ESSOR Programme

ESSOR

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

WINNF Conference 2013

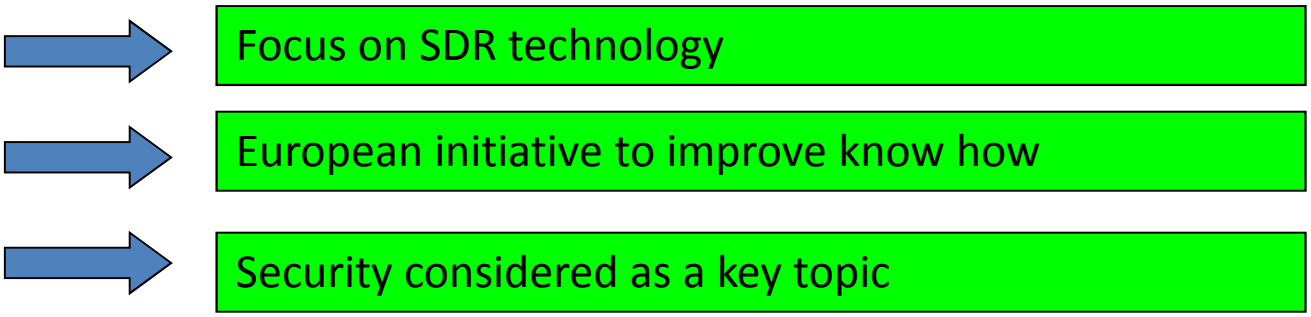
Munich – 12 June 2013

Agenda

1. Strategic Aim and Main Expectations
2. Stakeholders and Relationships Scheme
3. ESSOR Contract Overview
4. ESSOR Perspectives on SDR
   - 4.1 ESSOR Architecture
   - 4.2 ESSOR HDRWF
5. Status of Activities
6. The future
7. Conclusions

Strategic Aim

- The aim of the ESSOR Programme is to provide the basis for development and production of Software Defined Radio (SDR) products in Europe to meet the requirement for fielding such equipment in Europe within the timeframe of 2011-2015 (depending on National SDR Programmes roadmaps) .



Expected Main Outcomes

- The ESSOR Programme will provide **a common architecture**, shared by the Participating States, that defines the framework for the development of radio platform software and associated security elements.
- This architecture is key to **interoperability**, **portability** and will promote the development of SDR equipment in Europe.
- Interoperability and Portability will be tested through the development of a waveform with advanced communication characteristics, the **HDR WF**.

Participating States Expectations

- **To improve interoperability** between EU Members States, the USA and NATO, and public safety/homeland security communication systems by the means of:
  - Deployment of SDR concepts, architecture and technologies
  - Deployment of common Information Security Architecture
  - Definition and validation of new coalition waveforms (WF) to be used in future Network Enabling Capability (NEC) operations
- **To master SDR architectures and technologies in Europe** in order to:
  - Facilitate WF (Waveform) portability between different SDR products
  - Facilitate the future development of new generations of SDR products
  - Maintain a competitive offer in Europe
- **To leverage on current National/Multinational investments** and optimise future European developments in these domains.

2. Stakeholders and Relationship Schemes

Participating States

ESSOR

European Secure SOftware-defined Radio

- **Finland**
- **France**
- **Italy**
- **Poland**
- **Spain**
- **Sweden**

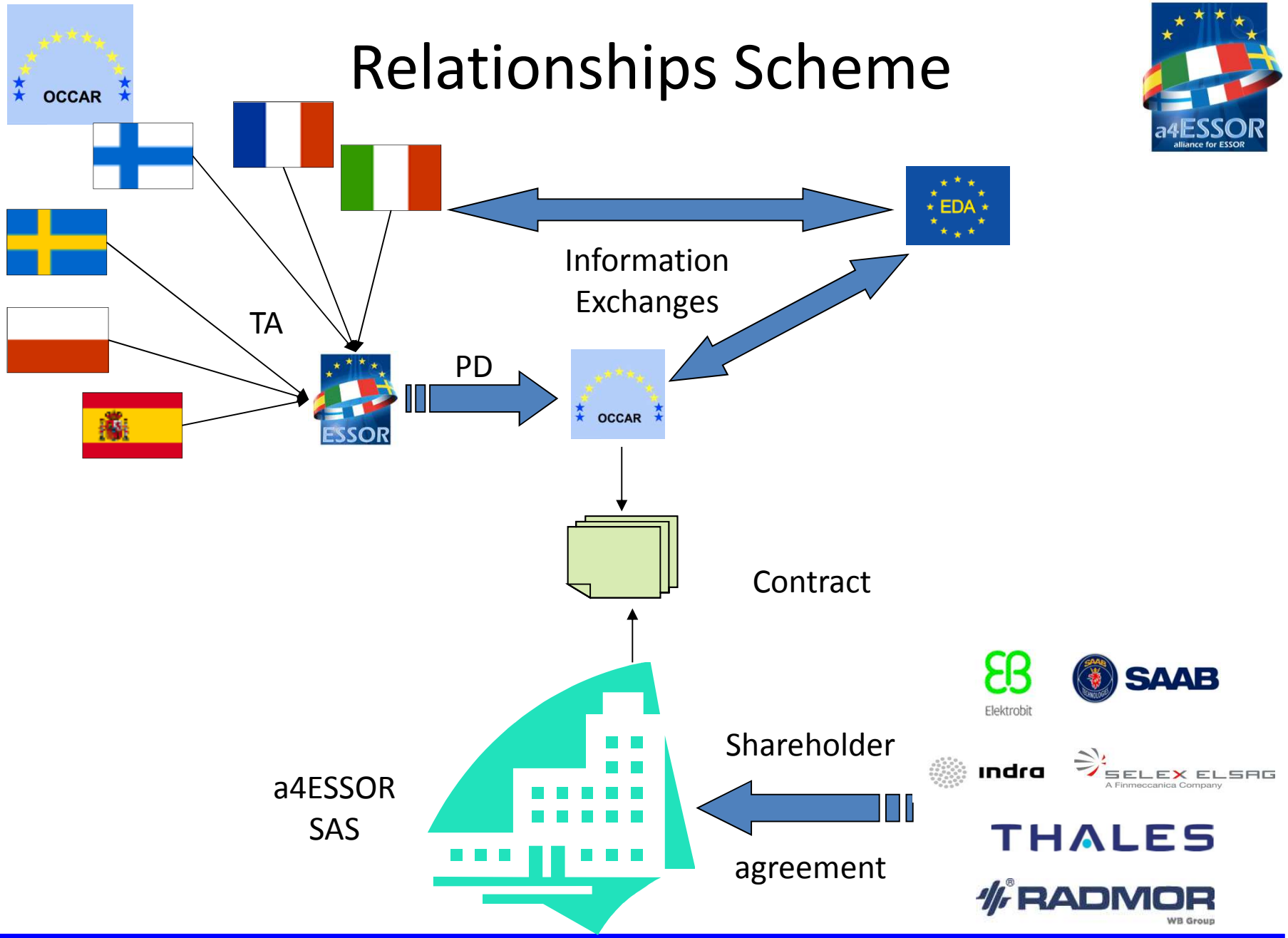
www.occar-ea.org/programme/ESSOR

questions-essor@occar.int

ESSOR Industries

- **a4ESSOR SAS** Joint Venture is the **Prime Contractor**.
- Shareholder Agreement between the six following Main sub-contractors:
  - **Elektrobit** (Finland);
  - **Thales Communications & Security** (France);
  - **Selex ES** (Italy);
  - **Radmor** (Poland);
  - **Indra** (Spain); and
  - **Saab** (Sweden).

Relationships Scheme



3. ESSOR Contract Overview

ESSOR Programme

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

Base WF Porting

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

6 NC different SDR Platforms updated to ESSOR Architecture

2011

2013

HDR Target WF

HDR Target WF

HDR Target WF

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

Multinational Validation

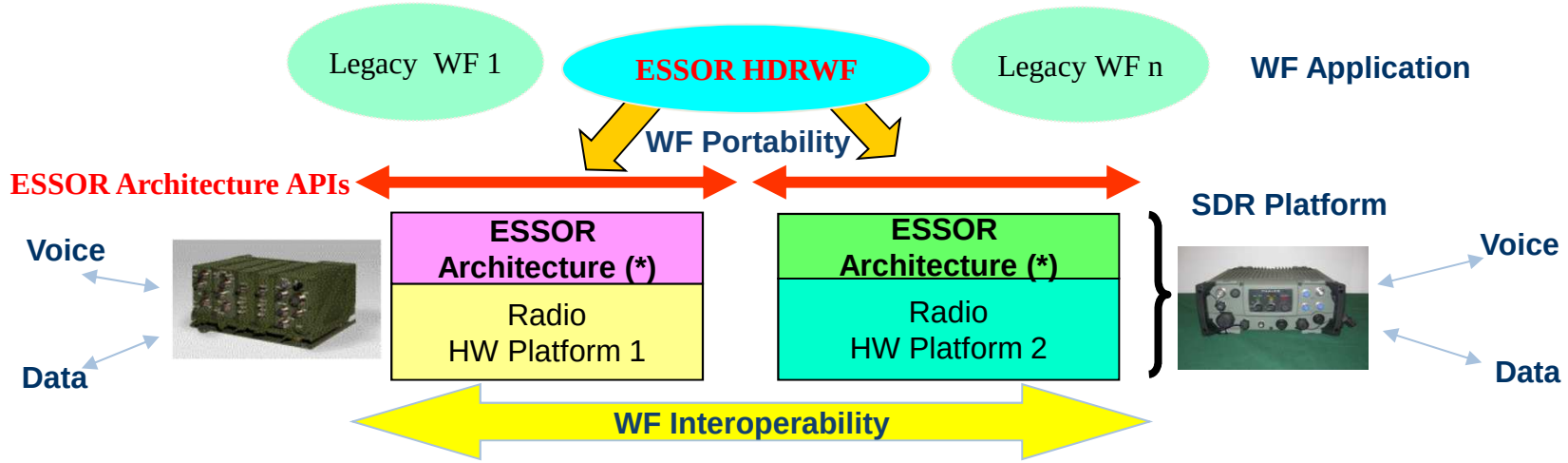
(*) AL: Abstraction Layer and APIs

4. ESSOR Perspectives on SDR

4.1-ESSOR Architecture

ESSOR Perspectives on SDR

- ESSOR Program addresses the following topics
  - Definition and development of a new Coalition High Data Rate WF (**ESSOR HDRWF**) for Ad-Hoc mobile tactical radio-communication network for Land Applications.
  - Definition of the **ESSOR Architecture** in order to facilitate WF Portability amongst the different National SDR Platforms.



(*) ESSOR Architecture: OE, Connectivity and APIs (RD, RS, RSS)

Goals of ESSOR Architecture

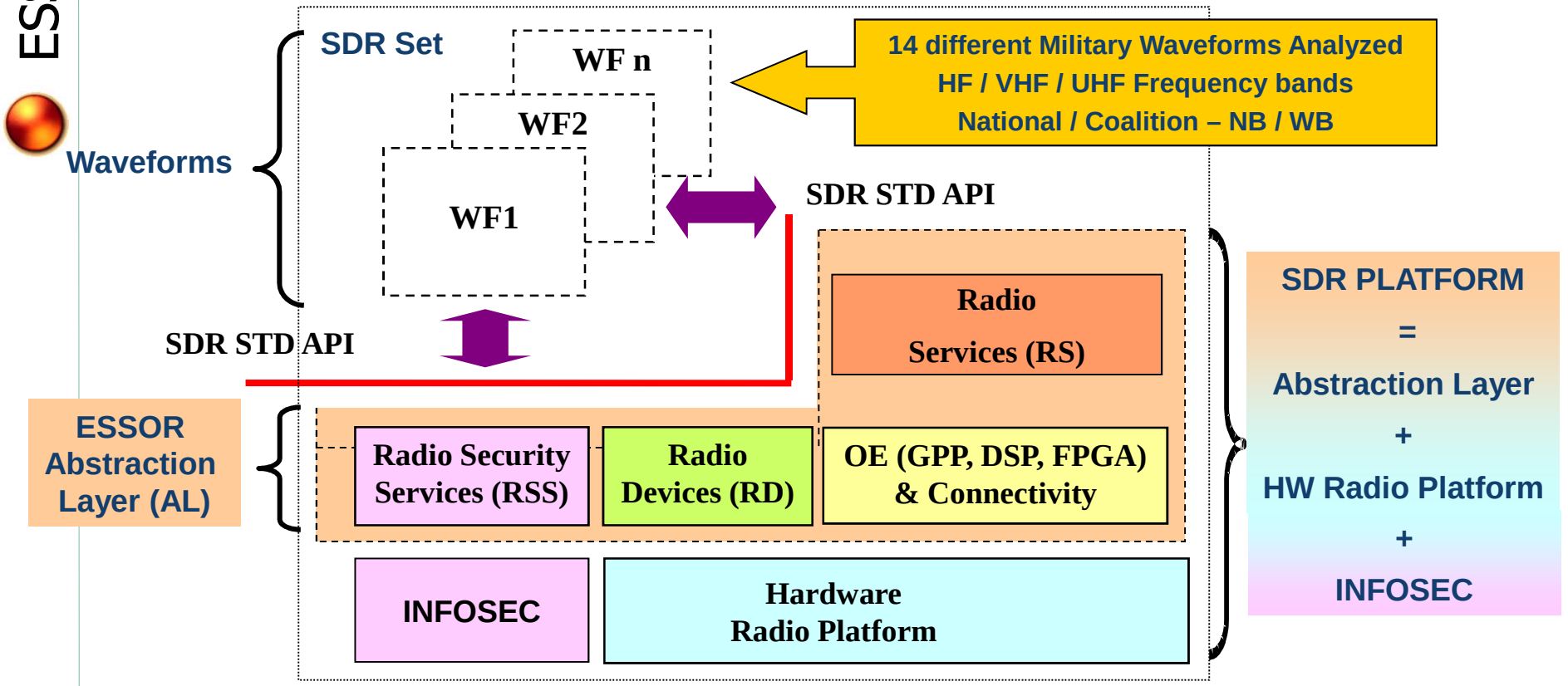
- ESSOR Participating States (PS) and Industries have recognized for a long time the outstanding benefit of the SCA as a de facto Procurement Specification / Standard for SDR in Military Business.

- The ESSOR Architecture extends the public part of the SCA in order to facilitate WF Portability amongst the ESSOR Participating States, maximising the compatibility with the open parts of the SCA.

- Under ESSOR Participating States control, the goal of the ESSOR Program is also to release these SCA extensions in order to achieve future SDR Architecture Standardisation.

ESSOR Architecture – Main Parts

- ESSOR Architecture defines APIs between WFs and SDR Platform (composed of HW Radio Platform + INFOSEC + Abstraction Layer), addressing Operating Environment (OE), RD, RS and RSS elements.
  - These elements are the core of an SDR Standardization approach



ESSOR Architecture Extensions

- ESSOR Architecture extends the following specifications
  - JTRS SCA 2.2.2 and API Release 1.0.3
  - WINNF Transceiver APIs

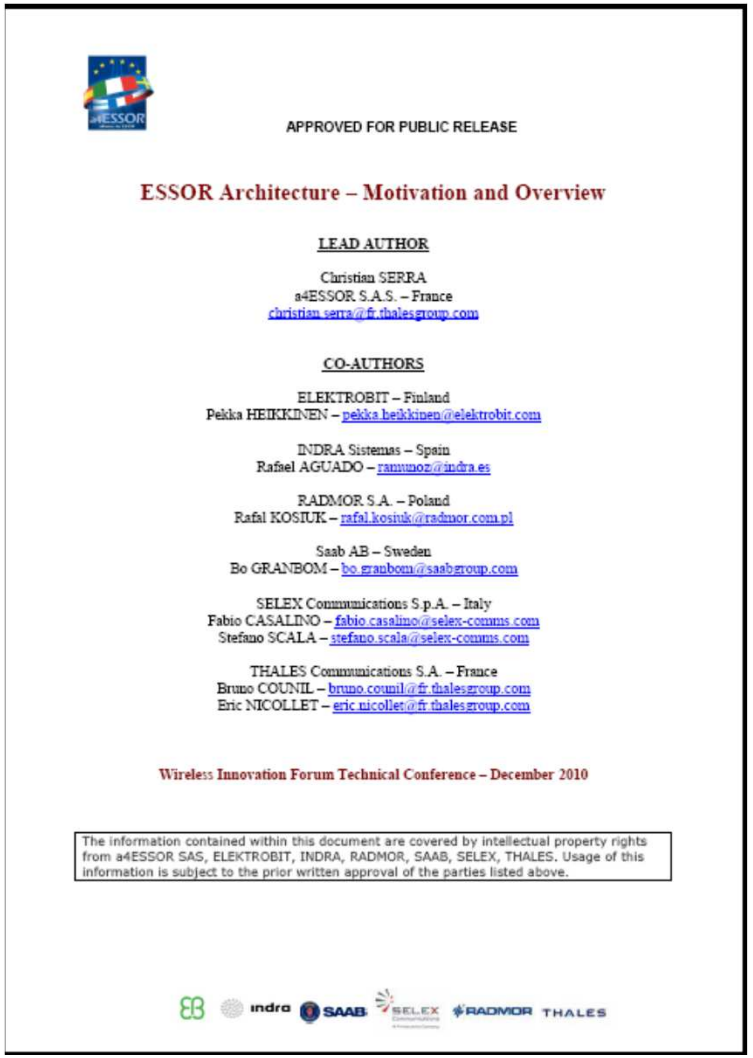
ESSOR Architecture Functional Elements		Existing Published Specifications Referenced	ESSOR Architecture Efforts
OE	Execution Environment	SCA 2.2.2 GPP (CF, OS)	***Extensions for DSP & FPGA OE***
OE	Connectivity	SCA 2.2.2 CORBA on GPP JTRS MHAL on DSP / FPGA	***Extensions for: CORBA on DSP/FPGA MHAL DSP /FPGA***
Radio Devices (RD)		Published JTRS RD APIs	***RD Extensions***
		WINNF Transceiver APIs	***Transceiver Extensions***
Radio Services (RS)		Published JTRS RS APIs	***RS Extensions***
Radio Security Services (RSS)		SCA Security Supplement for Information Only (*)	***Defining High Level ESSOR Security Architecture and RSS API***

(*) SCA Security Supplement not more supported by SCA 2.2.2 release

ESSOR Architecture Description

- More details about ESSOR Architecture can be found into the following publication
  - **"ESSOR Architecture – Motivation and Overview" Wireless Innovation Forum Technical Conference – December 2010**
- Available from **WINNF website**:
  - http://groups.winnforum.org/d/do/3824
- **Contributions to SCA 4.0** through WINNF SCA Next WG focusing on very lightweight OE
  - AEP profile – WINNF-11-R-0005
  - UltraLw corba profile - WINNF-11-R-0007

  (www.wirelessinnovation.org)



APPROVED FOR PUBLIC RELEASE

ESSOR Architecture – Motivation and Overview

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Wireless Innovation Forum Technical Conference – December 2010

ESSOR Architecture Implementation

ESSOR Architecture is currently implemented on 6 different National Platforms

FIN National PTF EB FSRN Tactical Radio prototype Multi-channel	FR National PTF THALES FlexNet 1 Tactical Radio Mono-channel	IT National PTF SELEX Swave VQ1 Tactical Radio Multi-channel	PL National PTF RADMOR Lab Demonstrator Mono-channel	SP National PTF INDRA TERSO Lab Demonstrator Mono-channel	SE National PTF Rockwell Collins FlexNet 4 Tactical Radio Multi-channel
					

- ESSOR Architecture implementations allow the porting of the ESSOR HDRWF plus additional WFs according to each Nation request.
- Lessons learned from these implementations provide feedback on the ESSOR Architecture definition.

4.2-ESSOR HDRWF

ESSOR HDRWF Main Benefits

ESSOR HDRWF is a **Secure** Coalition Network which:

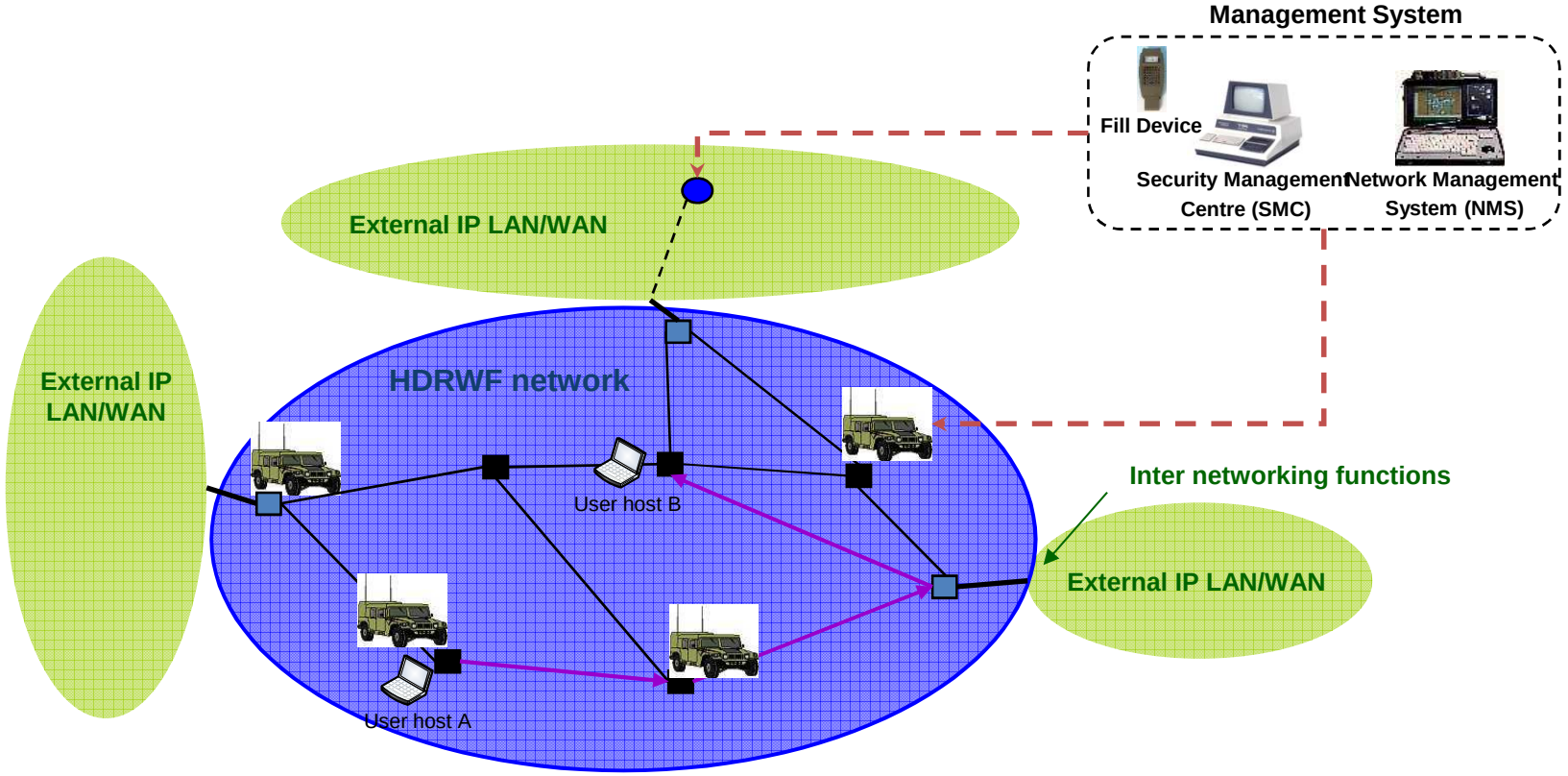
- Enhances connectivity on the battlefield by providing a High Data Rate network:
  - Vertical / horizontal communications through the network.
- Enables growth capacity of the forces:
  - Ad hoc network, self-organising and self-healing.
  - Merging / splitting of deployed units into / from an existing network.
- Improves efficiency of the forces on the move:
  - Mobility management for nodes / Changing situations while in route.
  - Communication on the move.
- Enables Network Centric Warfare:
  - 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, ~1,25 MHz bandwidth, Frequency-Hopping
- Network Size: up to 200 nodes
- Ad-Hoc: Mobility management of the nodes and communication on the move. Dynamic adaptation to the environment (Propagation, Node Density, Traffic, Advantaged Nodes, …)
- Synchronization: With and / or Without GNSS (mixed configuration)
- Radio Silence Capable
- Fully Secured: COMSEC / NETSEC / TRANSEC capabilities
- Compatible with standard IP applications: QoS driven approach – Unicast / Optimized Multicast / Broadcast traffic
- Voice Capable: Voice CNR Push To Talk (PTT) and VoIP
- Support Local or Remote Management and Supervision
- Vehicular deployment with interfaces to Air / Naval: Brigade and Below

ESSOR HDRWF System Overview

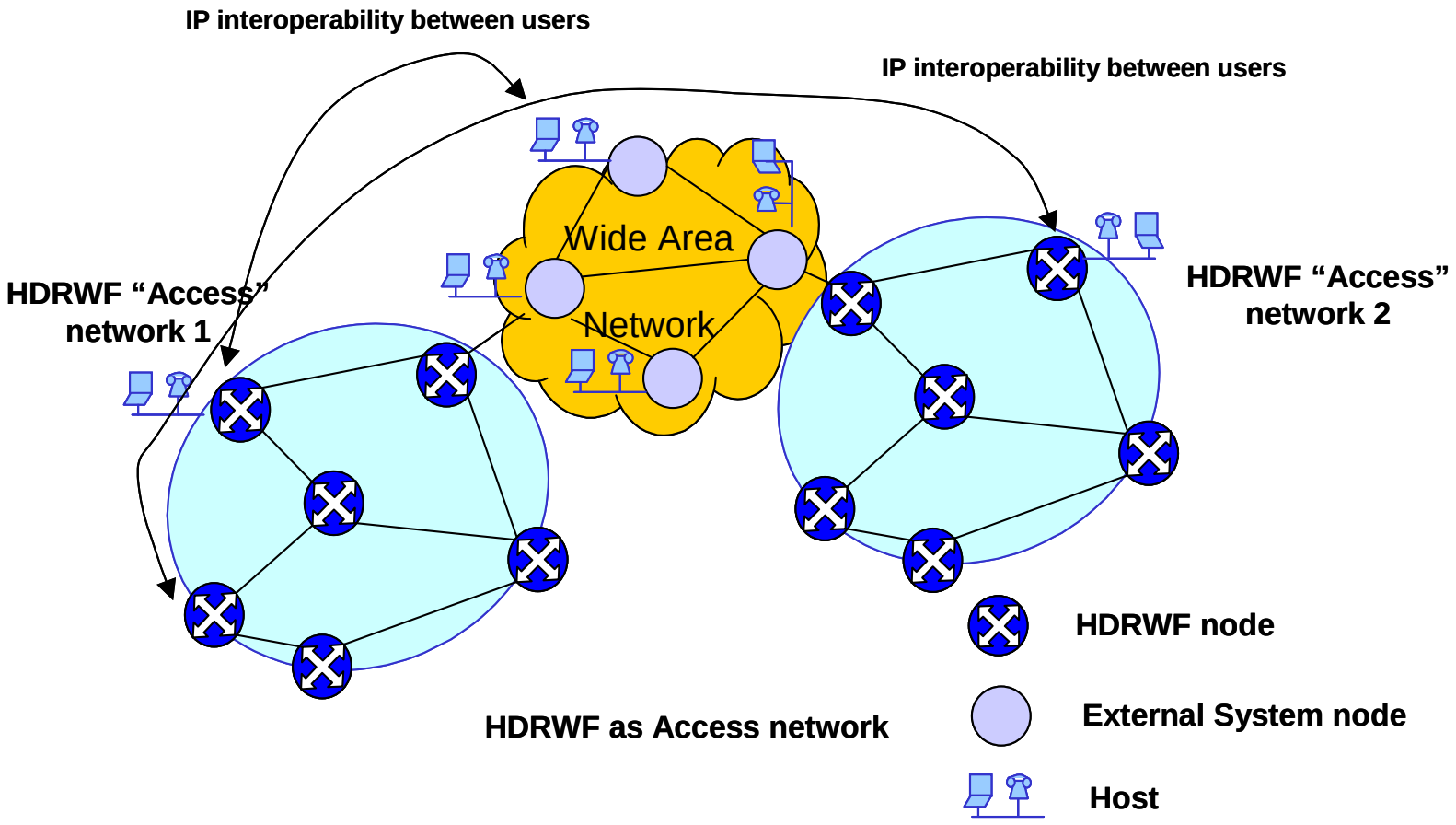
- Multi-hop mobile ad hoc network, self-organizing and self-healing.



- 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

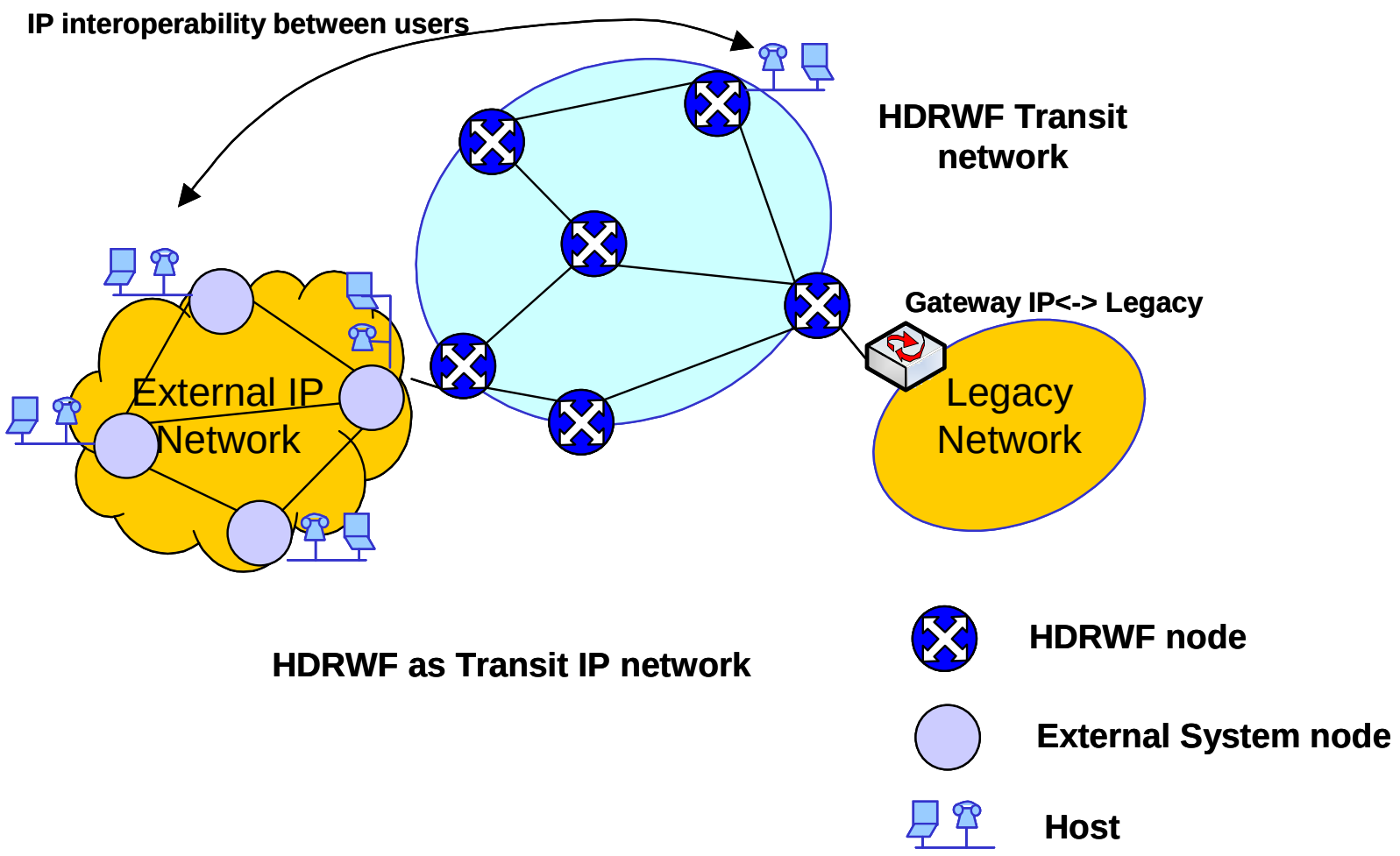
ESSOR HDRWF Use Cases

ESSOR HDRWF as an Access Network

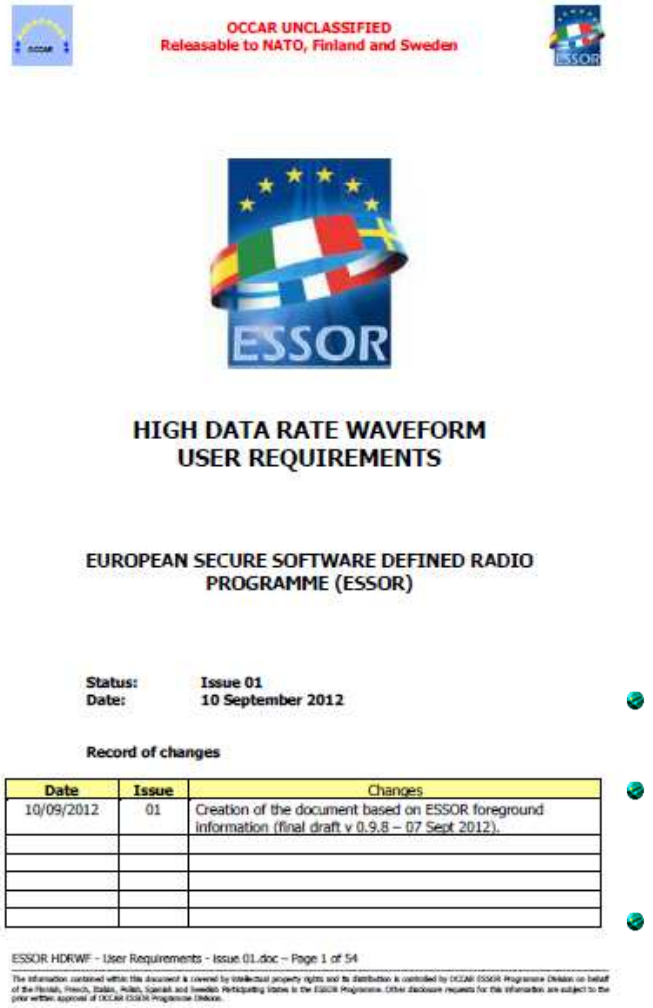


ESSOR HDRWF Use Cases

ESSOR HDRWF as a Transit Network



ESSOR HDRWF User Requirements



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HIGH DATA RATE WAVEFORM
USER REQUIREMENTS

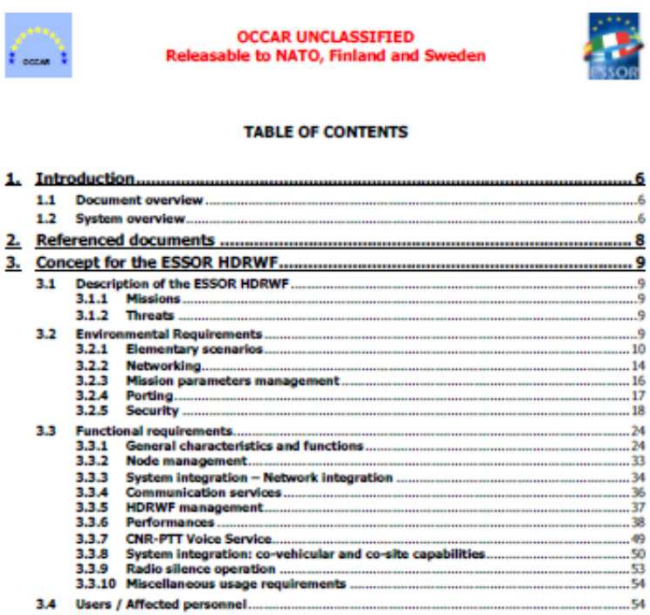
EUROPEAN SECURE SOFTWARE DEFINED RADIO
PROGRAMME (ESSOR)

Status: Issue 01
Date: 10 September 2012

Record of changes

Date	Issue	Changes
10/09/2012	01	Creation of the document based on ESSOR foreground information (final draft v 0.9.8 – 07 Sept 2012).

ESSOR HDRWF - User Requirements - Issue 01.doc – Page 1 of 54



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Releasable to NATO, Finland and Sweden

TABLE OF CONTENTS

- This document presents the main capabilities and performance of the ESSOR HDRWF.
- **The presented capabilities and performance have been validated though WF Design and High-Fidelity simulations.**
- This document has been released to NATO.

ESSOR HDRWF Performances (extract)

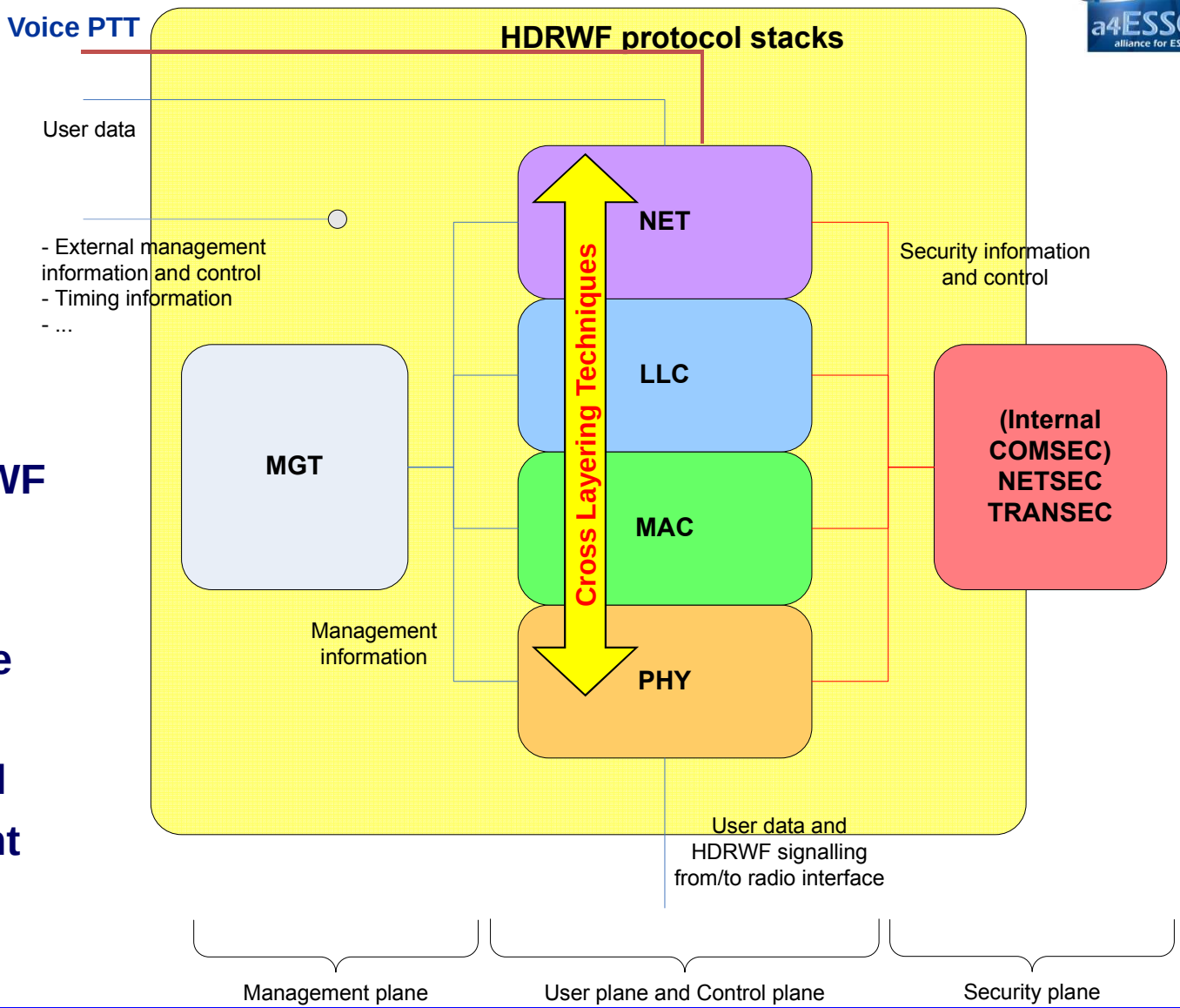
- Network Initialisation (*)

Configuration	Nb of Nodes	Static	Mobile (**)
All nodes with GNSS	5	< 15 sec	< 30 sec
	20	< 40 sec	< 1 min
	100	< 2 min	< 4 min
	200	< 3 min	< 6 min
All nodes without GNSS	5	< 30 sec	< 1 min
	20	< 2 min	< 2 min 30 sec
	100	< 5 min 30 sec	< 8 min 30 sec
	200	< 7min 30 sec	< 13 min (***)

- Fast Network Initialisation and robust Network Maintenance, even under adverse conditions
- Key characteristics which influence positively Late Entry node and Network Merging / Splitting associated performances

(*) for 95% of the nodes, (**) 20% nodes in motion, (***) 10% nodes with GNSS, 90% nodes without GNSS

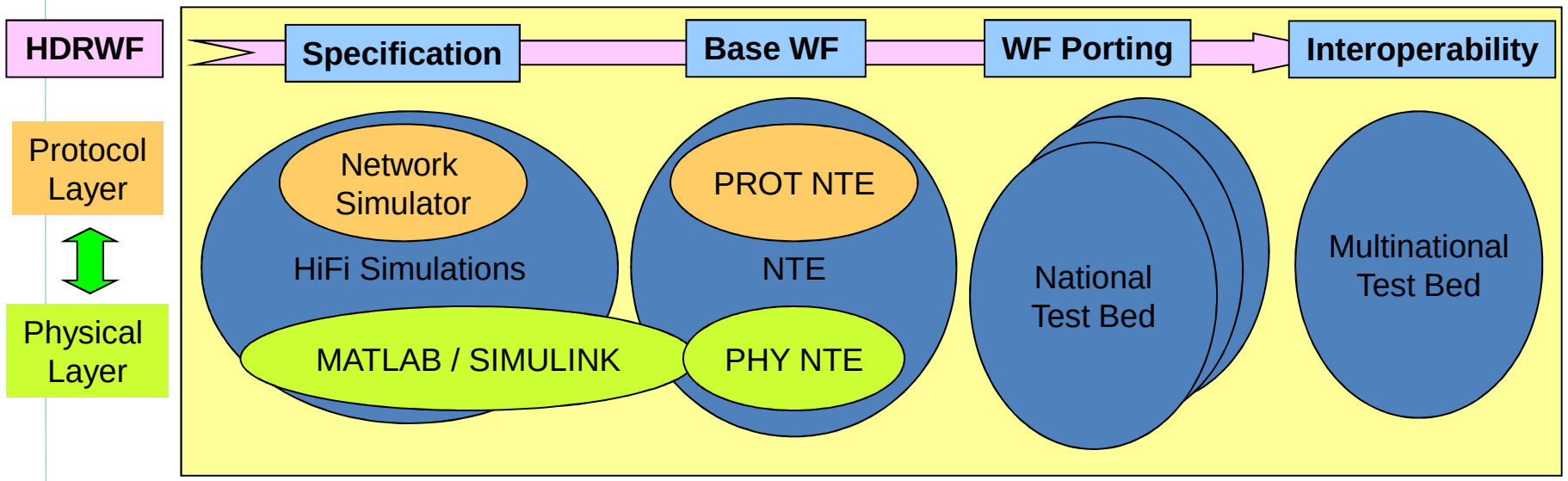
ESSOR HDRWF Protocol Stack Logical View



ESSOR HDRWF exhibits a Modular Architecture enabling Incremental Development

ESSOR HDRWF Development and Validation Steps

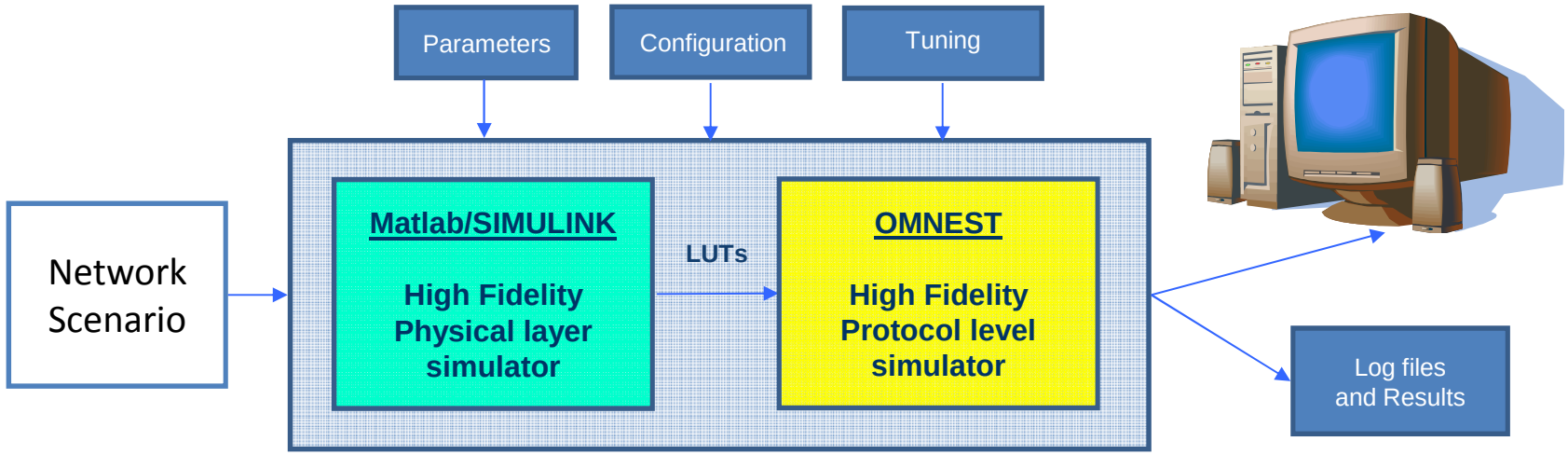
- HDRWF Development Steps
  - HDRWF Detailed Specification
  - HDR Base WF Software Development
  - HDRWF Ported on National SDR Platform
  - Interoperability Test Labs
- HDRWF Validation Steps
  - High Fidelity (HiFi) Simulations
  - Native Test Environment (NTE)
  - National Test Bed (*)
  - Multinational Test Bed (MTB)



- (*) National Test Bed is duplicated / extended from the MTB

ESSOR HDRWF Hi-Fi Simulations

- The goals of ESSOR HDRWF Hi-Fi Simulations are:
  - To validate the HDRWF specifications
  - To assess Performance in complex scenarios (Fading Channel, Large Number of Nodes, Mobility, …)
  - To provide models for the development of the HDR Base WF
- PHY link layer Simulator is based on Matlab/SIMULINK
- Protocol level Simulator is based on OMNEST
- Both Simulators are running independently from each other
  - Physical simulator results exported via Look Up Tables (LUT)



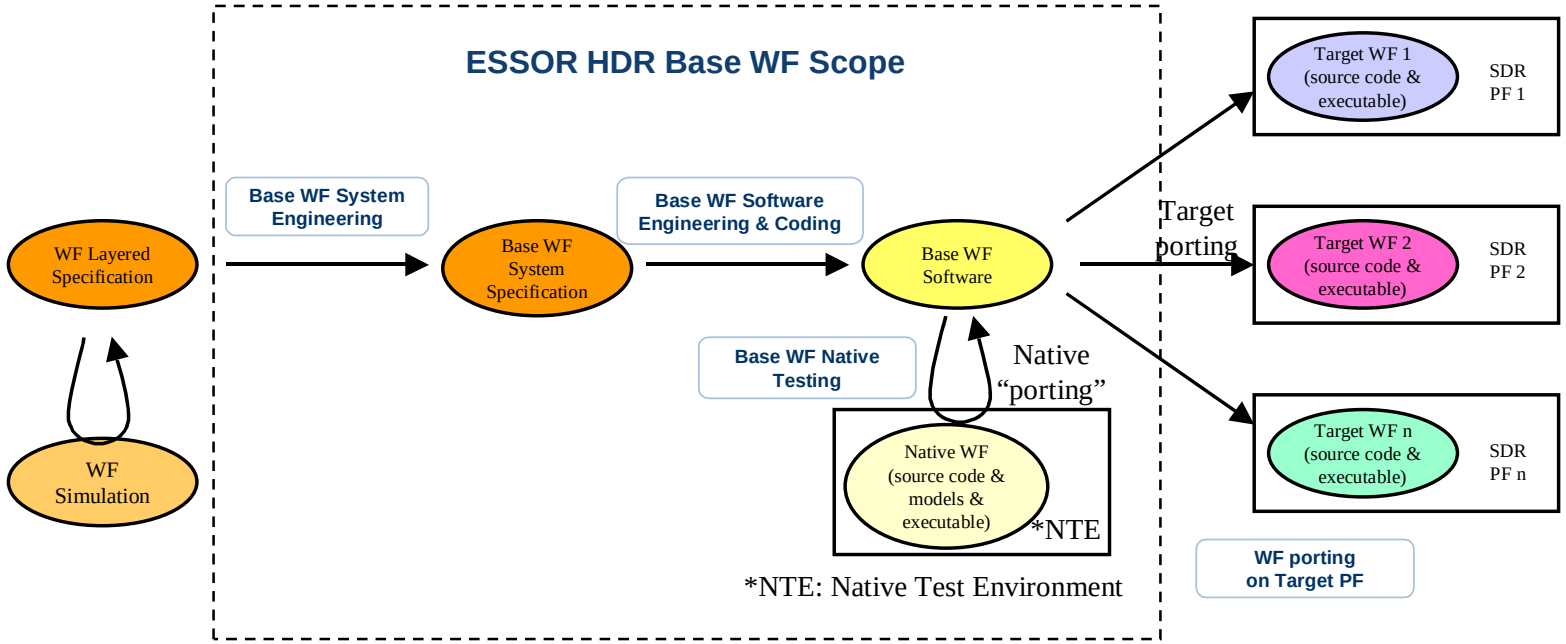
ESSOR HDRWF Hi-Fi Simulations

- More than 500 simulation runs were used to validate the HDRWF detailed specifications (Physical and Protocol)
  - For each scenario, several runs were executed covering different WF parameters and test configurations
- Different steps of validation
  - Layer Level Validation (PHY, MAC, LLC, NET)
  - Overall HDRWF Level validation
  - Fine Tuning Phase for adjusting HDRWF Parameters and Algorithms in front complex and large scenarios

HiFi Simulations are significant outputs for the ESSOR Program.
HiFi Simulations are essential for supporting the NATO STANAG process, providing proper assessment of WF Characteristics and Behaviour, without awaiting later Radio Verification and Validation

ESSOR HDR Base WF

- ESSOR HDR Base WF main goals
  - Portable software jointly developed by the 6 National Champions
  - Supported by the Common Criteria security assurance requirements
  - Developed using the ESSOR Architecture APIs
  - Supported by ESSOR Base WF Methodology for Portability
  - Validated on NTE to de-risk the national porting phase



ESSOR HDR Base WF Key Figures

- HDR Base WF split in Base Software Item (BSI)
- BSI Language (C++, C, VHDL) depends of targeted PE (GPP, DSP, FPGA)

- PHY Layer BSI Q=16
  - BSI for DSP only: Q=4
  - BSI for FPGA only: Q=2
  - "Dual" BSI: Q=10
    - Developed for both DSP and FPGA
  - Total: 26 specific Golden Sources

- Medium-grain granularity
  - driven by need for Signal Processing SW (C) / FW (VHDL) (***) portability on heterogeneous SDR Platforms made of DSP and FPGA PE (**)

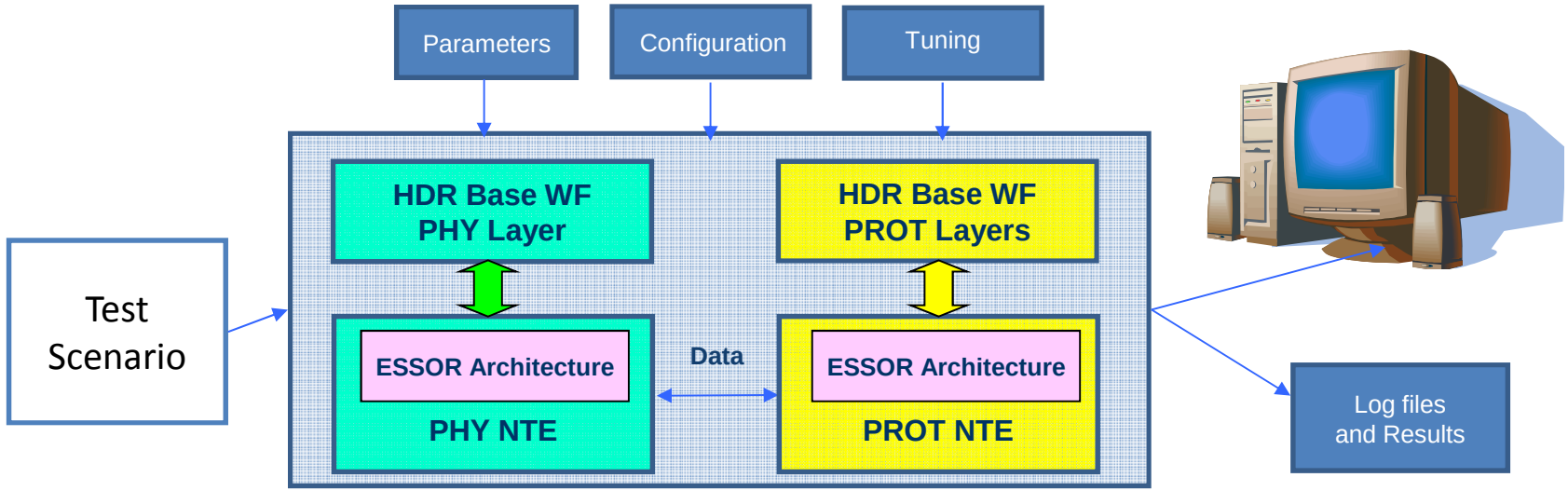
- PROT Layers BSI Q=17
  - MAC, LLC, NET, MGT layers
  - Golden Source: 230K SLoC(*)
  - Containers: 140K SLoC(*)

- Medium-grain granularity
  - driven by need for functional modularity, considering Software portability on multiple GPP PE (**)

(*) SLoC: Source Line of Code; (**) PE: Processing Elements (***) SW/FW: Software / Firmware

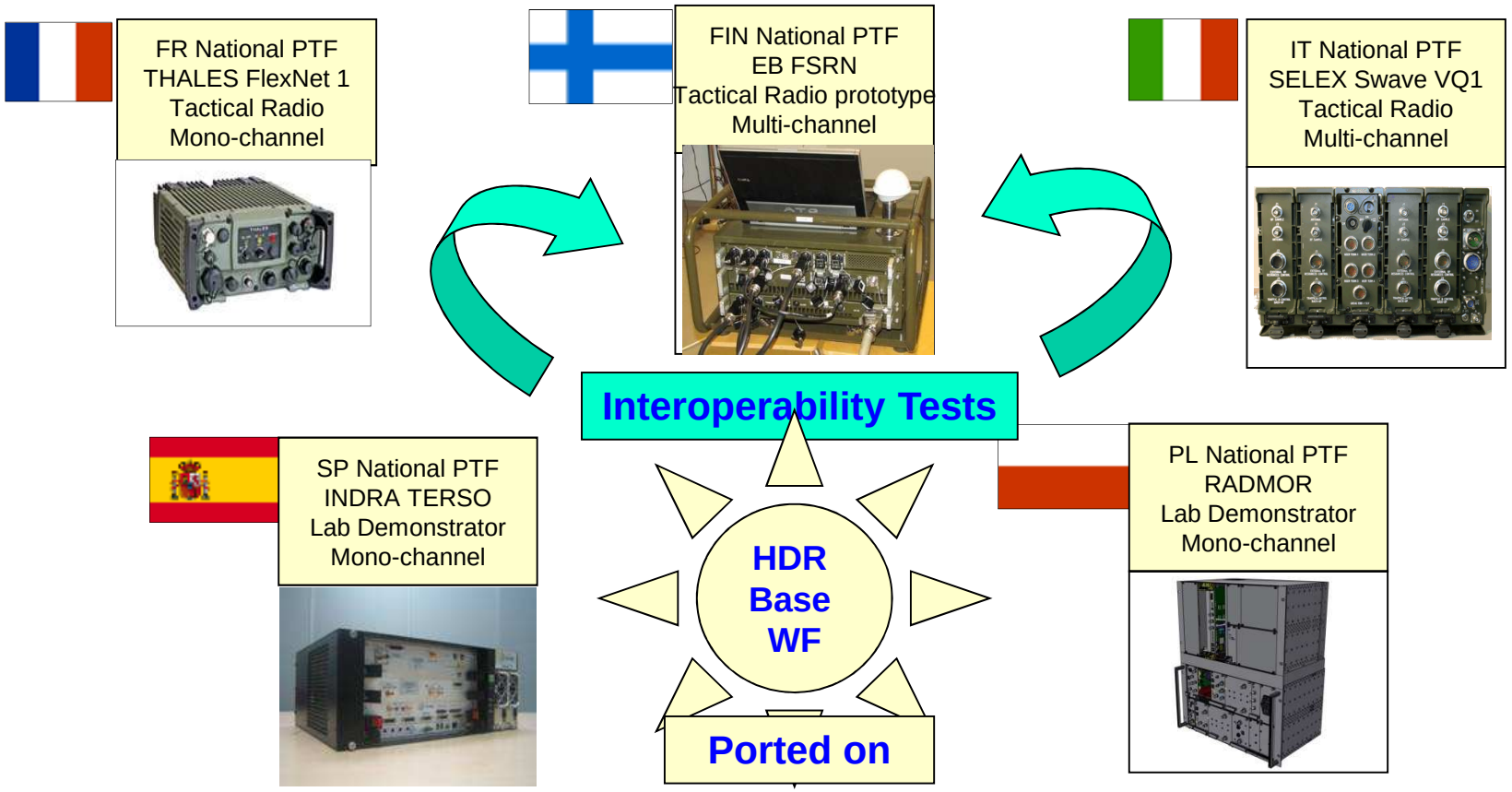
ESSOR Native Test Environment (NTE)

- NTE is a generic functional test framework which allows
  - to create, execute and monitor test cases
  - to record the simulation scenarios and allow replication of them
- NTE is composed of Protocol Native Test Environment (PROT NTE) and Physical Native Test Environment (PHY NTE) which are interconnected together to perform System Level verifications
- NTE is based on ESSOR Architecture APIs for the emulated components



ESSOR HDR WF Porting Activities

- HDR Base WF is currently ported on 5 different heterogeneous National SDR PTFs where ESSOR Architecture has already been implemented



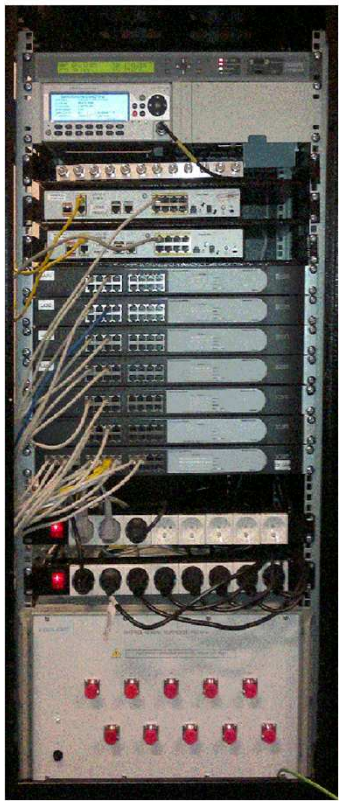
For budget constraints, Sweden has limited activities to ESSOR Architecture Implementation

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.**

5. Status of Activities

ESSOR HDR WF Status

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

Finalized

- HDR Base WF Development
  - Common HDR WF software code shared amongst the 6 National Champions
  - Validated on NTE for de-risking the porting activity and ensure interoperability
  - Cornerstone for the SDR Business Model

In Progress

- HDR Base WF Porting on the National Platforms
  - National Implementation and Validation

In progress

- Multinational Test Bed (MTB)
  - Initial Labs Interoperability Demos in preparation

MTB Ready

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**
  - Acceptance Reviews of these implementations have been finalised between Industry and the Contracting Authority

Finalized

6. The Future

The Future

Potential follow on activities:

- **SDR Standardization and Certification**
- **ESSOR Products technical enhancement**
  - ESSOR Architecture
  - ESSOR HDRWF
- **Support to Operational Deployment**

7. Conclusions

Conclusions (1/2)

- The ESSOR Programme is **extending the public SCA specification in order to achieve WF Portability** amongst the ESSOR Participating States, maximising the compatibility with the SCA.
  - ESSOR Program puts efforts on DSP & FPGA OE (Scalability), RD, RS and Security Architecture (RSS).
  - ESSOR Architecture is currently implemented on National Platforms

- The ESSOR Programme is developing the **advanced Secure Coalition ESSOR HDR WF for mobile ad-hoc networking in UHF band:**
  - Provide Secure Data IP and Voice transmission capabilities;
  - HDRWF modular Architecture enables Incremental Development;
  - HDRWF System is characterized in front of High Fidelity Simulations;
  - HDR Base WF Methodology with associated Validation Tools (NTE) is the cornerstone for WF Portability;
  - HDR Base WF is being ported on different and heterogeneous National Platforms;
  - Interoperability test (MTB) will provide system level verifications.

- The ESSOR Programme is a **successfully running example of joint development between different Nations and Industries** in a high cooperative manner for Coalition purposes.

Conclusions (2/2)

- ESSOR Programme was launched by 6 Participating States in December 2008.
- High expectations from the Participating States to obtain:
  - the **ESSOR HDR WF Specification Standard**; and
  - the **ESSOR Architecture**.
- **The products are aimed at becoming operational**.
- **Future phase** of the ESSOR Programme is being initiated.
- ESSOR Participating States intend to have the HDR WF adopted in the **Coalition Wideband Networking Waveform (COALWNW)** program and as a **standard for the European Community and NATO**.
- Release of any information is under OCCAR-EA / ESSOR Participating States control.

ESSOR Programme

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