



Managing SDR in the field

Trials, Experimentations & Deployments

WlnnComm Europe 2014 - Rome, 6th November





Managing SDR in the field

Presentation Outline

Delivering innovative solutions in the field requires:

- Strong commitment from both industry and customers
- Very clear and deep co-operation
- Support from “the operational guys”, who will be the *owner* of the solutions
- Willingness to accept and work on feedbacks, being positive or negative

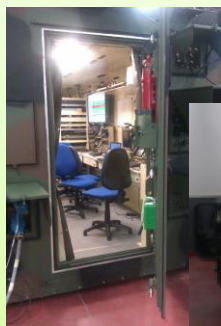
This is the path that Selex ES is pursuing in order to create an assessment process for developing and improving products

This presentation highlights Selex ES experiences adopting this approach as applied to the SDR product line, while investigating the related management solutions.

Managing SDR in the field

Selex ES knowledge is built on...

Real-life experiences in Trials, Exercises and Experimentations



Modelling & Simulation and Management Solutions

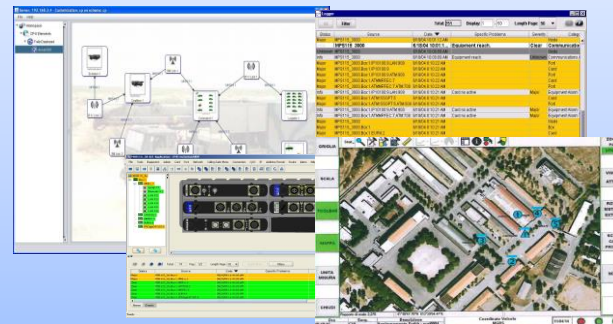


Table of Content

Experience types

- Trials
- Experimentations
- Customer exercises
- Deployments



Fielded scenarios

- Description
- Collaboration approach



Benefits of the Experiences

- Customer feedbacks & Lessons learned



Managing Deployed SDR Radios

- Highlights of Selex solutions



The way ahead

- What's behind the corner

Field experiences involving SDR

Experience types 1/2

During the years, several field activities have been performed and results placed in the “experience bag”

- Trials

- Pre-bid/offer
- Focus on capability demonstration
- Less “open minded”...



- Experimentations

- Operational evaluations, jointly performed with the customer, usually at customer premises
- “Hands-on” on existing solutions or proof-of-concept
- Focus on consolidation/evolution of specific solutions
- Oriented in achieving the best knowledge on both requirements and product definition/tailoring

Field experiences involving SDR

Experience types 2/2

- Customer Exercises
 - International context
 - With direct involvement of/support from industry
 - Great opportunity to share knowledge and solutions
 - Focus on interoperability and in depth stress-tests in “almost real life” contexts
- Deployments
 - In theater operations
 - Real use of solutions delivered as part of contractual activities
 - Sometimes industry is directly involved
 - Usually give rise to new requirements / improvement opportunities

Field experiences involving SDR

Contributions to Deployment of Military SDR

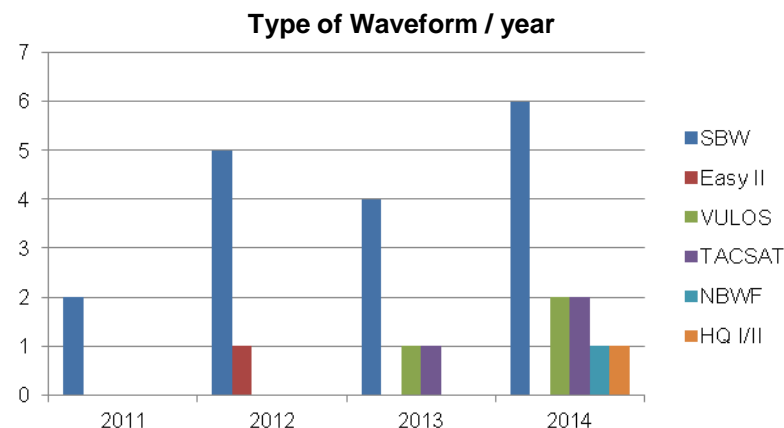
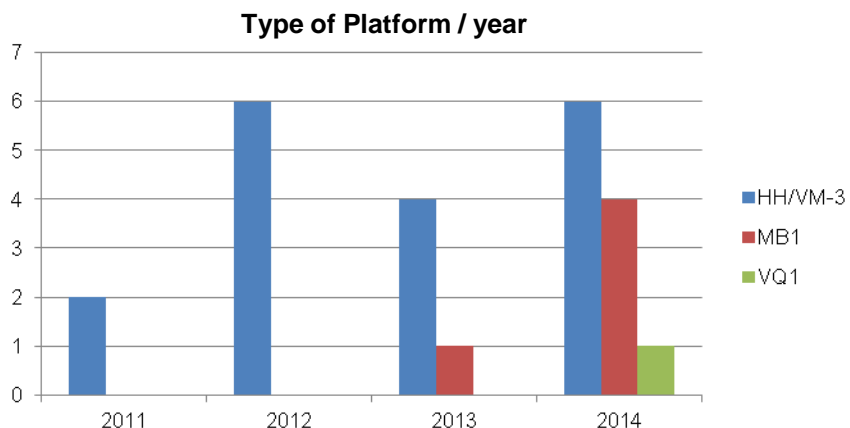
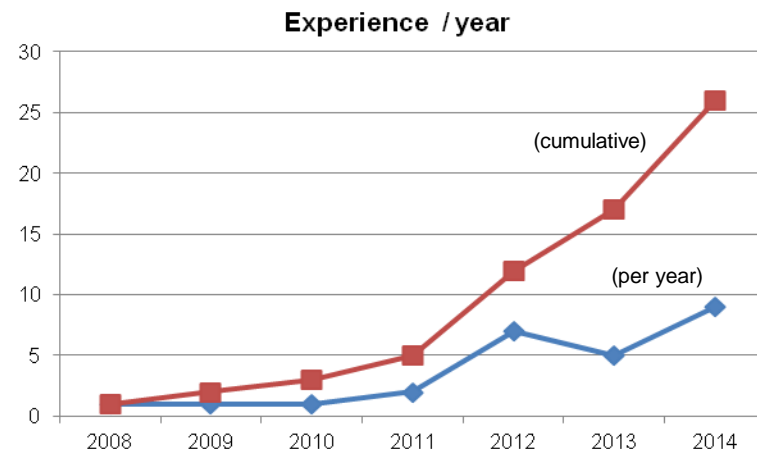
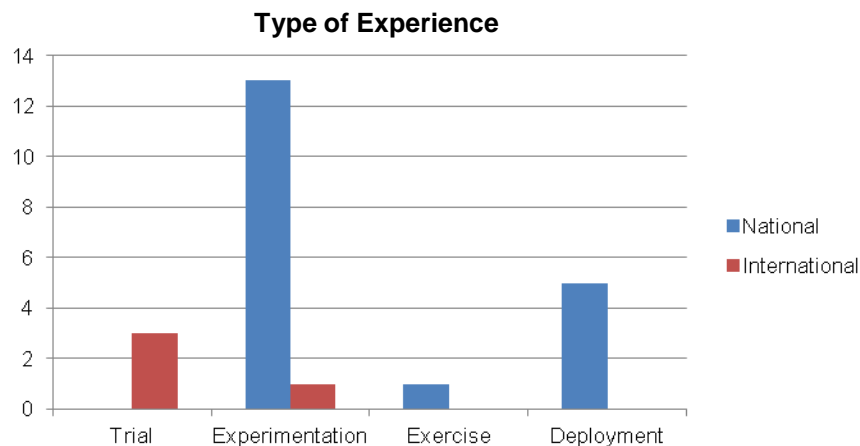
An overall of **26** different experiences performed

- Spanning over **7 years** of collaboration with domestic and international customers
- Covering **4 SDR platforms**
- Involving **6+ Waveforms**
- Field experiences are mainly based on
 - Tactical environments
 - Land operations
 - Deployable, vehicular and dismounted solutions
 - Interoperability GAG, GG
 - Interoperability with third parties devices (legacy)



Field experiences involving SDR

Contributions to Deployment of Military SDR



Field experiences involving SDR

Summary of Selex ES experiences

Year	Country	Experience	Experience Type	Solutions	WF	Platform
2008	Italy (FNEC)	Soldato Futuro	Deployment	Dismounted	-	(*)
2009	Italy (VBM)	VBM I Tranche	Op. Experiment	Vehicular	-	(*)
2010	Italy (VBM)	VBM II Tranche	Op. Experiment	Vehicular	-	(*)
2011	Italy (SCUTI)	SDR HH Presentation	Op. Experiment	Dismounted	SBW	HH
2011	Italy (SCUTI)	Sperimentazione Operativa HH	Op. Experiment	Dismounted	SBW	HH
2012	Germany	HH Demonstration	Trial	Dismounted	EASY II + MIL	HH
2012	Italy (FNEC)	ITB Integrated Test Bed	Deployment (Simulation)	Vehicular	SBW	HH, VM-3
2012	Italy (VBM)	VBM III Tranche	Deployment	Vehicular	SBW	VM-3
2012	Italy (SF)	Joint Trial 2012 Soldato Futuro (Android)	Op. Experiment	Dismounted	SBW	HH

* Pre SDR experiences

Field experiences involving SDR

Summary of Selex ES experiences

Year	Country	Experience	Experience Type	Solutions	WF	Platform
2012	Afghanistan	VBM III Tranche	Deployment	Vehicular	-	(*)
2012	Italy (MMI)	Sperimentazione Radio SDR HH	Op. Experiment	Dismounted Vessel	SBW	HH
2012	Italy (MMI)	Atalanta Mission (Anti-pirates Ops)	Exercise	Pacific Sea	SBW	HH
2013	Italy (SCUTI)	Sperimentazione Operativa MP 1 st Session	Op. Experiment	Dismounted Vehicular Deployable	VULOS TACSAT	MB1
2013	Italy (VTLM)	VTLM RCP	Deployment	Vehicular	SBW	HH, VM-3
2013	Italy (FNEC)	Soldato Futuro (Android)	Op. Experiment	Dismounted	SBW	HH
2013	Italy (SCUTI)	Aule SCUTI	Deployment (Training)	Vehicular	SBW	HH, VM-3
2013	Brazil	Tactical System Experiment (CCOMGEX)	Op. Experiment	Vehicular Deployable	SBW	HH, VM-3

* Pre SDR experiences



Field experiences involving SDR

Summary of Selex ES experiences

Year	Country	Experience	Experience Type	Solutions	WF	Platform
2014	Italy (SCUTI)	Sperimentazione Operativa MP 2 nd Session	Op. Experiment	Dismounted Vehicular	SBW VULOS TACSAT	HH, MB1
2014	Italy (BFSA)	Blue Force Situation Awareness F2	Deployment	Vehicular	SBW	HH, VM-3
2014	Germany	HH Demonstration	Trial	Dismounted	NBWF	HH
2014	Italy (SCUTI)	Sperimentazione Operativa MP 3 rd Session	Op. Experiment	Dismounted Vehicular	VULOS	MB1
2014	India	Tactical System Trial	Trial	Vehicular Deployable	SBW	HH, VM-3
2014	Italy (SCUTI)	Sperimentazione Operativa VQ1	Op. Experiment	Dismounted Vehicular Deployable	SBW VULOS	VQ1, HH, VM-3
2014	Italy (MMI)	NATO TRIAL MARITELERADAR	Op. Experiment	Dismounted Vessel & land	SBW	HH, VM-3

Field experiences involving SDR

Summary of Selex ES experiences

Year	Country	Experience	Experience Type	Solutions	WF	Platform
2014	Italy	Artillery Amphibians troops (COMACA)	Op. Experiment	Dismounted	SBW	HH
2014	Italy (SCUTl)	Sperimentazione Operativa MP 4 th Session	Op. Experiment	Vehicular Deployable	TACSAT	MP1 (MP50)
2014	Italy (SCUTl)	Sperimentazione Operativa MP 5 th Session	Op. Experiment	Vehicular Dismounted	SBW, HQ I/II	MP1
2014	Italy	Eagle Joker	Customer Exercise	Vehicular Deployable	SBW	HH,VM3
2015	Italy	ESSOR Field Trial (FIN / F / ITA)	Op. Experiment	Vehicular Deployable	HDR	VQ1

Field experiences involving SDR

Collaboration approach

All of the above contributed to create a strong collaboration approach improving products, systems and customer satisfaction

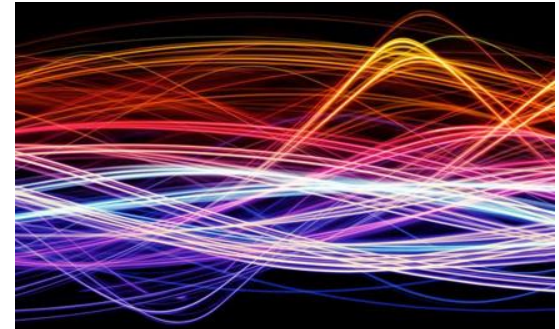


Fielded Reference Operational Scenarios (FROS)

Waveforms Products

- **Available WFs Products**

- Soldier Broadband Waveform (SBW)
- SINCGARS
- HaveQuick I/II
- Narrow Band WFs (NBWF VULOS)
- TACSAT
- High Data Rate WF (HDR)
- Easy II / MIL-STD-188-220C

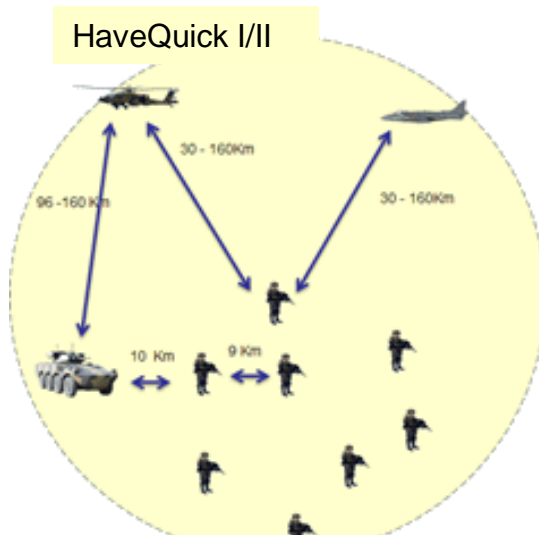
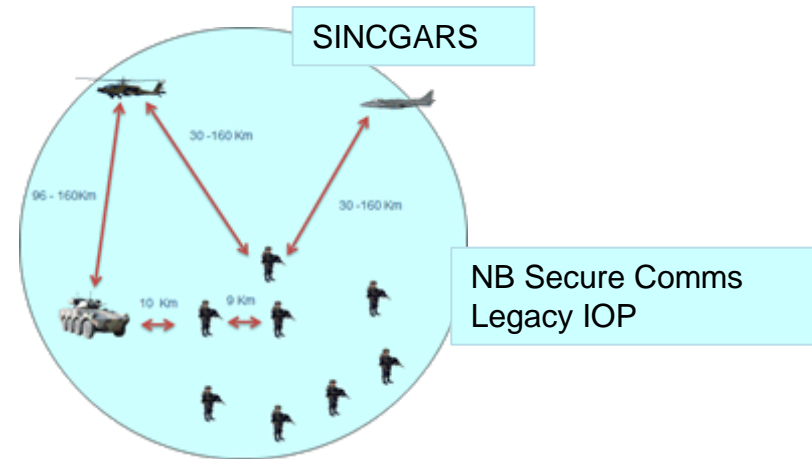
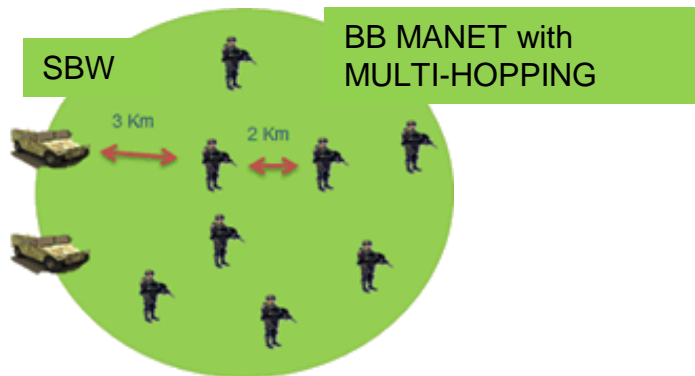


- **Any WF supports specific operational scenarios**

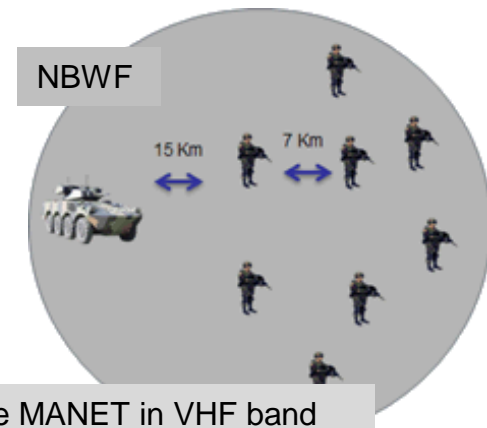
- Best fit specific deployment conditions
- Exploit peculiar communications features

Fielded Reference Operational Scenarios (FROS)

Scenarios vs Waveforms

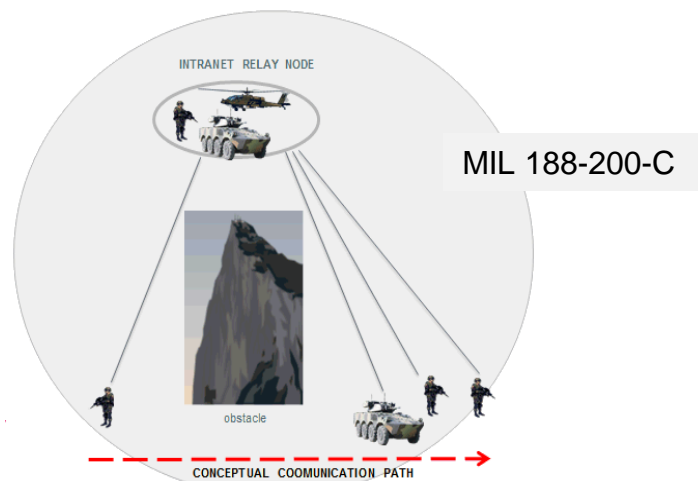
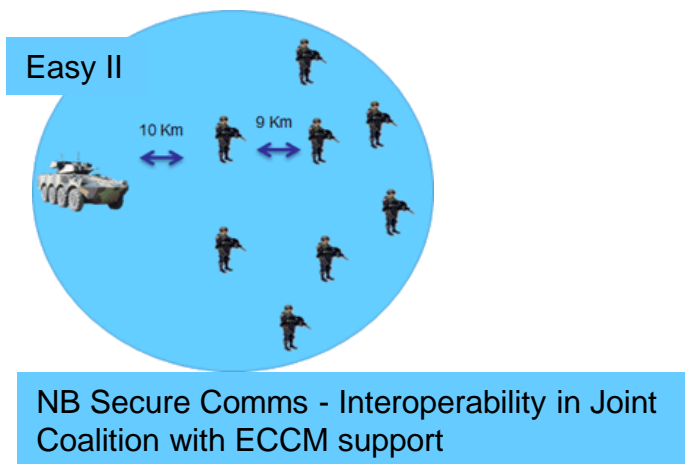
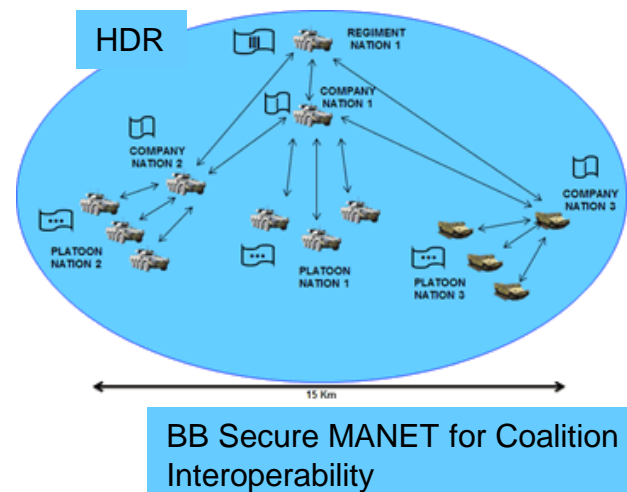
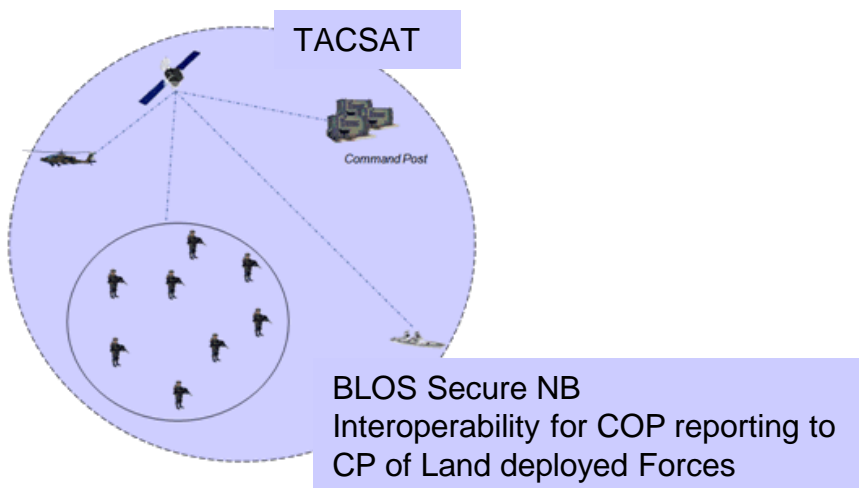


Joint (GAG) Multinational NB Interoperability JTAC support for Landing Forces



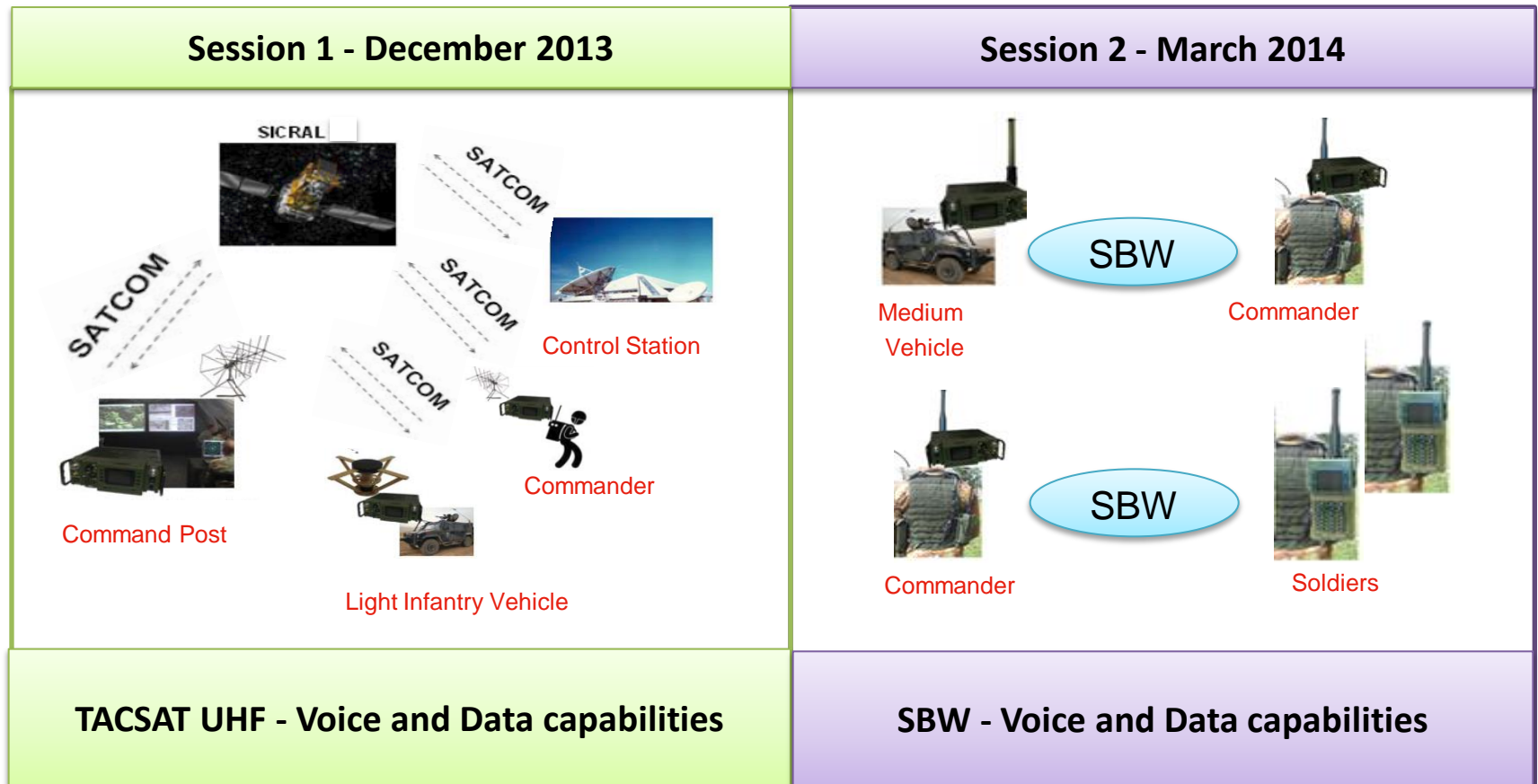
Fielded Reference Operational Scenarios (FROS)

Scenarios vs Waveforms



Examples of successfully experienced Scenarios

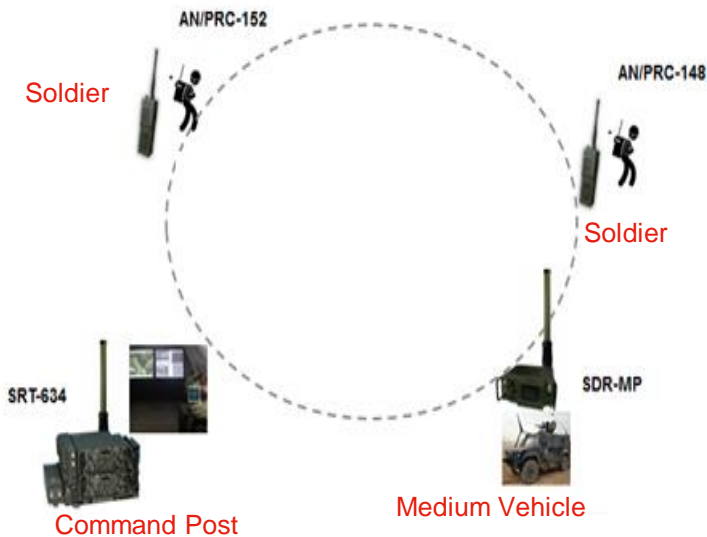
SDR ManPack Operational Experimentation 2013/2014 - SCUTI Italian MoD



Examples of successfully experienced Scenarios

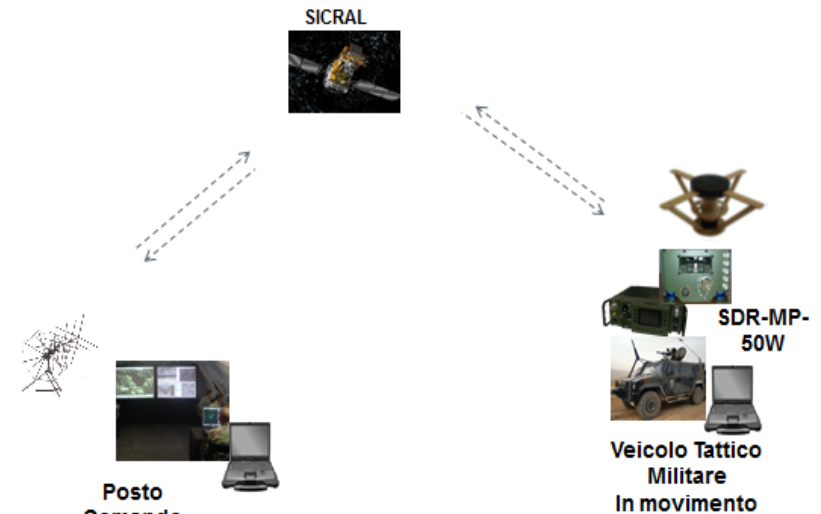
SDR ManPack Operational Experimentation 2014 - SCUTI Italian MoD

Session 3 - July 2014



**VLOS interoperability with
AN-PRC148/152 and legacy radios**

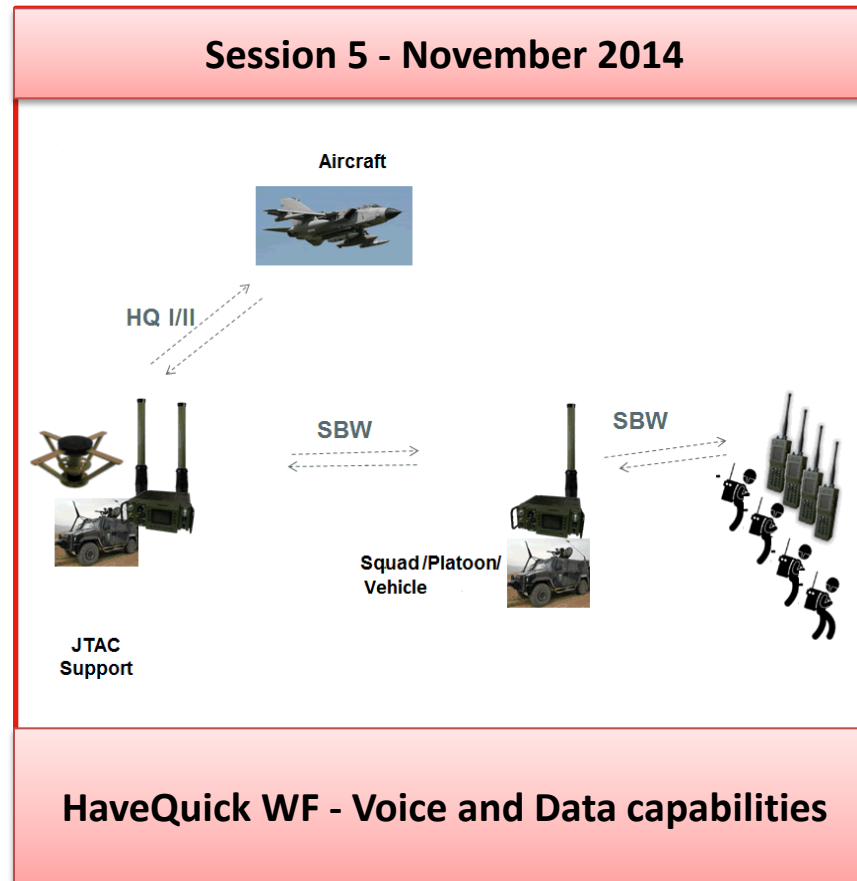
Session 4 - October 2014



**Vehicular HPA for UHF TACSAT -
Voice and Data capabilities**

Examples of successfully experienced Scenarios

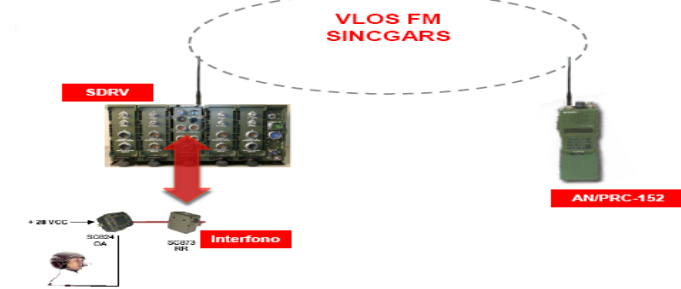
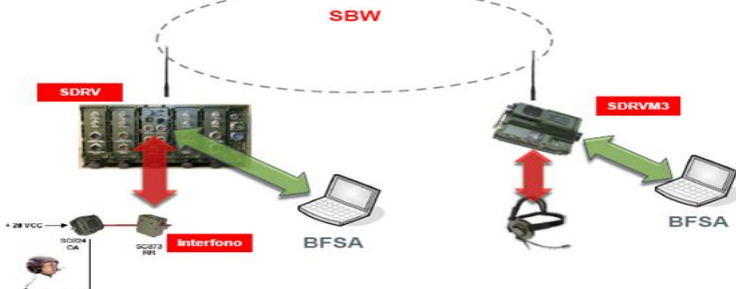
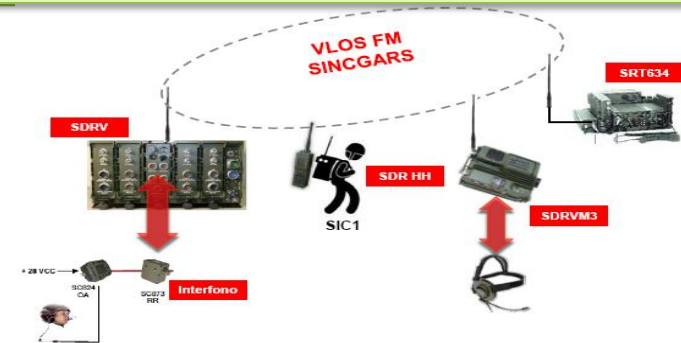
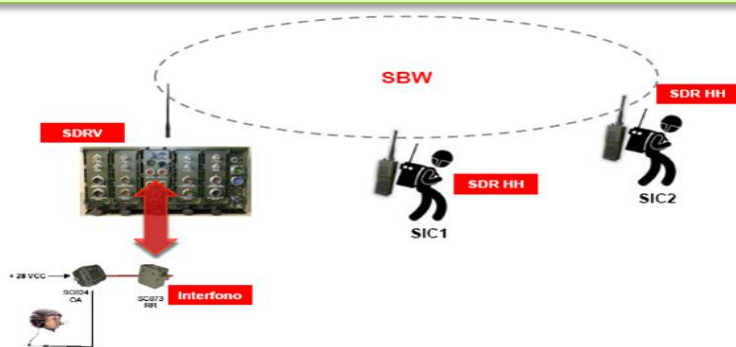
SDR ManPack Operational Experimentation 2014 - SCUTI Italian MoD



Examples of successfully experienced Scenarios

SDR Vehicular VQ1 Operational Experimentation 2014 - SCUTI Italian MoD

Session 1 - September 2014



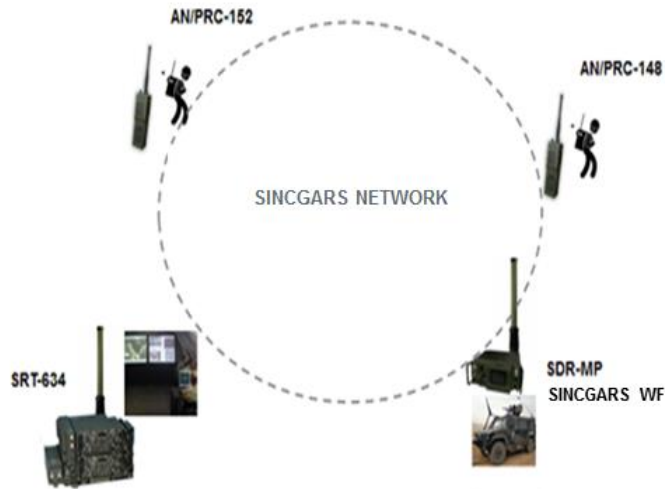
**SBW Waveform on multiple platforms
SDR VQ1, HH and VM3**

**SDR VQ1 - HH and VM3 on VULOS and
interoperability with AN-PRC148/152
and legacy radios**

Further Field Test Scenarios

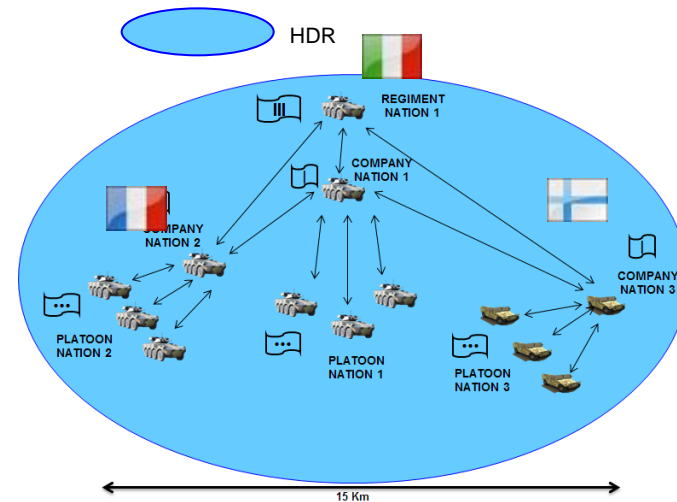
SCUTI, ESSOR, ...

SCUTI Session 6 - Beginning 2015



SINGARS WF - Interoperability with AN-PRC radios capability

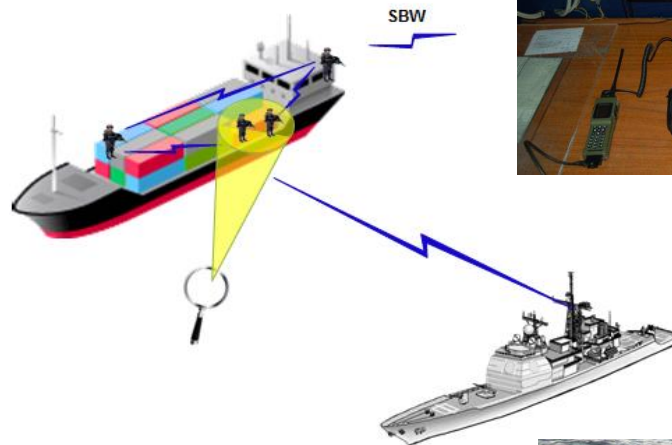
ESSOR Phase 2 - 2015



HDR Waveform Technical Field Tests

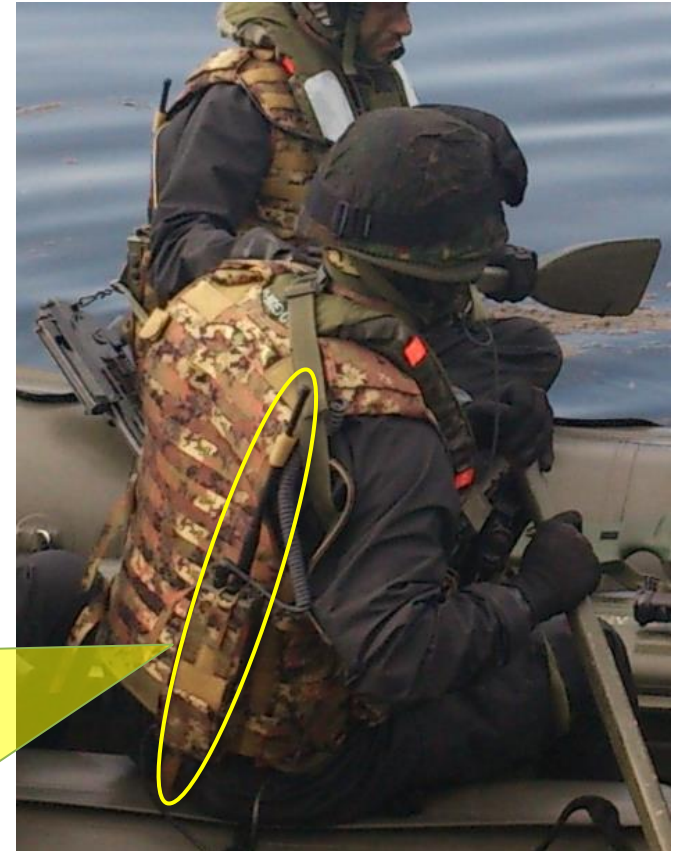
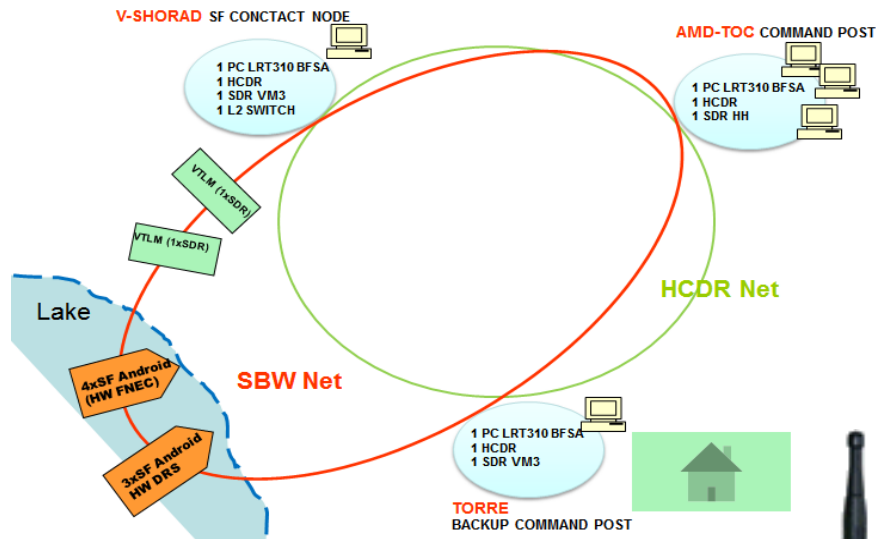
Examples of successfully experienced scenarios

Atalanta Mission Anti-pirates Operation



Examples of successfully experienced scenarios

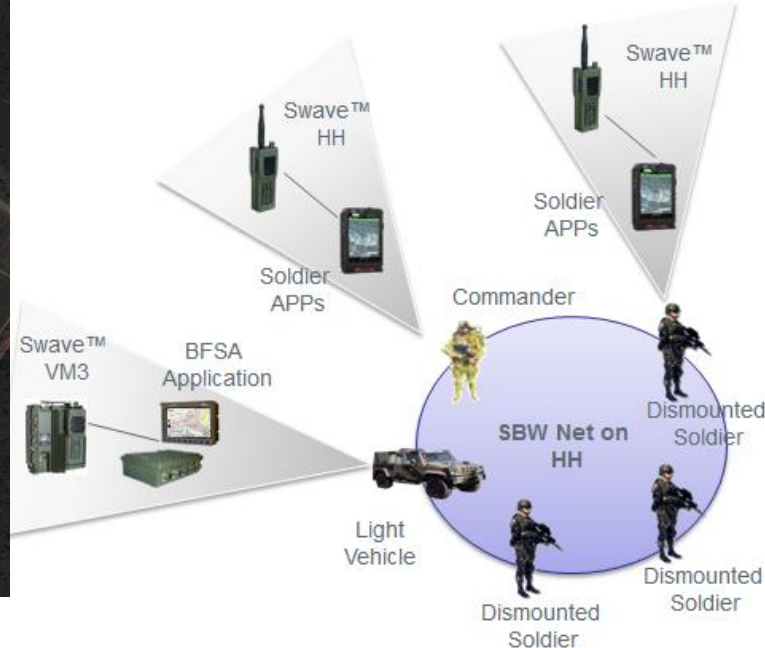
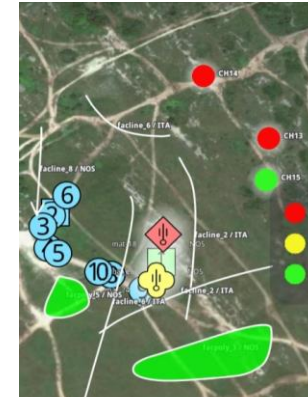
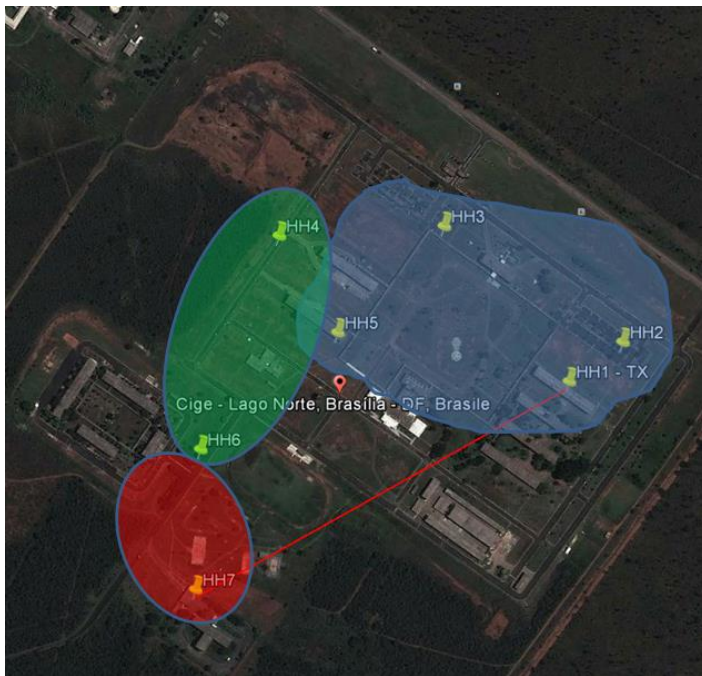
COMACA - Artillery Amphibians Troops



Examples of successfully experienced scenarios

CCOMGEX - Brazilian Army

A field test with Dismounted Android C2 applications over SBW network



Scorpion H2

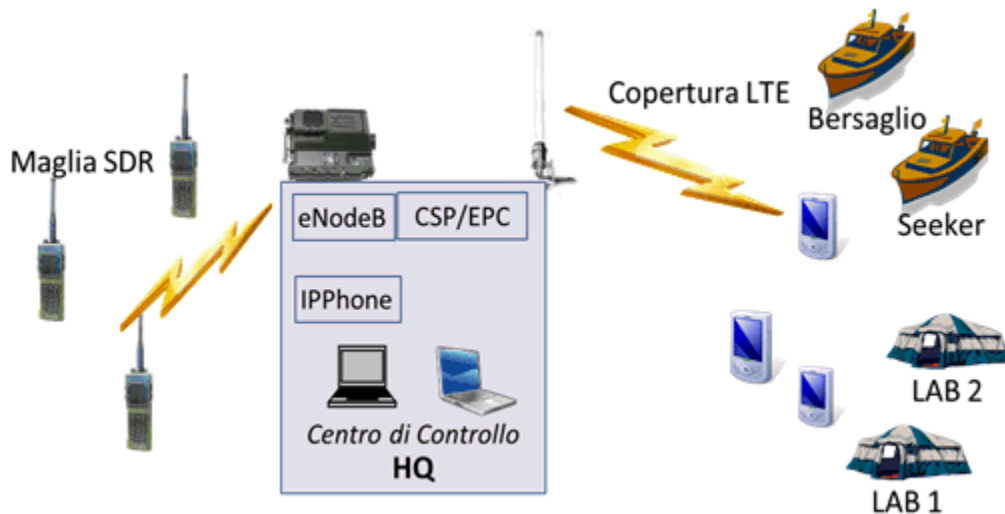


SDR-HH

Examples of successfully experienced scenarios

NATO TRIAL MARITELERADAR - LTE (4G) and SDR Cooperation

Using Selex ES Defense Communication Service Platform (D-CSP) to integrate different access network technologies



Offered services

- Surveillance: radar, video streaming
- Command and Control
Convergence for a Joint Situation awareness
- Unified users management
- Unified Comms (voice)



A 'shot' of a set of Experimental Results

Type	ID	Test	Time (sec)	Average (sec)
Data on SATCOM Link MIL/STD 188-181 4800 bps	1	PA Updating	10	20
	2	Single PA Sending	10	
	3	Packed PA Sending	11	
	4	Entity insertion - Unit	12	
	5	Entity insertion - Material	13	
	6	Entity insertion - Geometry	12	
	7	Entity insertion - Control Feature	12	
	8	Entity insertion - Graphical Order	20	
	9	Scenario Snapshot - On demand	20	
	10	Scenario Snapshot - Scheduled	20	
Data on SATCOM Link MIL/STD 188-181 2400 bps	11	PA Updating	3	8
	12	Single PA Sending	3	
	13	Packed PA Sending	7	
	14	Entity insertion - Unit	9	
	15	Entity insertion - Material	8	
	16	Entity insertion - Geometry	9	
	17	Entity insertion - Control Feature	9	
	18	Entity insertion - Graphical Order	9	
	19	Scenario Snapshot - On demand	9	
	20	Scenario Snapshot - Scheduled	11	
Data on SATCOM Link MIL/STD 188-183 4800 bps	21	PA Updating	10/10	No
	22	Single PA Sending	10/10	
	23	Packed PA Sending	10/10	
	24	Entity insertion - Unit	10/10	
	25	Entity insertion - Material	10/10	
	26	Entity insertion - Geometry	10/10	
	27	Entity insertion - Control Feature	10/10	
	28	Entity insertion - Graphical Order	10/10	
	29	Scenario Snapshot - On demand	10/10	
	30	Scenario Snapshot - Scheduled	10/10	
Voice SATCOM Link MIL/STD 188-181 2400 bps	31	Counting number series 1-10	10/10	
Voice SATCOM Link MIL/STD 188-183 4800 bps	32	Counting number series 1-10	10/10	
Voice SATCOM Link MIL/STD 188-181 2400 bps	33	Counting number series 1-10	10/10	
Voice IOP VULOS on SDR HH	34	Counting number series 1-10	10/10	
Voice IOP VULOS on SDR MB1	35	Counting number series 1-10	10/10	
Voice IOP VULOS on SDR VQ1	36	Counting number series 1-10	10/10	
Voice IOP VULOS on AN-PRC/148	37	Counting number series 1-10	10/10	
Voice IOP VULOS on AN-PRC/152	38	Counting number series 1-10	10/10	

Results collected during
SCUTI Operational
Experiments

Benefits of the Experiences

Lessons learned – Impacted Areas

Experiences resulted in

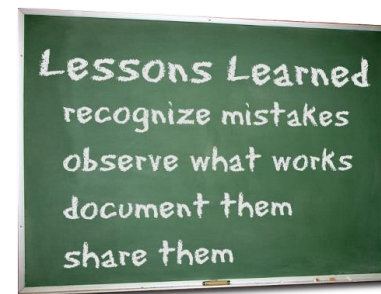
- Changes in the initial requirements/functionalities
 - Related to real-life operational challenges
 - Usually limited in scope
- Solution enhancements
 - Performances
 - Ergonomic
- Interoperability
 - Scope extensions
 - Enhanced operational scenarios (Joint / Multinational)
- New opportunities
 - Operational improvements
 - Industrial benefits



Benefits of the Experiences

Lessons learned - Some Reported Items 1/2

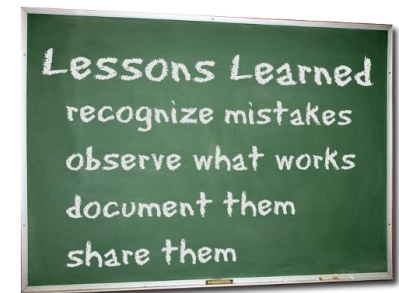
- Effectiveness of SCA architecture in porting the same WF to different platforms
 - Seamless integration & interoperability during field test
- RAZOR TACSAT Antenna folding/transportability operational requirements
 - A new more ergonomic solution already implemented and made available
- Embed 50W V/UHF Power Amplifier into vehicular VQ1 platform
- New Software Requirements/Functions for MB1, like
 - Identifiable tone for emergency calls
 - Beacon Function
 - Specific “beep” alarm signal for TACSAT availability
 - Calling group information shown on display



Benefits of the Experiences

Lessons learned - Some Reported Items 2/2

- Development request of a MB1 radio model for Simulation in the Integrated Test Bed
- Manpack kit enhancements
 - More comfortable backpack configuration
 - Remotable Man-machine interface
 - Remotable PTT - wireless o wired
- Manpack hardware strengthening
 - Improve radio emergency recharging using vehicle battery
 - Improve radio battery life for continuous voice-video links
 - Improve display brightness
- Manpack Interoperability
 - Extend MIL-STD-188-220 support for interoperability



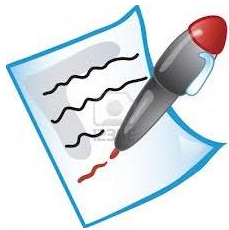
Benefits of the Experiences

RAZOR TACSAT Antenna - A Real Case

BEFORE...



Customer requests during SCUTI Experiment



Contestualmente, si propongono le seguenti migliorie all'accessorio d'antenna TACSAT Razor – pop up:

- sostituire il sistema di estrazione/ripiegamento d'antenna a filo proposto, con un altro sistema che eviti l'aggrovigliamento (es. filo con guaina simile a quello dei freni per biciclette);
- realizzare un equipaggiamento che si adatti al giubbotto antiproiettile in uso alla FA e che contenga il complesso radio in parola compresi gli accessori, da utilizzare, possibilmente, nelle prossime sessioni di test.

Request Accepted



Selex-ES Implementation on Customer request



Antenna changes realized

...and AFTER



Managing Deployed SDR Radios

Modelling & Simulation and Network Management Solutions



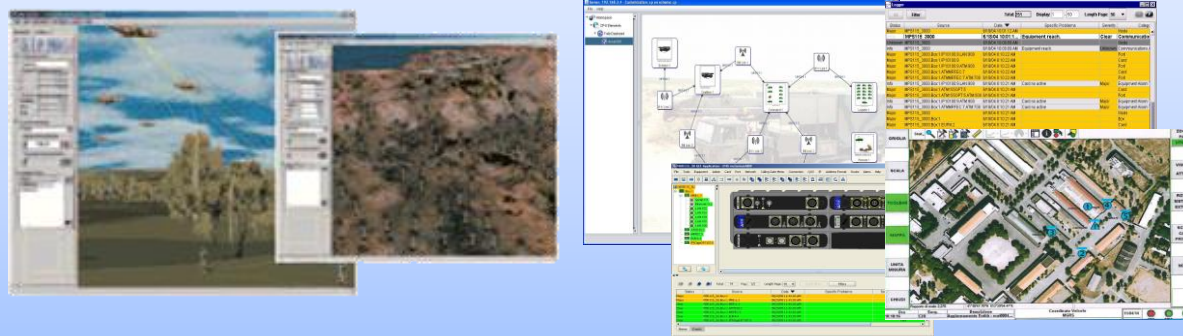
Managing SDR in the field

Selex ES knowledge is built on...

Real-life experiences in Trials, Exercises and Experimentations



Modelling & Simulation and Management Solutions

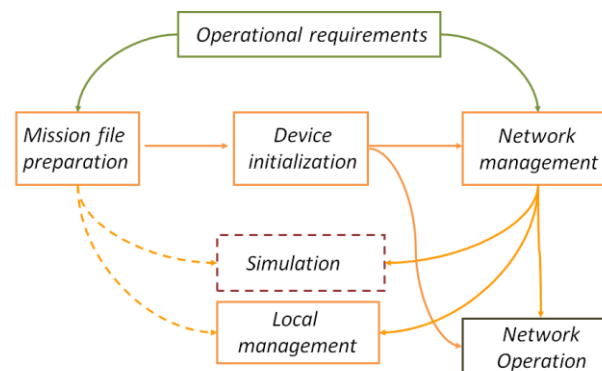


Managing SDR networks

Why is it so important?

SDR devices are becoming more and more powerful

- New Waveforms, introducing new capabilities
- Extended interoperability
- Increased supported services



**Most of the times additional power means additional complexity
to be managed**

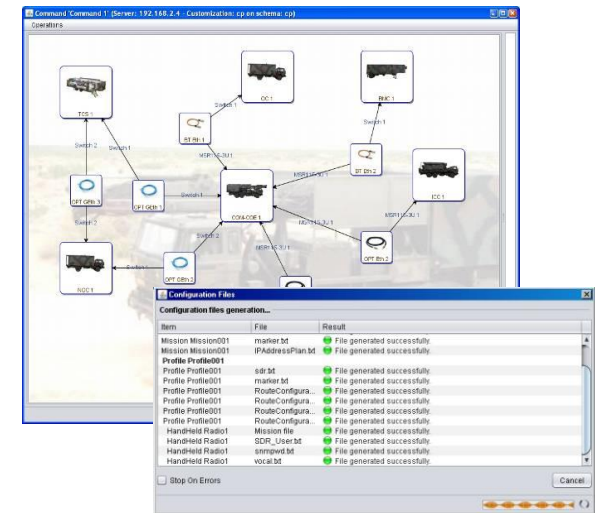
Modelling & Simulation and Network Management solutions shall support network operators during all the management phases (on- and off-line)

Managing Deployed SDR Radios

SDR Supervision tool

Planning & mission files preparation

- Translating operational user needs into technical information
 - Based on operational requirements and constraints definition
 - Supporting multiple Waveforms
 - Providing best solutions
 - Tailored to low- or medium-profile operators
- Offering the parameterization capability of the radio modules according to templates
 - Easy configuration and set-up
 - Exploiting the use of building-blocks
- Generating configuration files directly loadable into the radio devices
 - Common format definition of Base WF parameters values



Managing Deployed SDR Radios

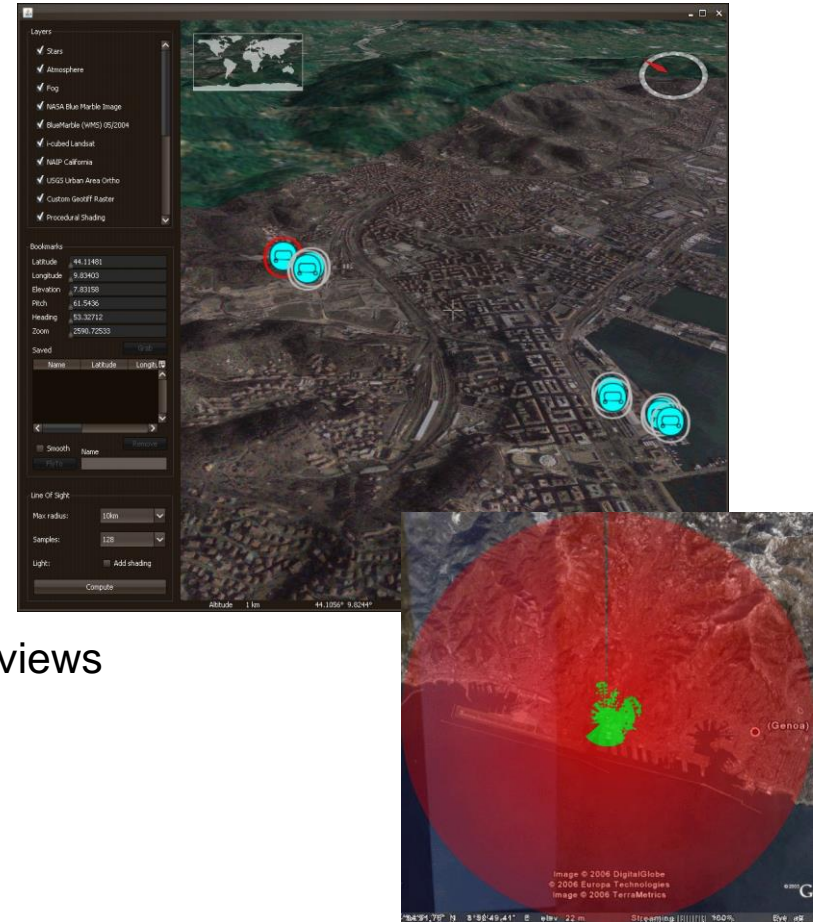
SDR Supervision tool

Device Initialization

- Initializing devices
 - Distribution and load of configuration files
 - Pre-loading of required waveforms

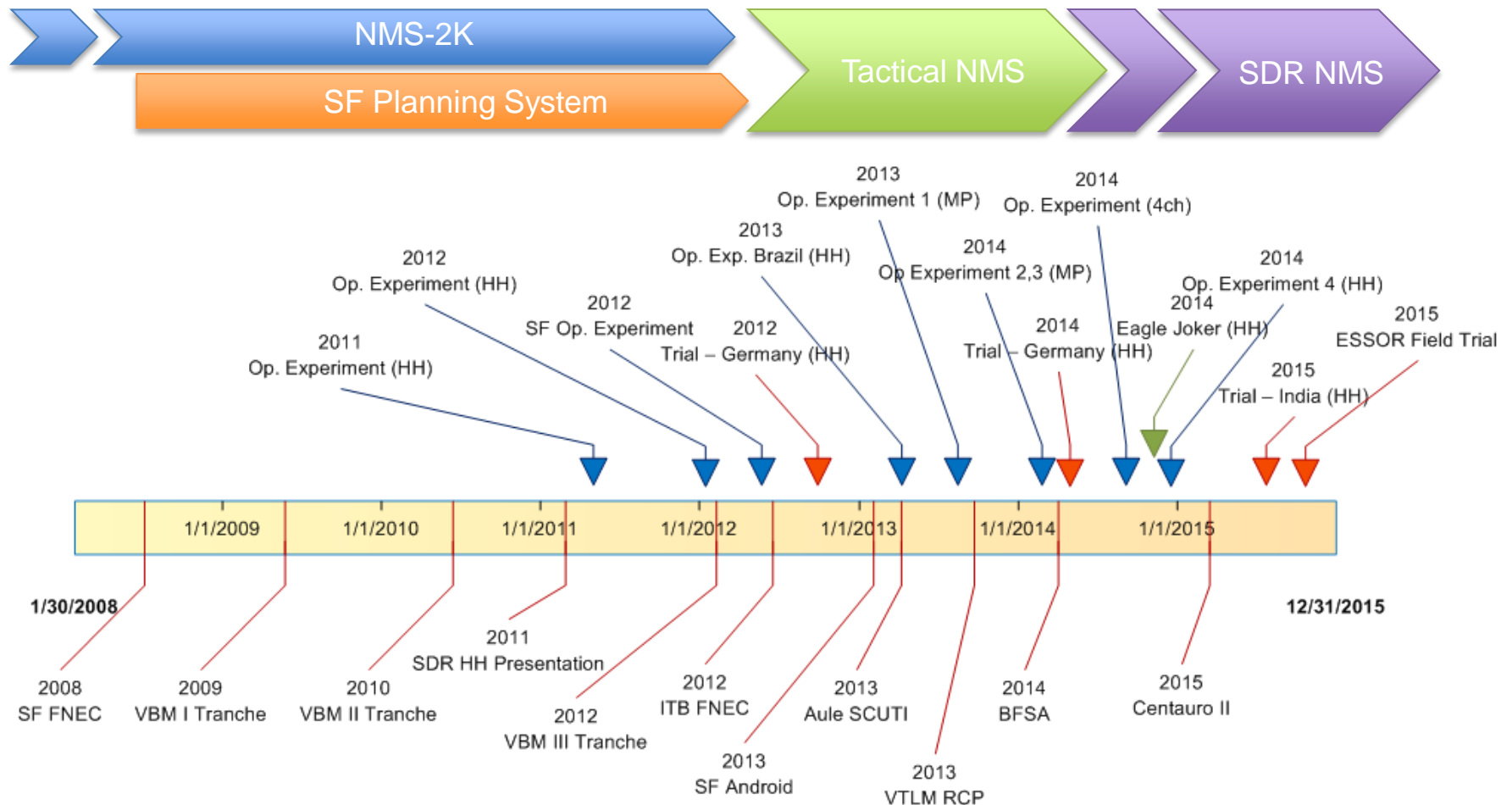
Network Management

- Tracking network topology and status
 - Reachable nodes
 - Device alarms
 - OTAx (management, re-keying, zero-ization)
- Integration of management and C2 operational views
 - Nodes position
 - Sensors information
 - Coverage areas
 - Messaging / Path tracking



Notional evolution of Selex ES SDR Management Products

NMS-2K and beyond - Past, present & future



Managing Deployed SDR Radios

A Simplified Approach Made Real

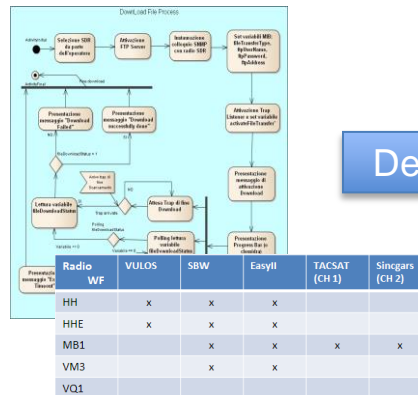
Complexity

Easy of management

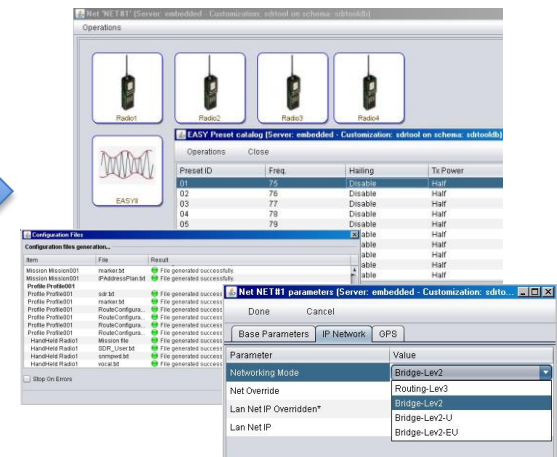
- Network needs
 - Several waveforms
 - 100+ parameters
- Unified model
 - Templates
 - Standard building blocks
 - Dynamic rules
- Simple user views
 - Intuitive forms
 - Configuration files

Waveform parameters	Model Entity
INSTANTIATED_PHYSICAL_CHANNEL	Default
CIPHER_TEXT_ALGORITHM_ID	Default
BYPASS_PDU_ID	Default
AUDIO_OUTPUT_VOLUME	Default
PLAIN_TEXT_ALGORITHM_ID	Default
BER_TEST	Default
DATA_TRANSFER_RELIABILITY	Net
VOICE_CRYPTO_MODE	Net
DATA_CRYPTO_MODE	Net
SIDETONE	Net
SAVON_SESSION_TIMEOUT	Net
CONVERSATION_TIMEOUT	Net
WF_STANBY_MODE	Net
WF_IDLE_ACTIVE_PERIODIC	Net
NET_MONITORING_INTERVAL	Net
HIGH_EFFICIENCY	Net
TX_TONE_ENABLED	Net
TX_TONE_ENABLED	Net
RF_TX_POWER	Preset
RF_CHANNEL	Preset
CIPHER_TEXT_KEY_ID	Preset
CIPHER_TEXT_CERTIFICATE_ID	Preset
COMMANDER_STATUS_UPPER_PTT	Radio Instance
COMMANDER_STATUS_LOWER_PTT	Radio Instance
LISTEN_MODE	Radio Instance
NET_INDEX_SELECTED	Radio Instance
OWN_NICKNAME	Group
UPPER_PTT_PRIVATE_DESTINATION	Group
LOWER_PTT_PRIVATE_DESTINATION	Group
GROUP_NORMAL_PRIORITY	Group member
GROUP_HIGH_PRIORITY	Group member
UPPER_PTT_MODE	Group member
LOWER_PTT_MODE	Group member
UPPER_PTT_GROUP_DESTINATION	Group member
LOWER_PTT_GROUP_DESTINATION	Group member
AUDIO_GROUPS_MIX	Group member
RSSI_AVERAGING_PERIOD	Status
RSSI_LEVEL	Status
CLASSIFIER_RULES	Dynamic according to rules
MULTICAST_VLAN_RULES	Dynamic according to rules

Analysis

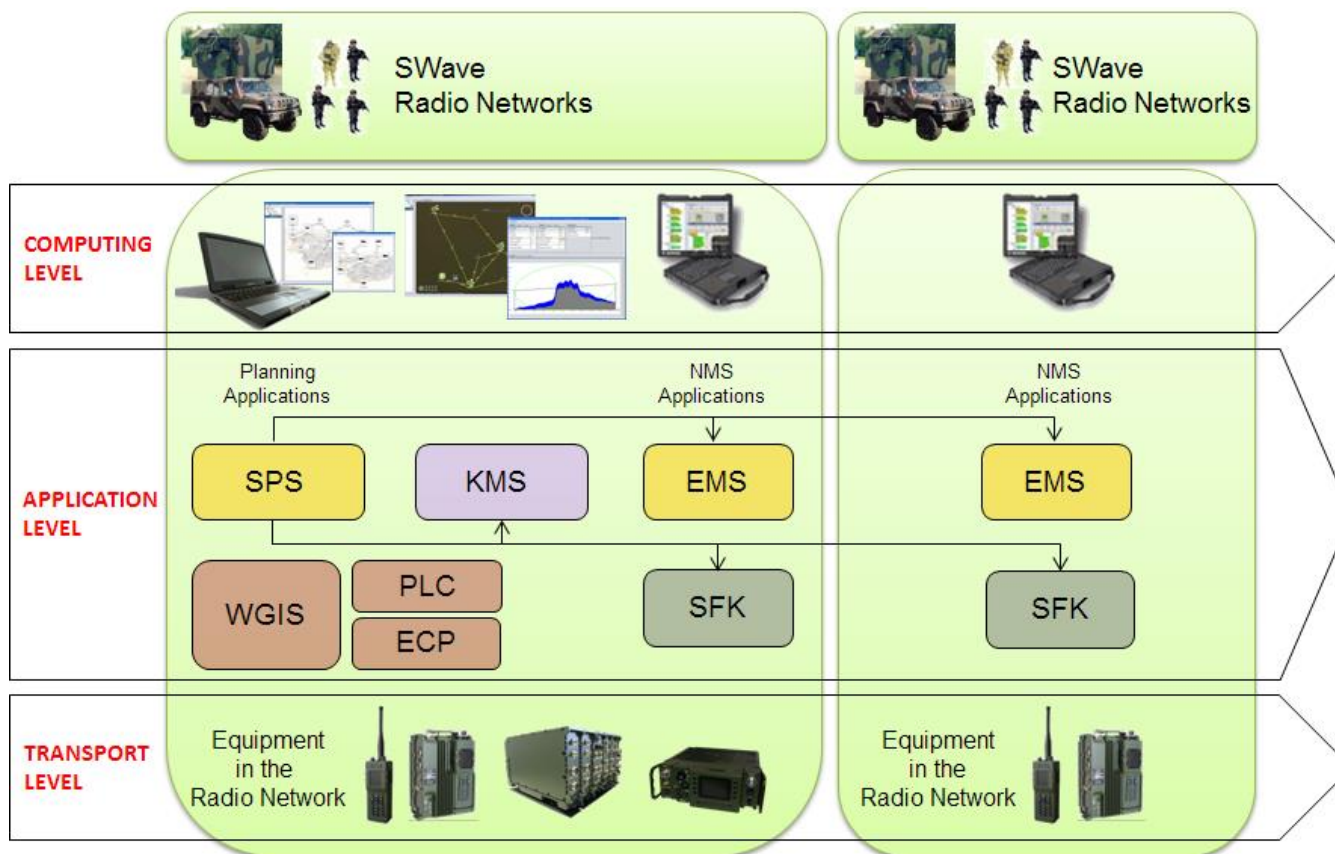


Design



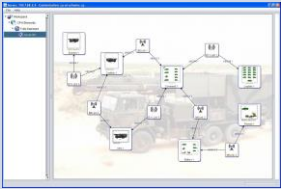
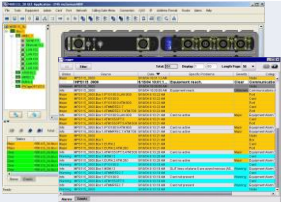
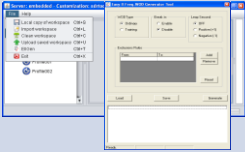

Managing Deployed SDR Radios

NMS Product Components




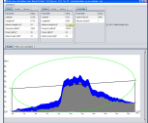
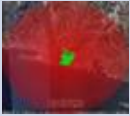



Managing Deployed SDR Radios

SDR NMS - Core Products

	Name	Description
	Scenario Planning System (SPS)	<p>SPS implements a generic framework (network model) for supported network scenarios, defining</p> <ul style="list-style-type: none"> • A set of planning levels, identifying a hierarchy across the network • The relations between network nodes according to communications requirements • A model for each network element to be deployed and that will be part of the service to be planned
	Element Manager System (EMS)	<p>EMS is responsible for direct management of SDR radios, interfacing with higher management layers to configure, control and reporting of updated network information</p> <ul style="list-style-type: none"> • Downloading equipment configurations, prepared by the SPS application • When directly connected to a master radio gathers topology information of remote radios and their status
	Key Management System (KMS)	<p>KMS is responsible for generating and distributing of sensitive material (TRANSEC keys, frequency hopping information), to the SDR radios deployed during mission planning</p>
	SDR Filler Kit (SFK)	<p>SFK is responsible for managing, in a secure way, configuration and keys transfer from the generation applications, SPS and Key Management System, to the SDR radios</p>

Managing Deployed SDR Radios

SDR NMS - SPS Ancillaries

	Name	Description
	World Wind Geographic Information System (WGIS)	WGIS is responsible to interact with a geo-referenced view (as opposed to a logical one), by supporting planning and monitoring activities in deploying SDR radios in the field
	Path Loss Calculation (PLC)	PLC provides information related to the feasibility of radio links, in order to support network planning decisions, on the base of the analysis of radio modeling information, terrain elevation information (DTED Level 0, 1 and 2 format) and geographic location characteristics (e.g. rainfall rate)
	Electromagnetic Coverage Prediction (ECP)	ECP analyzes the strength of a signal propagated over a circular area (or a sector) by considering radio factory and installation data as well as terrain information
	Mutual EM Visibility (MEV)	MEV is tailored for the specific task of ECP calculation among two specified radio/geo-referenced points
	Head Quarter Visibility (HQV)	HQV is tailored for the specific task of evaluating Mutual EM Visibility of all deployed radios with respect to a specific location (typically, Head Quarter position)
	Path Coverage Evaluation (PCE)	PCE performs a dynamic evaluation of Head Quarter Visibility when radios move along a pre-defined path

Managing Deployed SDR Radios

NetComm Simulation Product

NCSE is the Selex ES Modeling and Simulation environment based on the OPNET® suite, enabling

- Simulation of any operational network asset
 - Infrastructure networks
 - Mobile networks
 - Satellite networks
- Modeling and simulating new technologies (Software Defined Radio, MANET, WiMAX) before their introduction “in the field”, verifying their applicability in complex scenarios
- Support of “State of the art” Communication and Networking technologies:
 - Suite of MANET protocols
 - Satellite communications
 - Wireless
 - 2D/3D visualization of communications



Managing Deployed SDR Radios

Network Simulation Product - NetComm Modelling Capabilities

Modeled Radio Equipments

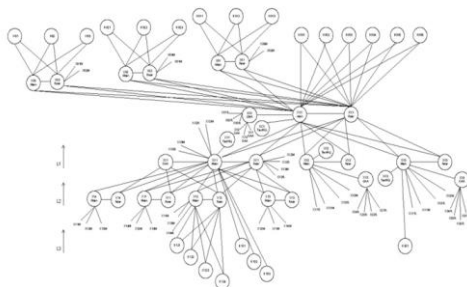
- MH5xx series for emulate radio relay link
- HDR for wireless broadband links
- SOTM-X for satellite communications
- MSR165 for tactical mobile routing
- SDR HH with SBW WFs for manet dismounted enviroment
- MILS GW for security exchanges in different domain levels



QoS preliminary design

- Achievement of non blocking network structure
- Performance parameters optimization

Network dimensioning



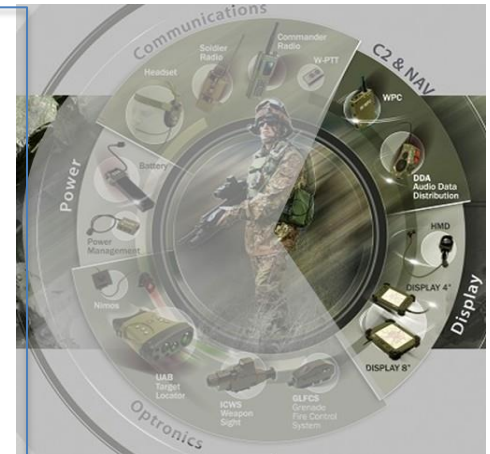
- Nodes number and type
- Links budgeting
- Physical topology and connectivity

Integrating Deployed SDR Products into C4I Systems

Vehicular and Dismounted C2 solutions



- Selex ES C2 Applications support
 - Tactical Situation Acquisition & Awareness
 - Digital Maps Management
 - Chat and Messaging Services
 - Navigation Function like Route and Waypoints
 - Interoperability in Joint-coalition environment
 - SDR radio management



Soldiers



- In Dismounted environment voice and data communications for Squad members and Commander are assured by using the tactical SDR platforms HH with SBW WF



- In Vehicular environment voice and data communications for vehicles and higher operational levels up to HQ are guaranteed by using the tactical SDR platforms VM3, MB1 and VQ1 with VULOS, SBW, TACSAT WFs

Managing SDR in the field

Trials, Experimentations & Deployments - Conclusions



The way ahead

Experiences Benefits

Teamwork



Customer
Feedback

Final Report


SCUOLA DELLE TRASMISSIONI E INFORMATICA
SM – Ufficio Gestione Sviluppo Sistemi C4

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OGGETTO: Relazione finale sperimentazione operativa della sta. radio SDR MANPACK e del Soldato Futuro Android - 1ª sessione.

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e, p.c.: STAMADIFESA VI Reparto
MARIDIPART LA SPEZIA



Work in Progress

Selex ES SDR Product improved

New
Experiment



Optimization/
Enhancement



Building on experience



THANK YOU FOR YOUR ATTENTION

