (point solution to long term structured strategy) that appears promising in front of the RFI's more general stakes.

The WInnF draws the attention of the AFLCMC readers on the fact the usage policy should be clearly distinguished from the technological framework.

With that distinction in mind, the WInnF advocates consideration of **WInnF Transceiver Facility** and **SCA-based International SDR Standards** as essential technology enablers for the AFLCMC to derive its own usage doctrine, that will exhibit differences from the usage made in other US (typically: JTNC, industry) and international (ESSOR, SVFuA, …) contexts.

The WInnF stands ready to participate to any further inquiry from AFLCMC regarding those matters, and envisions the elaboration of a fruitful relationship with the AFLCMC inspired from the one currently existing with the JTNC.

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