ESSOR

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

PROGRAMME ACHIEVEMENTS & PERSPECTIVES

WInnComm Europe 2015 – Erlangen – 07 Oct. 2015

Agenda

1. ESSOR Programme Achievements
2. Successful Interoperability Qualification Testing events
3. ESSOR Contributions to WF Portability and Interoperability with Lessons Learned
4. Release of information
5. Future Perspectives

1. ESSOR Programme Achievements

ESSOR Programme – Stakeholders

ESSOR Participating States

Contracting Authority:
•OCCAR

Program Decision established between: (*)

•Finland
•France
•Italy
•Poland
•Spain
•Sweden

(*) Under the umbrella of European Defense Agency (EDA)

ESSOR Industries

Prime Contractor:
•a4ESSOR SAS

Joint Venture established between:

•Bittium (former Elektrobit)
•Thales Communications & Security
•Selex ES
•Radmor
•Indra
•Saab

Contract overview

2010

ESSOR Architecture definition

2011

High Fidelity Simulations

HDR WF Specification

2010

WF Specification Elaboration

Design Methodology

2012

HDR Base WF

Base WF Development

ESSOR ARCHITECTURE (APIs & OPERATING ENVIRONMENT)

Native Test Environment

ESSOR AL(*)  ... **ESSOR AL(*)**  ... **ESSOR AL(*)** 

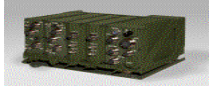
Base WF Porting

6 NC different SDR Platforms updated to ESSOR Architecture

HDR Target WF | **HDR Target WF** | **HDR Target WF**

2011

2013/ 2014

ESSOR AL(*)  ... **ESSOR AL(*)**  ... **ESSOR AL(*)** 

HDRWF ported on different NC SDR Platforms with National Validation

Contract activities started on **1 January 2009** (T0).

2014/2015

Multinational Validation

(*) AL: Abstraction Layer and APIs

ESSOR Architecture Status

- **ESSOR Architecture and APIs documents**
  - ESSOR Architecture definition
    - Operating Environment
    - Security Architecture
  - Radio Devices APIs;
  - Radio Services APIs;
  - Radio Security Services APIs.

Finalized

- **Implementation of the ESSOR Architecture on the National Platforms**
  - Lessons learned from these implementations provide feedback on the ESSOR Architecture definition.

Finalized

ESSOR HDR WF Status

- **HDR Waveform Definition:**
  - Evolutivity / Modularity / Parameterization;
  - Elaboration of Draft Standard;
  - Supported by High Fidelity Simulations.

Finalized

- **HDR Base WF Development and Validation:**
  - Common HDR WF software code amongst the 6 National Champions;
  - Incremental Validation on NTE for de-risking the porting activity and ensure interoperability;
  - Cornerstone for the SDR Business Model.

Finalized

- **HDR Base WF Porting on the National Platforms:**
  - National Implementation, Validation, Qualification.
  - Incremental Approach

Finalized

- **Multinational Labs Interoperability:**
  - Supported by Multilateral Test Bed (MTB)
  - Incremental Approach

Finalized

ESSOR HDR WF Incremental Demonstrations and Qualification

- **Demonstration of HDR Base WF Protocol Layers on Protocol Native Test Environment (PROT NTE)** — June 2013
- **Demonstration of HDR Base WF Physical Layer on Physical Native Test Environment (PHY NTE)** — July 2013
- **Demonstration of Initial Point to Point capabilities of HDRWF ported on NCs PTF** — Early Fall 2013
- **Demonstrations and Lab Qualification Reviews with HDRWF Network capabilities ported on NCs PTF** — Mid 2014 – Mid 2015
- **Multinational Interoperability Lab Qualification Reviews with HDRWF Network capabilities** — Q4 2014 – Mid 2015

2. Successful Interoperability Qualification Testing events

Successful Interoperability Qualification Testing events

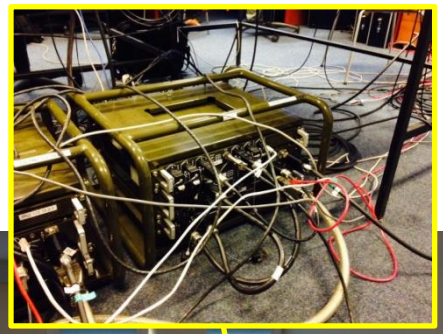
- **First Interoperability Functional Qualification Review** (FQR) in December 2014 in Gdynia (Poland).
  - **Four different nations/radio platforms.**
  - **"Essential" functional scope,** including MANET (mobile ad hoc network) features, self organising / self healing with and without GNSS, data traffic, video streaming, connection with external networks, security, etc.
- **Second FQR** in May 2015 in Gdynia (Poland).
  - **Three different nations/radio platforms.**
  - **"Complete" functional scope.** In addition to the "essential" capabilities, new waveform features: VoIP capabilities, QoS (Quality of Service) management, power and data rate adaption, OTAD/R/Z (Over The Air Distribution, Rekeying and Zeroize) operations, etc. **All the waveform security mechanisms activated** (COMSEC, TRANSEC and NETSEC).
- **Third FQR** in June 2015 in Gdynia (Poland).
  - **Five different nations/radio platforms.**
  - **"Complete" functional scope.**

ESSOR Programme

Successful Interoperability Qualification Testing events

Italian SDR PTF

Finnish SDR PTF



Polish SDR PTF

French SDR PTF

Spanish SDR PTF

Successful Interoperability Qualification Testing events

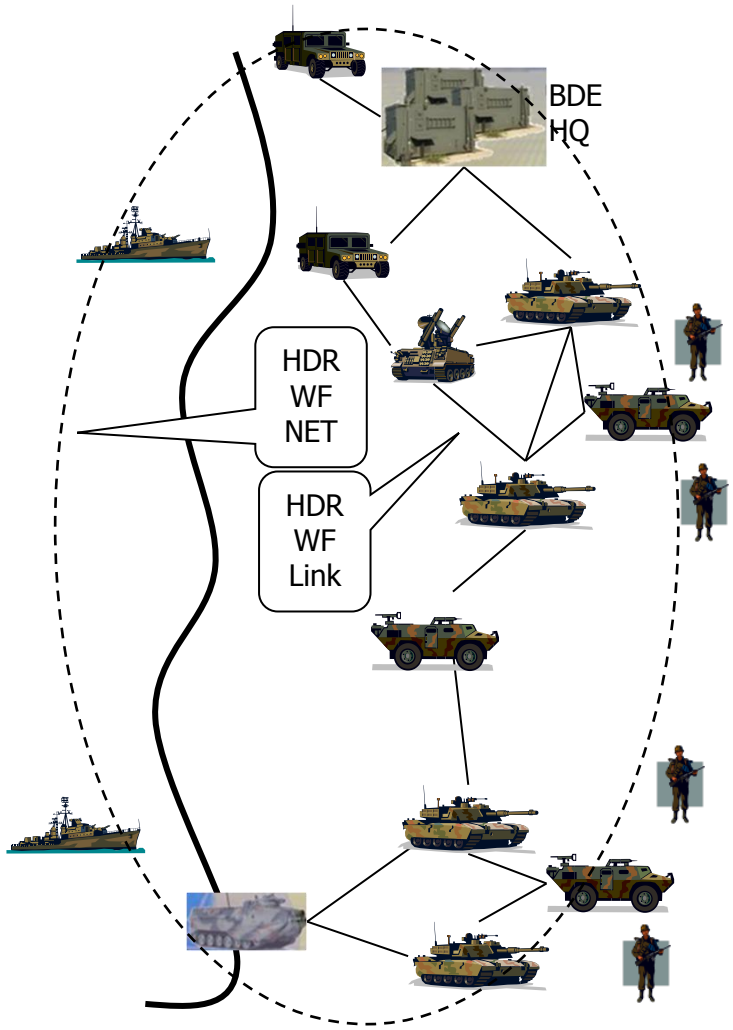
- These Interoperability FQRs are milestones of paramount importance, as they demonstrate that the **interoperability in military radio-communications is achievable through** the software defined radio (**SDR**) technology.
- Each nation can use its own national SDR radio equipment and **interoperability** 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 the **NATO Wideband Waveform STANAG**.
- These events confirm that **ESSOR Architecture** and **ESSOR Methodology For WF Portability** are fully relevant for the SDR business area.

3. ESSOR Contributions to WF Portability and Interoperability with Lessons Learned

ESSOR HDRWF Main Benefits

ESSOR HDRWF is a **Secure Coalition Network**

- Enhances connectivity on the battlefield 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:
  - Mobility management for nodes.
  - Communication 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 with compatible security policy levels through open interfaces.



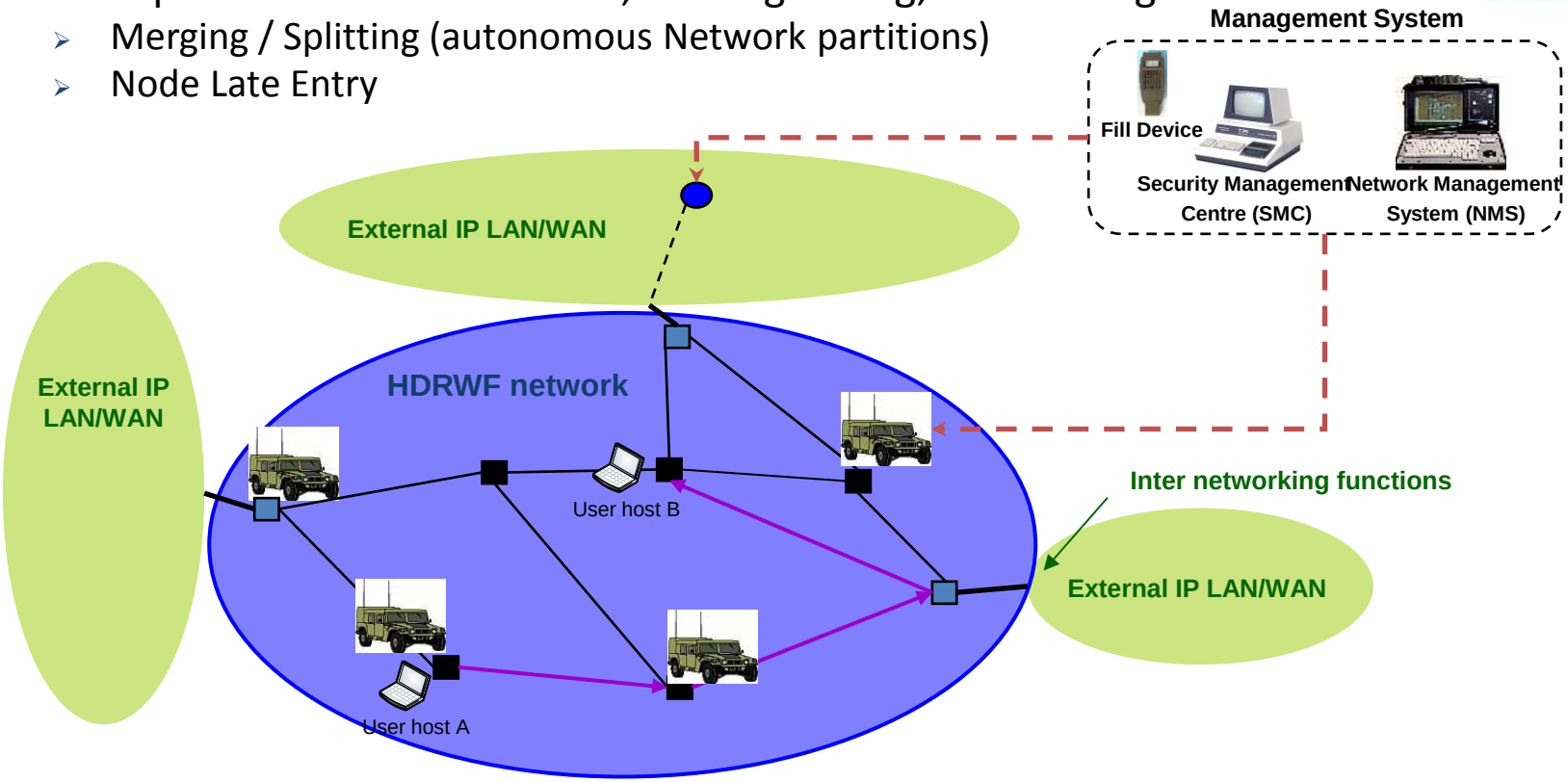
ESSOR HDR WF Key Features

- High Data Rate: **~1 Mbps, ~ 512 kbps, ~ 256 kbps** at Radio Link
- UHF: 225-400 MHz (extensible), **~1,25 MHz** bandwidth, **Frequency-Hopping**
- Designed to support up to **200 nodes** per Network
- **Ad-Hoc:** Mobility management of the nodes and communication on the move. **Dynamic adaptation to the environment** (Propagation, Node Density, Traffic, Advantaged Nodes, …)
- **Node mobility:** up to 130 km/h (PHY assessed up to 400 km/h)
- Synchronization: **With / Without GNSS**, taking advantage of the GNSS when available (**Mixed** configuration)
- (O) Radio Silence Capable
- **Secure**: Red / Black – **Embedded** COMSEC / NETSEC / TRANSEC / OTAR/D/Z
- Compatible with standard **IP applications**: QoS driven approach – Unicast / **Optimized Multicast** / Broadcast traffic
- **Voice Capable**: VoIP; (O) Voice CNR Push To Talk (PTT)
- Support **Local or Remote Management and Supervision**

(O) - Objective Requirements refer to features addressed up to the Architectural Definition level (HDRWF SSDD), providing sound foundations for future increments.

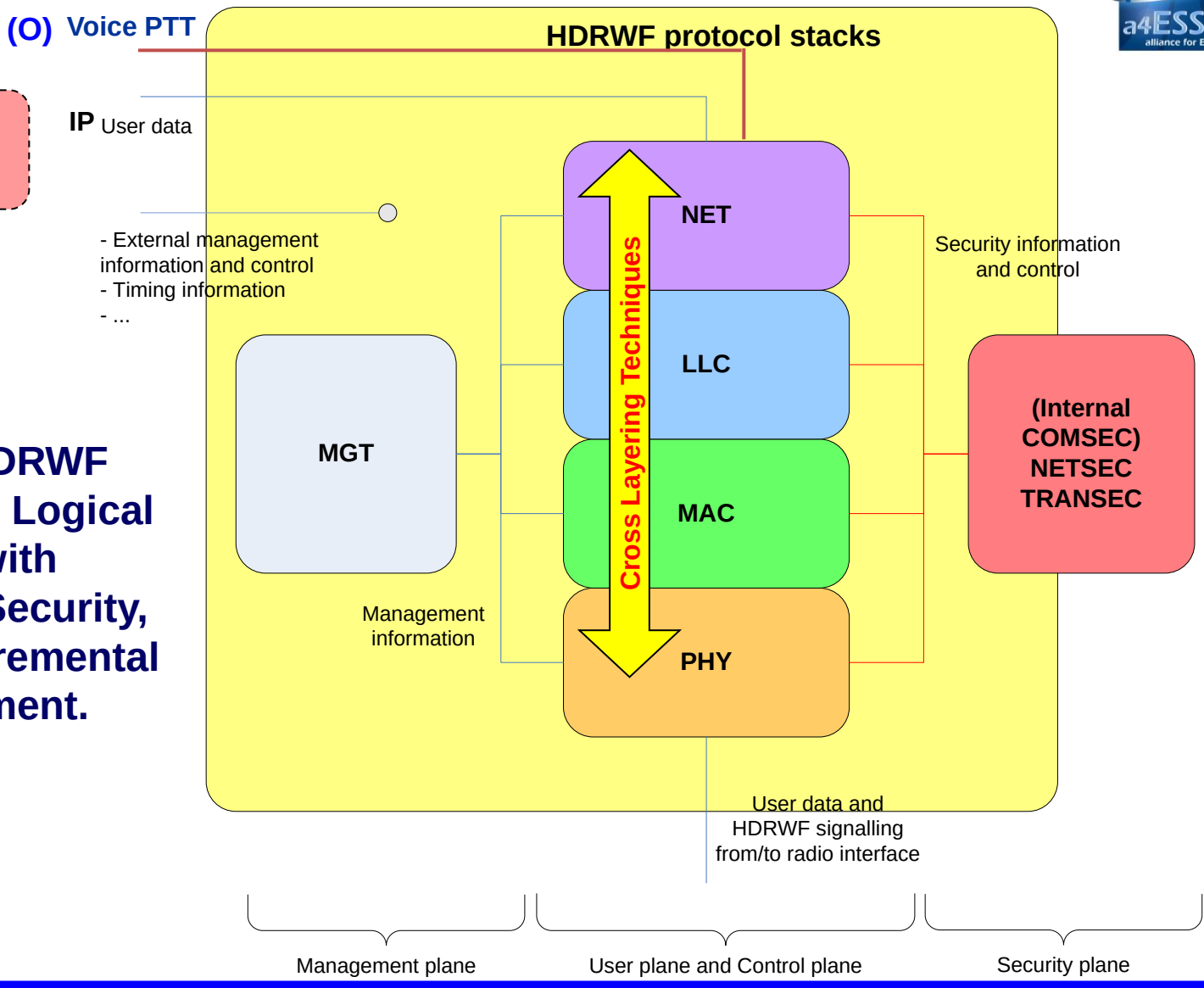
ESSOR HDRWF System Overview

- Multi-hop mobile ad hoc network, self-organizing, self-healing
  - Merging / Splitting (autonomous Network partitions)
  - Node Late Entry



- Nodes are sharing **compatible Mission Parameters** (Keys, Frequencies, @, …)
- Nodes act as source **Transmitter**, destination **Receiver** or **Relay**
- Connected to IP external networks through **inter-networking functions**
- Over-The-Air (OTA) Network Management performed by **NMS** and **SMC**

ESSOR HDRWF Logical Stack



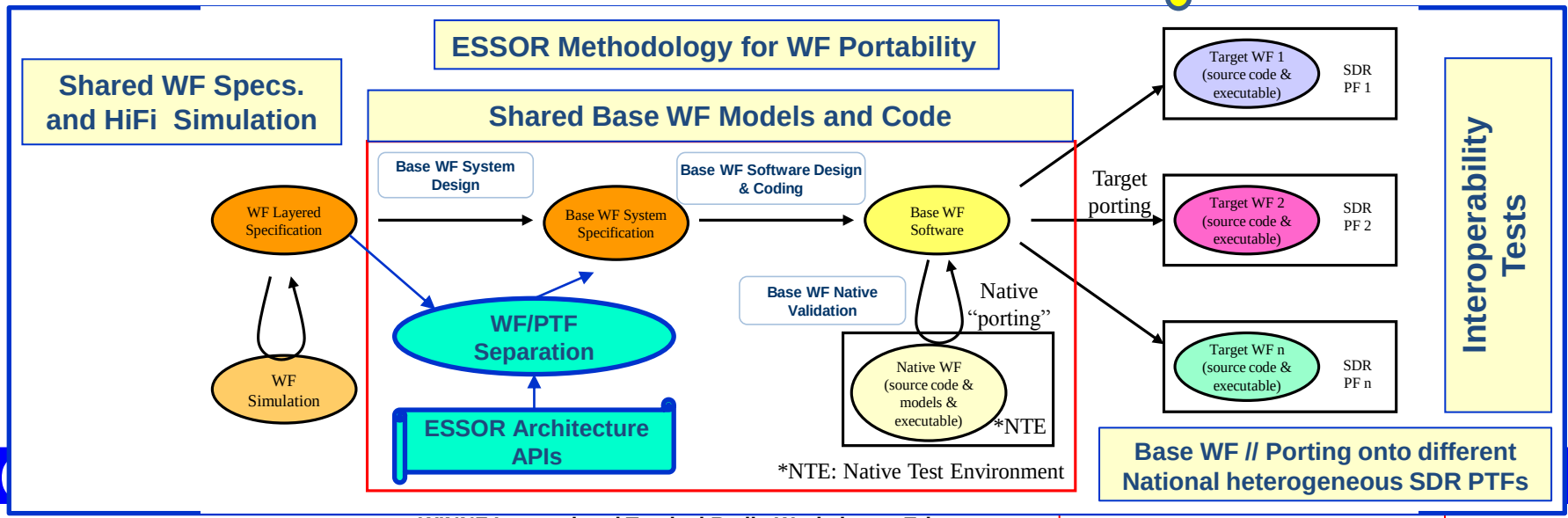
ESSOR HDRWF provides full Logical Stack with embedded Security, enabling Incremental Development.

ESSOR Methodology for WF Portability (Generic Methodology)

- **Shared WF Specifications** and **High Fidelity** (HiFi) **Simulation Models**
  - HiFi Models provide **Interoperability Assessment References**
- **Shared Base WF Models** and **Validated "Golden Source Code"**
  - **WF / PTF Separation** for defining Base WF "Golden Source" scope
  - **Base WF Modularity** for addressing the **diversity of Target PTF**
  - **Portable Base WF** vs. **Optimized Ported Target WF**
  - **Validation on Native Test Environment (NTE)**
- **Base WF Porting on different National heterogeneous SDR PTF**
  - Shared Test Scenarios / Test Vectors / Test Results
- **Interoperability validation among different national PTFs**

Base WF elaboration: 4 Steps
- **Base WF System Design**
- **Base WF Software Design**
- **Base WF Software Coding**
- **Base WF Native Validation**

Validated ESSOR Methodology for Portability

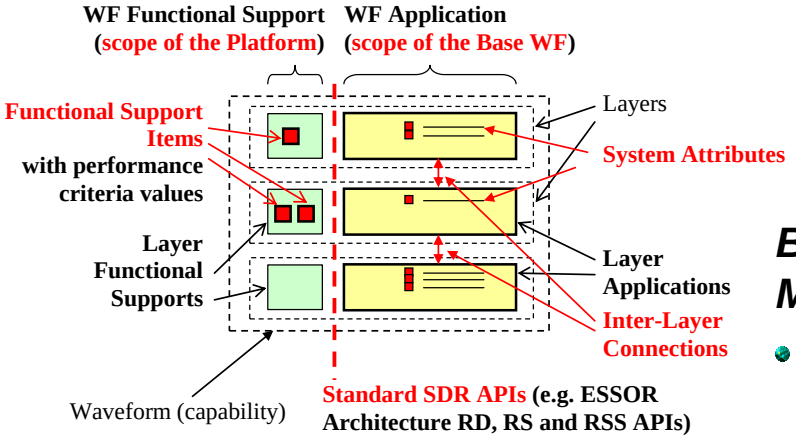


Base WF System Design

- Base WF System Design phase encompasses 3 activities:

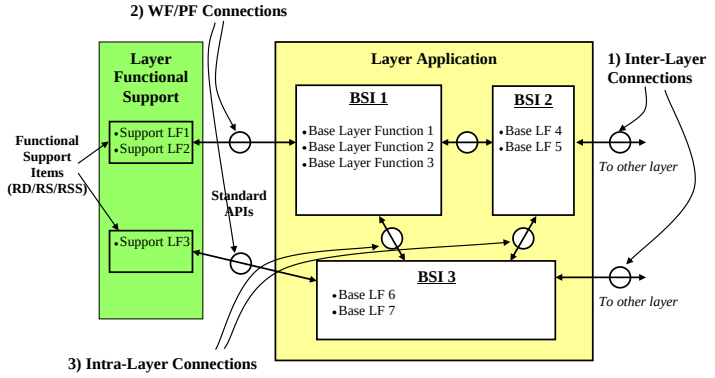
***WF/PF Separation:* Each layer is split in 2 parts**

- The functionalities assigned to the **Base WF,** implemented in a **portable SW manner**
- the **Functional Support** implemented by the **PF** executing the WF of interest
- **Base WF / Functional Support** interfaces are determined by a set of functional APIs (**RD, RS, RSS**) with associated **Perf. Criteria** (performance reqs applying to the *functional support* that the PF has to deliver)



Base WF Partitioning:

- **Base WF Layers** are decomposed into functional components named **Base Software Items (BSIs)**.
- **BSI granularity** drivers:
  - **Diversity of PF** to be addressed.
  - **Security (**Red / Black separation)
  - **Coarse grain**: low number BSIs / interfaces
  - **Fine grain:** compatible with diverse mapping



Base WF Mapping

- To choose the ***target programming language(s)*** that is /are to be used for SW implementation of **each BSI.**
- **Several target languages** can be chosen for a given BSI, for instance C and VHDL (case of "**dual BSIs**").

Base WF Software Design & Coding

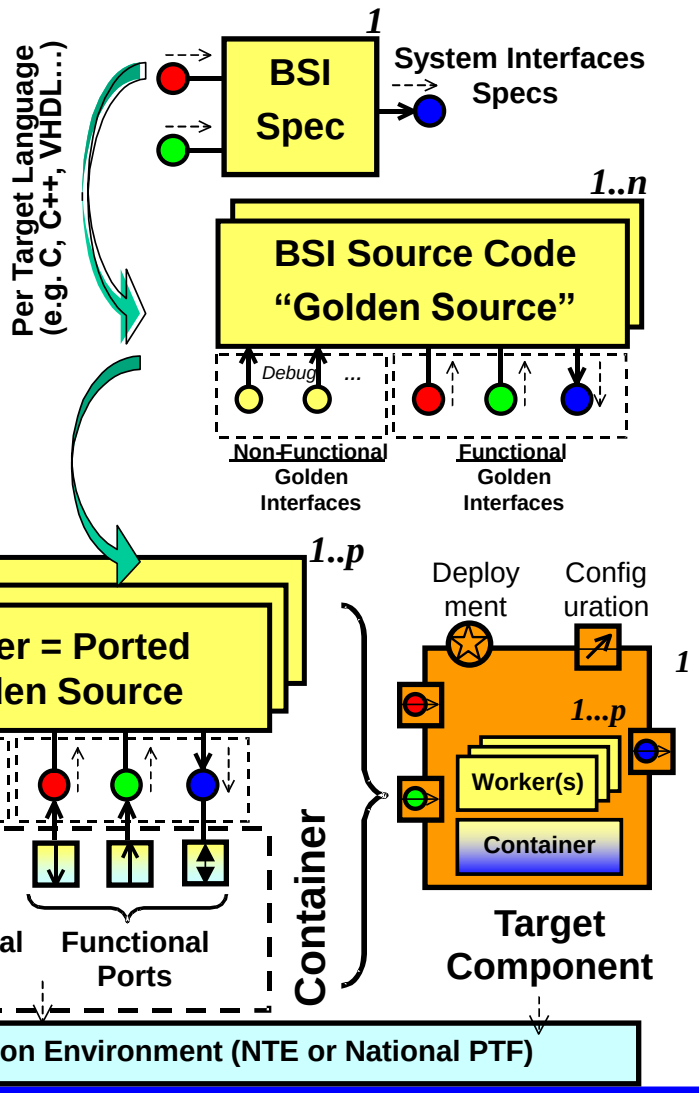
- Develops **BSIs SW implementation** for the **target language(s)** selected by Base WF mapping.

Golden Sources:

- The **functional requirements** of the BSI, along with **critical resources** implementation budgets (memory , DMIPS, CLB …) in line with the selected **Processing Elements.**
- **Independent** from **Configuration and Deployment (**SCA CF) and **Connectivity** (CORBA, MHAL) mechanisms.
- **Golden Source coding rules** derived from JSF program with a specific set defined for C, C++ and VHDL languages.

Target components are composed of:

- **The Worker(s)** in charge to execute the **ported BSIs Golden Source.** Optimizations can take place as required during the porting (e.g. usage of dedicated libraries or hardware accelerators).
- **The Container**, supports **Worker(s)** operation in providing, **based on** the available **Execution Environment**, Deployment & Configuration, Connectivity and RT scheduling.
- **IDL characterization of Worker interfaces** and usage of **standard-compliant Execution Environments** allow usage of code generation tools for Container (e.g. CORBA broker).



ESSOR HDRWF Incremental Verification

	DROP I	DROP II	DROP III	DROP IV
Increment (DROP)	**MINIMUM Point to Point Communications**	**BASIC Networking Capabilities**	**ESSENTIAL IP Services**	**COMPLETE HDRWF Functionalities**
Functional Scope	**Point to Point communications with simplified data exchanges**	**Ad-hoc network (synch, build, merge, split, late entry …)**	**Ad-hoc network with IP Traffic (Unicast, Multicast, Broadcast) and External IP connectivity**	**Full Network Flexibility in terms of Topology and Traffic**
Supported Capabilities				

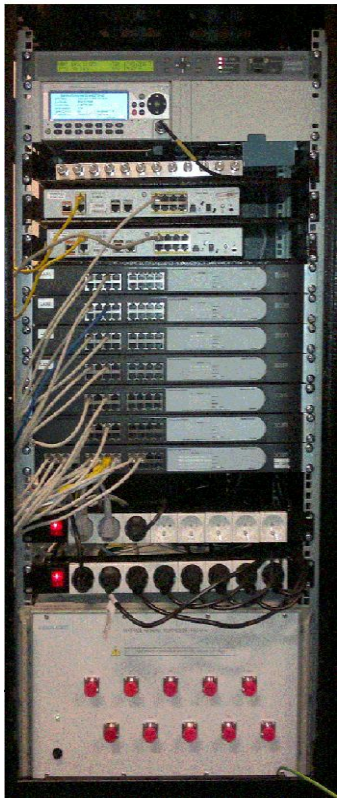
Progressive Integration and Verification of HDRWF Functionalities
(at HDR Base WF and HDR Target WF (porting) levels)
Foster proper work alignment amongst NCs

Multinational Test Bed (MTB)

- **MTB is a system test environment used** for all system level validation activities of the **HDR WF ported on the different National Platforms**
  - **National System Test Beds** performed by the different ESSOR NCs
  - **Interoperability tests** performed between the different ESSOR NCs

- **MTB allows**
  - to interconnect through an **RF Switch Matrix up to 10 Radio Nodes** (loaded with the ported HDR WF), where each of Node is connected to a User LAN, which is transporting the User Traffic.
  - to create, execute and monitor of HDR WF System Test Cases
  - to collect and analyze the results of System Tests of HDR WF
  - to control Test Bed components/tools from remote centralized Test Bed Controller

- **MTB provides the following User Services**
  - Unicast / Multicast / Broadcast IP Traffic with configured QoS
  - VoIP calls (P2P and conference)
  - Video/Images transfer
  - FTP
  - SNMP V3
  - HTTP
  - Emails exchange
  - Chat
  - others…



As a basis MTB uses a common interface for communication between Test Tools used during tests in a way allowing the Test Coordinator to interact with the subject of test – **HDR WF Radio Node.**

Lessons Learned

- The method used to develop and port HDRWF is showing its benefits

Incremental Porting and Validation Activities:

- Follow the rhythm of **Base WF incremental testing and release**.
- **Such release is ported into each PTF**, the tests which are defined for each steps are performed nationally by all NCs.
- **De-risking Interoperability** is achieved by exchanging in advance between NCs **offline test vectors** in order to be sure that all the parameterization is inline.
- After that, **effective interoperability** testing between different NCs is conducted.

Lessons Learnt

- **Simulation** gives confidence on technical decision made, the achievable performance and provides **common references** for validating National porting phases.
- **NTEs validated Base WF Golden Source code** allow developers to concentrate on Target PTF issues (like performance) during porting phase.
- Using common code for National porting activities **facilitates faster feedback on Base WF** (change requests / bug reports) with ability to allocate more workforce on same topic.

4. Release of Information

SCA Standards Evolution

- Relying on ESSOR Architecture, ESSOR NCs contributed to SCA 4.1 elaboration efforts on additional updates to the **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

- Establishment of an **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**:
  - Approved in principle by the 6 ESSOR PS.
  - OCCAR-EA acts in the name and on behalf of the 6 ESSOR PS.
  - Agreement being finalised.
  - Expected signature within the next 2 months.

Release of Information to NATO

- The ESSOR community:
  - **Provided NATO with the HDR WF SSS (UC).**
    - Delivered on 02 September 2015 to NHQC3Staff.
  - **Is organising an Interoperability Demonstration event to NATO**
    - On Wednesday 25 November 2015 in Gdynia (Poland).
  - **Will provide NATO with some extracts of the simulation results from the design activities**
    - Incremental delivery plan.
  - **Investigates further release of Information.**

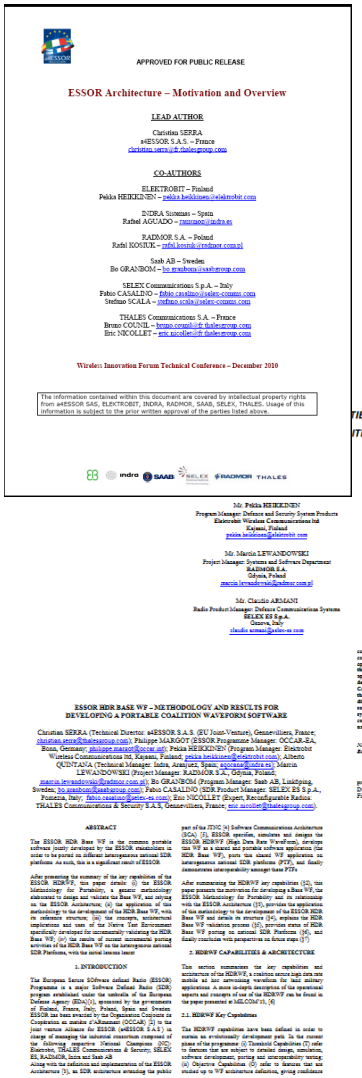
5. Future perspectives

Perspectives for the Future

- Follow on activities
  - **Support to Operational Deployment, including Field Tests**
  - **ESSOR Products technical enhancement:**
    - ESSOR Architecture;
    - ESSOR HDRWF.
  - **Considerations for Standardization of ESSOR Products**
- Best And Final Offer (BAFO) received in September 2015. Contract under negotiation.
- ESSOR Framework MoU for future work entered into force on 27/08/2015.

More Information

- All publicly available documents can be found in the OCCAR website: http://www.occar.int/42
- It contains links to all the information sources.



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ESSOR Architecture – Motivation and Overview

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

ABSTRACT

1. INTRODUCTION

2. HDRWF CAPABILITIES & ARCHITECTURE

2.1. HDRWF Key Capabilities

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