ESSOR

European **S**ecure **SO**ftware defined **R**adio

PROGRAMME ACHIEVEMENTS & PERSPECTIVES

WInnComm Europe 2016 – Paris – 11 Oct. 2016

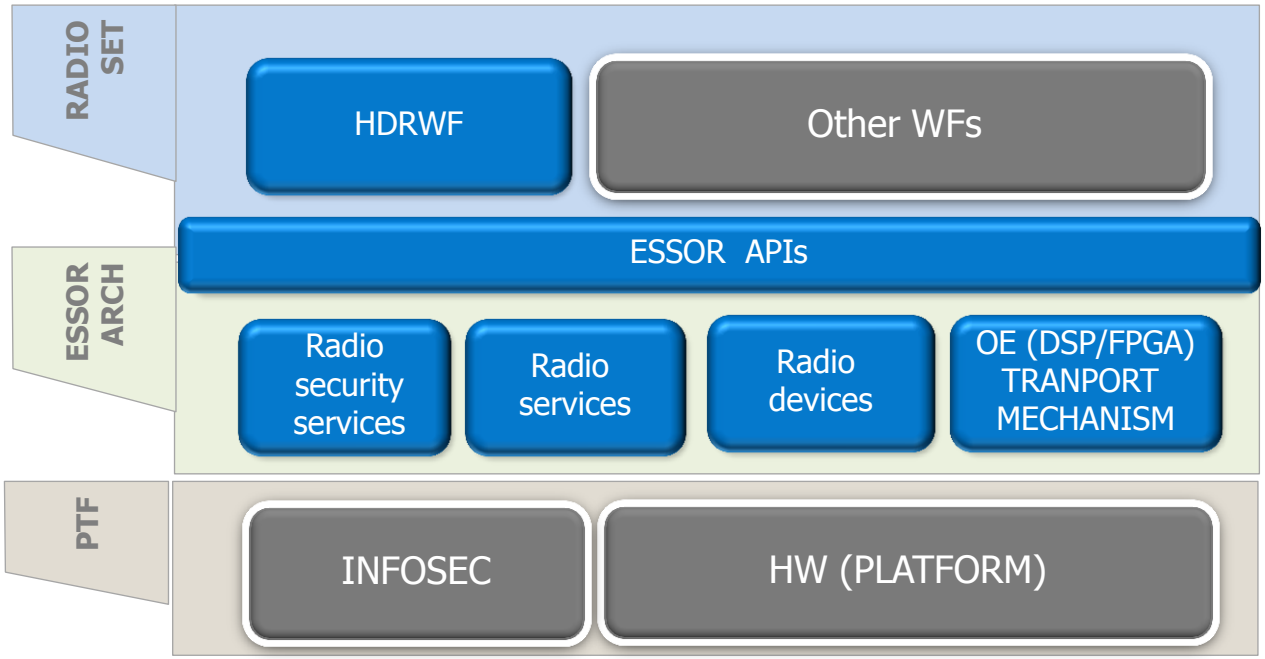
Agenda

1. ESSOR Programme Achievements
2. ESSOR HDRWF Overview
3. Successful Interoperability Testing events
4. SCA Standards Evolutions
5. Follow-on activities
6. Conclusions

1. ESSOR Programme Achievements

ESSOR Stakeholders

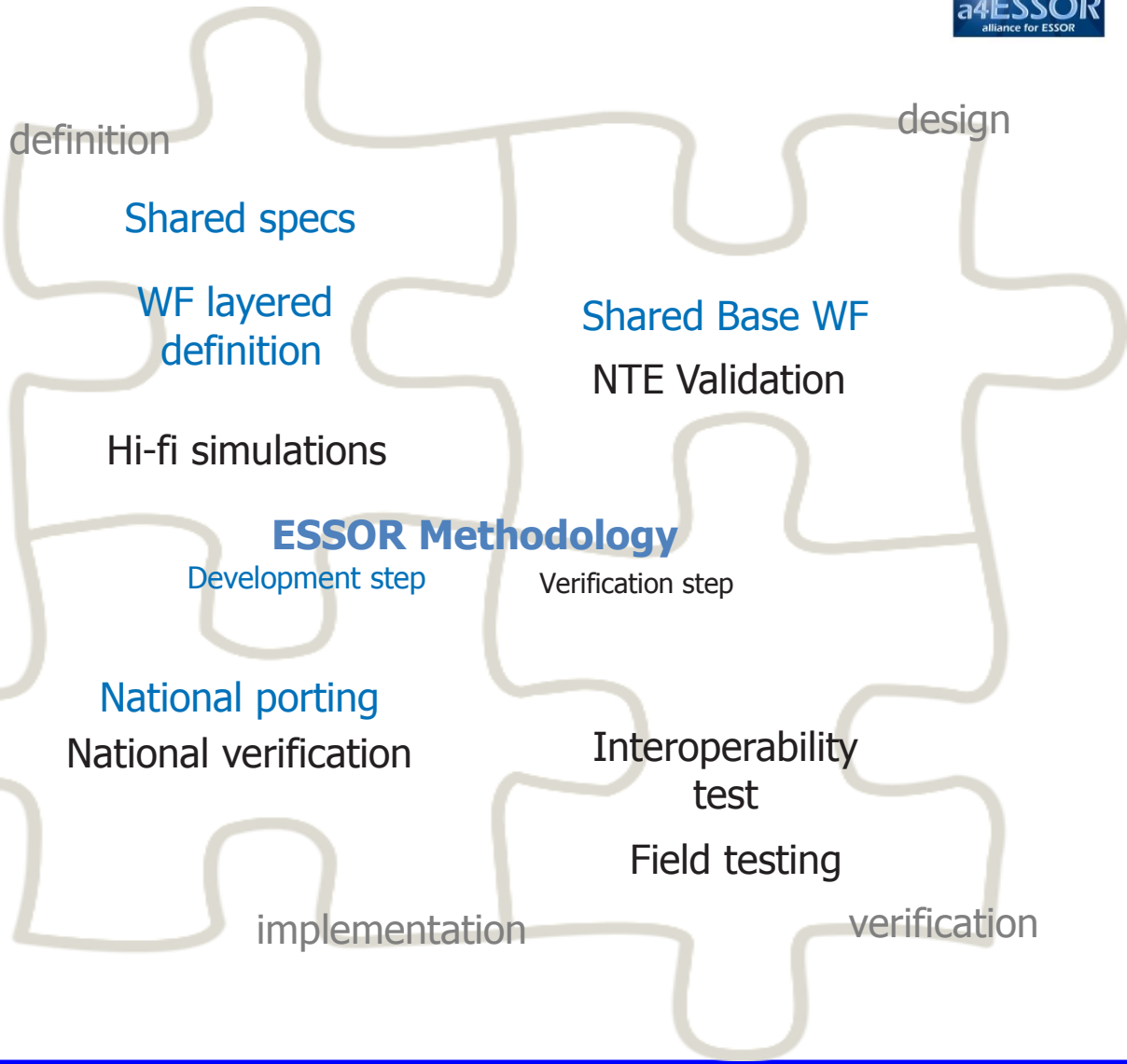
ESSOR Architecture



ESSOR HDRWF

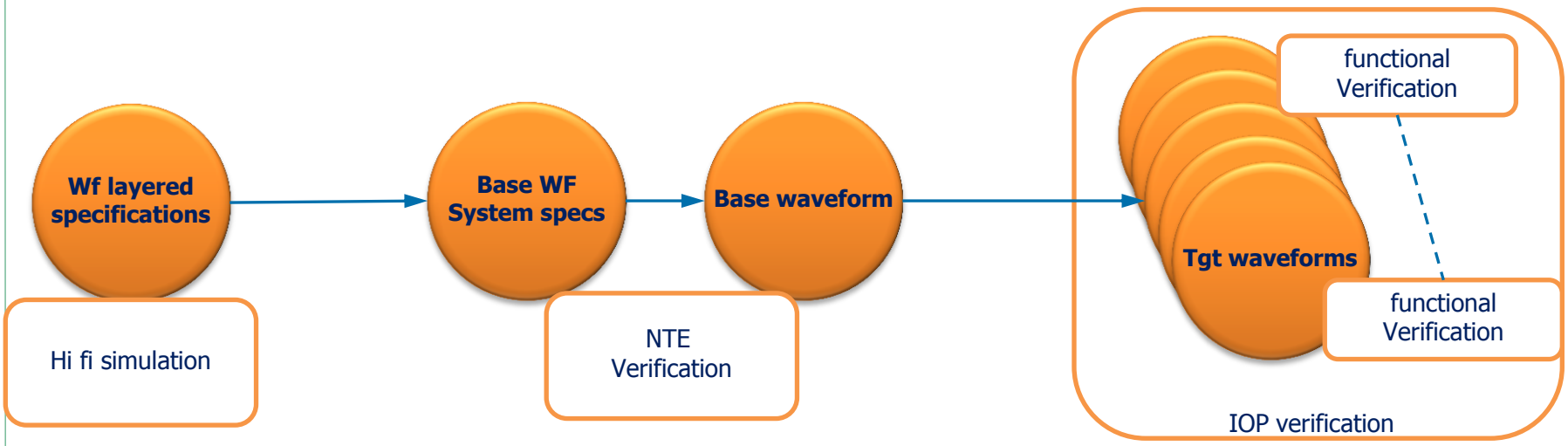
HDRWF: secure interoperable wideband waveform

- UHF band
- Up to 1 Mbps data rate
- Frequency Hopping
- 1.25 MHz bandwidth
- IP data
- Network synchronization with or without GNSS



ESSOR methodology : way of success

Common Implementation methodology



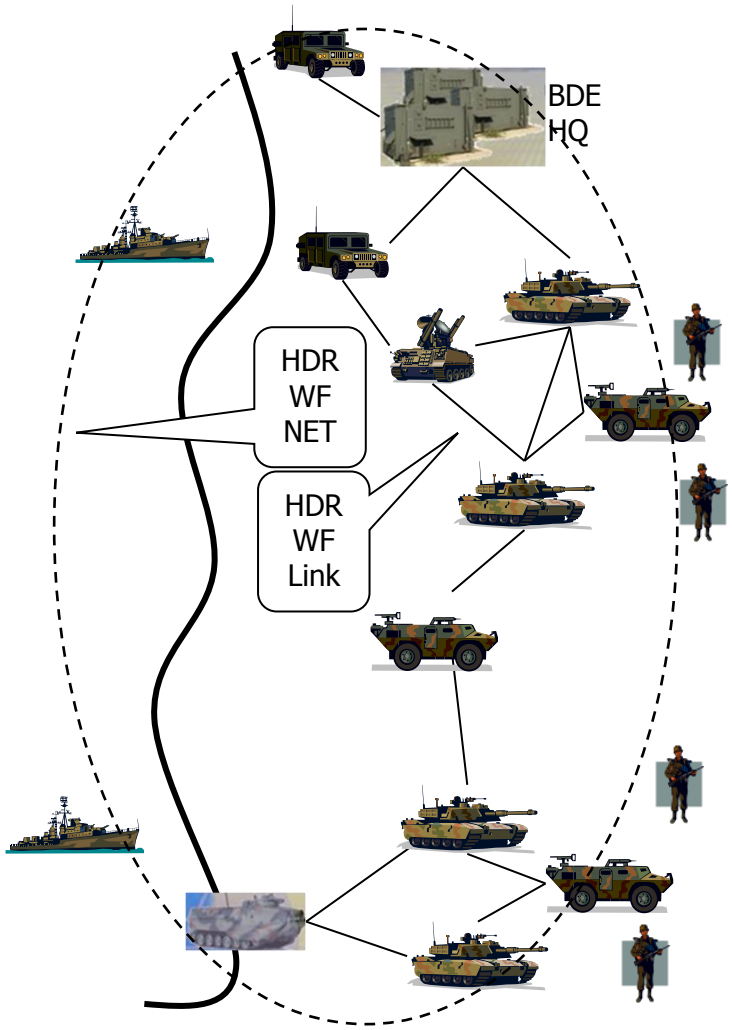
Common verification methodology & tools

2. ESSOR HDRWF Overview

ESSOR HDRWF Main Benefits

ESSOR HDRWF is a **Secure Coalition Network**

- Enhances connectivity by providing a High Data Rate network
- Enables growth capacity of the forces through Ad-hoc network, self-organising / self-healing
- Improves efficiency of the forces on the move
- Enables Network Centric Warfare
  - Vertical / horizontal communications
  - Transverse network used to interconnect CNR networks and/or Area Networks
  - IP Inter-networking between HDRWF network and legacy/future networks through open interfaces



ESSOR HDR WF Key Features

Secure Coalition WF Brigade and Below:

- UHF 225-400 MHz, ~1,25 MHz channel bandwidth
  - Allowing High Data Rate: up to 1 Mbps
- Up to 200 nodes per Network with
  - Efficient Frequency Resource usage (operate with few of frequency channels)
  - Dynamic Resource Allocation
- Ad-Hoc: Node Mobility up to 130 km/h (Land applications – extension to helicopters)
- Fully Secured: COMSEC / NETSEC / TRANSEC (Frequency Hopping)
- Robust Synchronization: With / Without / Mixed GNSS
  - Take benefit of GNSS when available (GNSS system agnostic)
- Operational use cases leaning on :
  - IP Unicast, Multicast, Broadcast, Full Duplex data and VoIP, Video streaming,
  - Join/split, Connectivity loss management

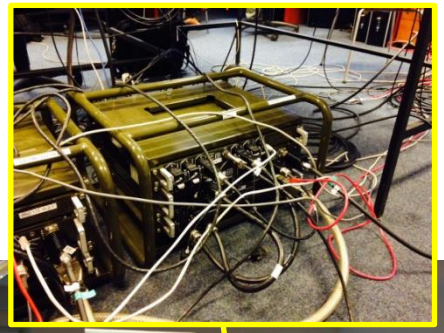
3. Successful Interoperability Testing events

Successful Interoperability Testing events

- **Interoperability in military radio-communications is achievable and achieved through** software defined radio (**SDR**).
- Each nation can use its own national SDR radio equipment and **interoperability** is achieved **through the usage of a common waveform application.**
  - ESSOR motto: "***interoperability through portability".***
- **Interoperability** has been achieved **among 5 different national SDR platforms from 5 different vendors/nations**:
  - 2 tactical radios (FRA and ITA), 1 tactical radio prototype (FIN), 2 lab demonstrators (ESP and POL).
- These events promote the **ESSOR HDR WF** as an excellent potential candidate solution for **multinational interoperability**.
- These events confirm that **ESSOR Architecture** and **ESSOR Methodology For WF Portability** are the first real cooperative success case in the military SDR panorama.

ESSOR HDRWF Interoperability Qualification (June 2015)

Italian SDR PTF



Finnish SDR PTF

Polish SDR PTF

French SDR PTF

Spanish SDR PTF

Heterogeneous platforms from the different ESSOR Nations

ESSOR Interoperability Demonstration to NATO / COALWNW (Nov/Dec 2015)

- Interoperability demonstrated in front of NATO and COALWNW (Gdynia – PL)
  - 6 nodes topology network in lab.
  - 4 different SDR from 4 ESSOR Nations
- Full HDRWF features (Network Building / Split / Merge, Rerouting, VoIP P2P & Conference, Multiple Video Calls, Video Streaming, File Transfer, IP Data, Full Security including Frequency Hopping, IPsec, OTAx,…)

ESSOR 2016 Interoperability Demonstrations

- Interoperability demonstrated full-week during Eurosatory 2016
  - Bittium / TCS interoperability (4 Nodes) on French MoD - CONTACT booth
    - Voice, Data, Video, highlighting the integration of the WF in a collaborative combat environment where sensors are interconnected
  - Bittium / Leonardo interoperability (2 Nodes) on Leonardo booth
    - Video streaming

- Bittium / Thales live “on-the-air” ESSOR demonstration during WinnComm 2016 (4 Nodes: Video, Voice, BFT, Chat, …)

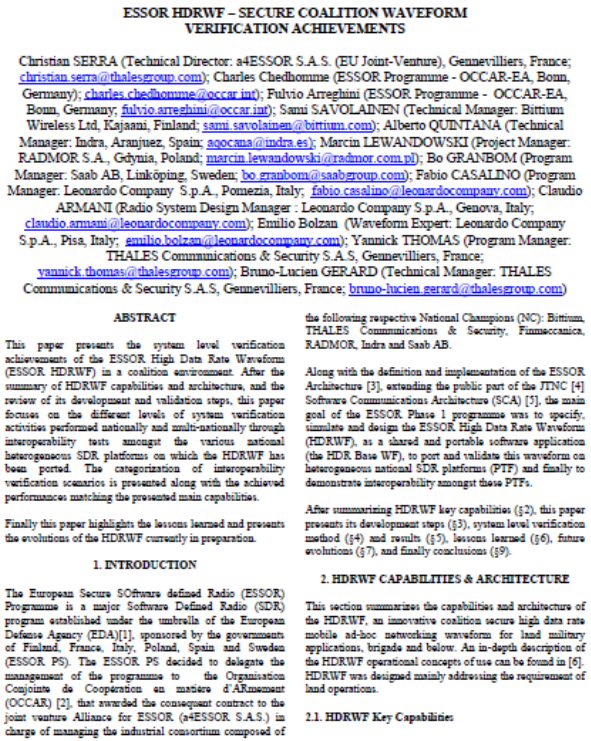
ESSOR HDRWF Field Testing & exercises

- ESSOR HDRWF Field Testing is currently being performed by several ESSOR Stakeholders
- A larger Interoperability Field test event (up to 15 nodes), performed by operational personnel in relevant operational scenario, is currently in preparation in Finland in Nov. 16 towards NATO and COALWNW
- Field Tests achievements, in line with ESSOR expectations and requirements, confirms the efficiency of the ESSOR methodology

ESSOR HDRWF Paper for WInnComm Europe 2016

ESSOR HDRWF – SECURE COALITION WAVEFORM VERIFICATION ACHIEVEMENTS

- HDRWF Key Capabilities
  - MANET and Synchronization, Remote and Local Management, IP Based Services, Spectrum and Signal in Space, Information Assurance
- HDRWF Architecture
  - PHY, MAC, LLC, MGT Layers
- HDRWF Development Steps
  - System Design, Base WF Software Development, Porting and National Tests, Interoperability Tests
- System Level Verification Method
  - Multinational Test Bed and Procedures
- System Level Verification Results
- Lessons Learnt
- Future Evolutions of the HDRWF



ESSOR HDRWF – SECURE COALITION WAVEFORM VERIFICATION ACHIEVEMENTS

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ABSTRACT

This paper presents the system level verification achievements of the ESSOR High Data Rate Waveform (ESSOR HDRWF) in a coalition environment. After the summary of HDRWF capabilities and architecture, and the review of its development and validation steps, this paper focuses on the different levels of system verification activities performed nationally and multi-nationally through interoperability tests amongst the various national heterogeneous SDR platforms on which the HDRWF has been ported. The categorization of interoperability verification scenarios is presented along with the achieved performances matching the presented main capabilities.

Finally this paper highlights the lessons learned and presents the evolutions of the HDRWF currently in preparation.

1. INTRODUCTION

The European Secure SOftware defined Radio (ESSOR) Programme is a major Software Defined Radio (SDR) program established under the umbrella of the European Defense Agency (EDA)[1], sponsored by the governments of Finland, France, Italy, Poland, Spain and Sweden (ESSOR PS). The ESSOR PS decided to delegate the management of the programme to the Organisation Conjointe de Coopération en matière d'ARmement (OCCAR) [2], that awarded the consequent contract to the joint venture Alliance for ESSOR (a4ESSOR S.A.S.) in charge of managing the industrial consortium composed of the following respective National Champions (NC): Bittium, THALES Communications & Security, Finmeccanica, RADMOR, Indra and Saab AB.

Along with the definition and implementation of the ESSOR Architecture [3], extending the public part of the JTNC [4] Software Communications Architecture (SCA) [5], the main goal of the ESSOR Phase 1 programme was to specify, simulate and design the ESSOR High Data Rate Waveform (HDRWF), as a shared and portable software application (the HDR Base WF), to port and validate this waveform on heterogeneous national SDR platforms (PTF) and finally to demonstrate interoperability amongst these PTFs.

After summarizing HDRWF key capabilities (§2), this paper presents its development steps (§3), system level verification method (§4) and results (§5), lessons learned (§6), future evolutions (§7), and finally conclusions (§9).

2. HDRWF CAPABILITIES & ARCHITECTURE

This section summarizes the capabilities and architecture of the HDRWF, an innovative coalition secure high data rate mobile ad-hoc networking waveform for land military applications, brigade and below. An in-depth description of the HDRWF operational concepts of use can be found in [6]. HDRWF was designed mainly addressing the requirement of land operations.

2.1. HDRWF Key Capabilities

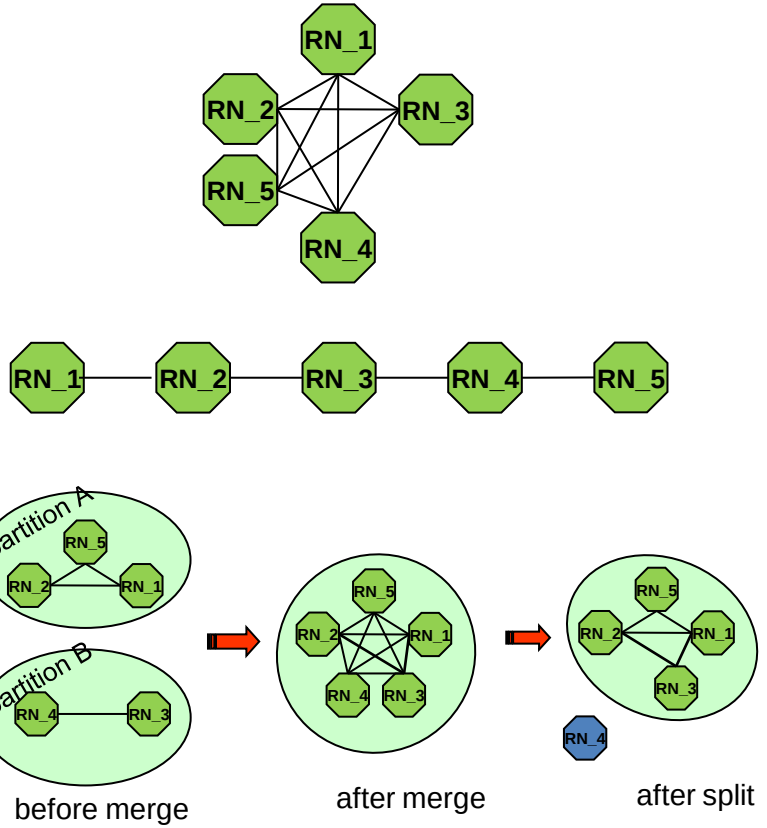
ESSOR HDRWF Paper for WInnComm Europe 2016

ESSOR HDRWF – SECURE COALITION WAVEFORM VERIFICATION ACHIEVEMENTS

- System Level Verification Results (extracts)

Network Initialization				
Network size	Network Topology	Mobility	GNSS	Performance
5	all neighbor	Static	Without	< 20 sec
5	all neighbor	Static	With	< 15 sec
5	Chain	Static	Without	< 25 sec
5	Chain	Static	With	< 20 sec
5	all neighbor	Mobility	Without	< 30 sec
5	all neighbor	Mobility	With	< 15 sec

Networks Merging / Splitting				
Network size	Network Topology	Node Mobility	GNSS	Performance
(3+2) to 5	2 Clusters merging	Mobility	Without	< 30 sec
		Mobility	With	< 15 sec
5 to (4+1)	1 Cluster splitting in 2	Mobility	Without	< 15 sec
		Mobility	With	< 15 sec



Fast Network Initialization and Maintenance (With / Without GNSS)

4. SCA Standards Evolution

SCA Standards Evolution

- Relying on ESSOR Architecture, ESSOR Community contributed to SCA 4.1 **Application Environment Profiles (AEPs)** and **Interface Definition Language (IDL) (ultra-)lightweight profiles.**
- The ESSOR Community really appreciated the **joint multinational efforts** performed in the **framework of the WINNF SCA 4.1 WGs** for elaborating the SCA 4.1 specifications, **integrating positively significant contributions provided by ESSOR**, and appreciates **SCA 4.1 normative reference to WINNF Std. "PIM IDL Profiles"**
- The ESSOR Community notes favourably that **Backwards Compatibility with SCA 2.2.2** and **Resource Constrained OE** have been at the core of SCA 4.1 efforts, enabling **re-use of past WF developments** (as ESSOR HDRWF and National / NATO WFs) and further **extending applicability** of SCA **on DSPs and FPGAs.**
- The ESSOR Community is looking positively to the **WINNF Transceiver (XCVR) Next efforts** and highlights the importance of **caring about Backward Compatibility, a key driver for future consideration.**
- As future phase of the ESSOR Programme is being initiated, the ESSOR Community is considering evaluating the impact of **WINNF Specifications** and **issued SCA 4.1** for **future enhancements of the ESSOR Architecture**, with the goal to **maintain the compatibility with the SCA.**

Relationship OCCAR-WInnF

- **OCCAR-WInnF agreement** (“MoU”) for the **exchange of information** in order to support the **harmonisation of the Software Communication Architecture (SCA) standards at international level** is in place since beginning of 2016

- ESSOR Transceiver APIs released to WINNF CCSCA
- ESSOR Timing service API ready to be released

- ESSOR PS investigates further release of information through OCCAR according to the progress of the harmonization activities in WINNF

5. Follow on Activities

Perspectives

To make ESSOR operationally use on the fields

Manage fielding

Technical testing

Joint exercises

Establish TLM approach

ESSOR Information Release to NATO

- The following ESSOR information has been released to support NATO for the WBWF standardisation
  - **ESSOR HDRWF User Requirement (UC)**
    - Released on Dec. 12 to NHQC3Staff
  - **ESSOR HDR WF SSS (UC)**
    - Delivered on Sept. 15 to NHQC3Staff
  - **ESSOR IOP Demonstration supporting charts (UC)**
    - Released on Dec. 15 to NHQC3Staff
- ESSOR PS investigating further release of information

6. Conclusions

Why ESSOR is a Success

A common architecture

A common Interoperable waveform

A common methodology

National implementations

A common management

You can **buy** a product and use it jointly

OR

You can cooperate to **create knowledge** and best practice through an efficient management.

Conclusions

- Interoperability demonstrations between different national PTFs is a **world's first success.**
- The ESSOR HDRWF Testing Domain is extending from **Laboratory Testing** to **Field Testing** and initial **Field Test results are in line with the expectations.**
- Based on governmental development initiative and ESSOR HDRWF **interoperability achievements**, featuring **state-of-the art** capabilities and techniques and able to support future extensions, the ESSOR Stakeholders are convinced that this new "**interoperability through portability**" process is the best approach for **Coalition interoperability waveforms**.

Conclusions: ESSOR is now …

- Ready to share our achievements to support standardization and coalition adoption
- Interoperability proven
- Portability proven
- Successfully field tested nationally and international field tests are starting

Operational community are looking forward to deploy on large and joint operational use

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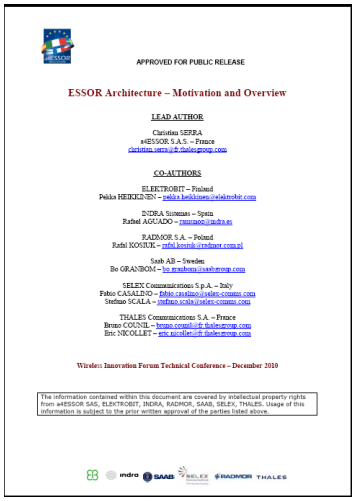
More Information

- Further reading:
  http://www.occar.int/42



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ESSOR Architecture – Motivation and Overview

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ESSOR Architecture information

ESSOR HDR BASE WF – METHODOLOGY AND RESULTS FOR DEVELOPING A PORTABLE COALITION WAVEFORM SOFTWARE

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ABSTRACT

The ESSOR HDR Base WF is the common portable software jointly developed by the ESSOR stakeholders in order to be ported on different heterogeneous national SDR platforms. As such, this is a significant result of ESSOR.

After presenting the summary of the key capabilities of the ESSOR HDRWF, this paper details: (i) the ESSOR Methodology for Portability, a generic methodology elaborated to design and validate the Base WF, and relying on the ESSOR Architecture; (ii) the application of this methodology to the development of the HDR Base WF, with its reference structure; (iii) the concepts, architectural implications and uses of the Native Test Environment specifically developed for incrementally validating the HDR Base WF; (iv) the results of current incremental porting activities of the HDR Base WF on heterogeneous national SDR Platforms, with the initial lessons learnt.

1. INTRODUCTION

The European Secure SOftware defined Radio (ESSOR) Programme is a major Software Defined Radio (SDR) program established under the umbrella of the European Defence Agency (EDA)[1], sponsored by the governments of Finland, France, Italy, Poland, Spain and Sweden. ESSOR has been awarded by the Organization Conjointe de Coopération en matière d'Armement (OCCAR) [2] to the joint venture Alliance for ESSOR (a4ESSOR S.A.S.) in charge of managing the industrial consortium composed of the following respective National Champions (NC): Elektrobit, THALES Communications & Security, SELEX ES, RADMOR, Indra and Saab AB.

Along with the definition and implementation of the ESSOR Architecture [3], an SDR architecture extending the public part of the JTNC [4] Software Communications Architecture (SCA) [5], ESSOR specifies, simulates and designs the ESSOR HDRWF (High Data Rate WaveForm), develops this WF as a shared and portable software application (the HDR Base WF), ports this shared WF application on heterogeneous national SDR platforms (PTF), and finally demonstrates interoperability amongst these PTFs.

After summarizing the HDRWF key capabilities (§2), this paper presents the motivation for developing a Base WF, the ESSOR Methodology for Portability and its relationship with the ESSOR Architecture (§3), provides the application of this methodology to the development of the ESSOR HDR Base WF and details its structure (§4), explains the HDR Base WF validation process (§5), provides status of HDR Base WF porting on national SDR Platforms (§6), and finally concludes with perspectives on future steps (§7).

2. HDRWF CAPABILITIES & ARCHITECTURE

This section summarizes the key capabilities and architecture of the HDRWF, a coalition secure high data rate mobile ad hoc networking waveform for land military applications. A more in-depth description of the operational aspects and concepts of use of the HDRWF can be found in the paper presented at MILCOM'10, [6].

2.1. HDRWF Key Capabilities

The HDRWF capabilities have been defined in order to sustain an evolutionary development path. In the current phase of the programme: (i) Threshold Capabilities (T) refer to features that are subject to detailed design, simulation, software development, porting and interoperability testing; (ii) Objective Capabilities (O) refer to features that are studied up to WF architecture definition, giving confidence

ESSOR HDRWF – CAPABILITIES AND PERSPECTIVES OF AN INNOVATIVE COALITION WAVEFORM

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Abstract—This paper presents the motivation and results of the European Secure SOftware defined Radio (ESSOR) programme concerning the capabilities and perspectives of the ESSOR HDRWF (High Data Rate WaveForm), an innovative coalition secure high data rate mobile ad hoc networking waveform for land military applications, brigade and below. It gives insight on ESSOR results in specifying, simulating and defining the ESSOR HDRWF. It moves from the User Requirements which drove the definition phase, resulting in a highly configurable waveform capable of adapting to different operating scenarios. It also details the main capabilities of the ESSOR HDRWF and analyses the achievable performances, considering radio link communication aspects along with overall ad-hoc network behaviour. Impact of site and topology of the network (from scarce networks with few nodes up to dense networks with high number of nodes) is considered. In order to support proper performance assessment, this paper highlights the High Fidelity Simulation environment and methodology put in place for the definition and design phase. Integration of the ESSOR HDRWF into the more general IP based Tactical Internet concept is also addressed and put in perspective of the associated NATO interoperability approach. In terms of innovative features, it addresses the capabilities of the ESSOR HDRWF to handle efficient synchronization in absence of common time reference (i.e. GNSS), to properly manage communication on the move and dynamic adaptation to the operational environment. In relation with the design activities, this paper presents an overview of the ESSOR Base WF approach allowing the development of portable software jointly developed by the ESSOR stakeholders, supported by the Common Criteria assurance requirements. In that perspective, the current porting activities of this shared software on the different and heterogeneous National SDR Platforms are summarized. Finally this paper focuses on the different levels of system validation activities which are planned and which will culminate with interoperability tests amongst the various national SDR platforms.

Keywords—ESSOR; SDR; HDRWF; Waveform; OCCAR; NATO; MANET; Common Criteria; Portability; SCA; IP; ORF; Base Waveform; Native Test Environment;

I INTRODUCTION

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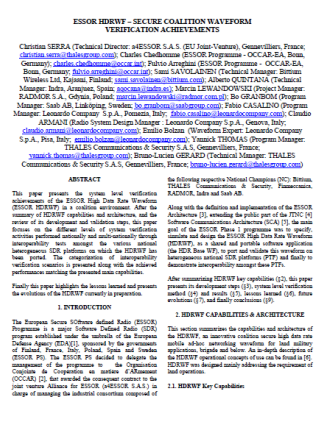

ESSOR HDRWF – SECURE COALITION WAVEFORM VERIFICATION ACHIEVEMENTS

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ABSTRACT

This paper presents the system level verification achievements of the ESSOR High Data Rate Waveform (ESSOR HDRWF) in a coalition environment. After the summary of HDRWF capabilities and architecture, and the review of its development and validation steps, this paper focuses on the different levels of system verification activities performed internally and multinationally through interoperability tests amongst the various national heterogeneous SDR platforms on which the HDRWF has been ported. The categorization of interoperability verification scenarios is presented along with the achieved performance matching the promised peak capabilities.

Finally this paper highlights the lessons learned and presents the evolutions of the HDRWF currently in progression.

1. INTRODUCTION

The European Secure SOftware defined Radio (ESSOR) Programme is a major Software Defined Radio (SDR) program established under the umbrella of the European Defence Agency (EDA)[1], sponsored by the governments of Finland, France, Italy, Poland, Spain and Sweden (ESSOR PO). The ESSOR PC decided to delegate the management of the programme to the Organisation Conjointe de Coopération en matière d'Armement (OCCAR) [2], that awarded the consequent contract to the joint venture Alliance for ESSOR (a4ESSOR S.A.S.) in charge of managing the industrial consortium composed of

ESSOR HDRWF information