



# Approach to SDR International Markets

WInnComm Europe 2014 – Rome

Fabio Casalino



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- Development and porting principles, SCA Framework, APIs
- Waveforms Development Kit

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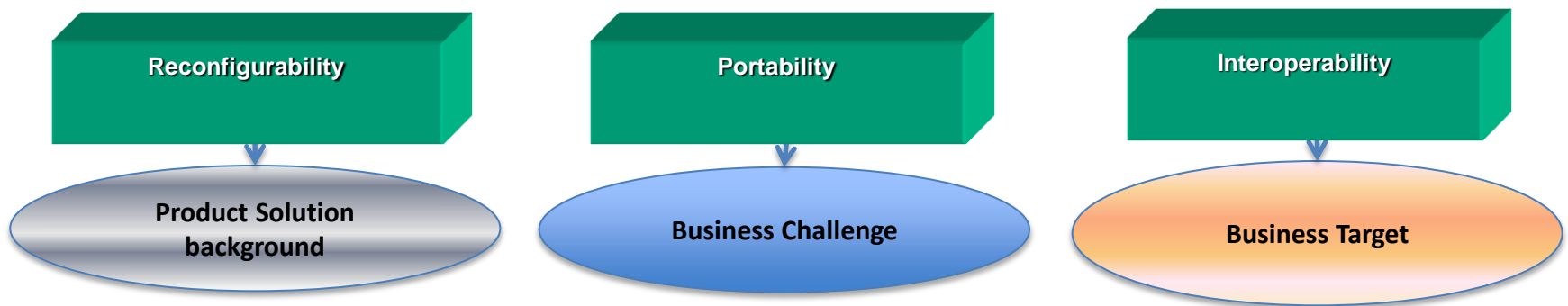
# Role of the Waveforms in SDR Military Business

## Key drivers

A waveform application is a software product implementing a specific communication scheme.

Three main principles can be seen also as market key drivers:

- Reconfigurability: enabling solutions, relying on design choices
- Portability: allows for rapid and cost effective solution availability
- Interoperability: main target capability to be achieved, based on communication specs such as coalition-defined



# Role of the Waveforms in SDR Military Business

## Key drivers

The above key principles drove Selex ES solutions as follows:

- **Selex ES Swave® Land SDR Platforms are fully reconfigurable**
- **Selex ES SDR WFs portfolio supports manifold operational scenarios**
- **Selex ES successfully ported several WF on all the Swave Platforms through well defined processes and methodology.**
- **The goal is to seize the opportunity of the manifold communication schemes in order to push for advancement of the SDR market**
- **Selex ES is willing to provide the same methodology and tools for being used by the customers in their premises**
- **Interoperability is one of the expected final goals of this process, when the business challenge of porting the national waveforms is achieved**

# Role of the Waveforms in SDR Military Business

**Key drivers**

**The cooperative path with customers for winning the challenge of the “portability” relies on:**

- **A National-level accomplished work bench and SW development environment**
- **SW experts from both the manufacturer and the customer**
- **Tailored to specific customer needs**
- **May work on customer’s national WFs, migrating them from dedicated radios to SDR platforms**
- **Take advantage of the available Swave® SDR product portfolio**

## SDR Platforms

### Hardware PLTFs

- Handheld HH
- Manpack MB1/VB1
- Vehicular Radio/Node VQ1
- Infrastructural/Naval

### Software PLTF

- Software Communication Architecture
- Operating Environment
- Platform Apps

### Ancillaries

- HPA/Couplifier
- Headset/Wireless PTT
- PTT/Video box
- Multirole Antennas
- Battery charger
- ....



SDR HH



SDR VM-3  
Single-Channel  
Vehicular

## SDR Waveforms

### New Generation WFs

- Soldier Wideband Radio/Network
- Vehicular Wideband Network
- Soldier/Backbone Narrowband Network
- Critical squad Communications

### Legacy Waveform

- Soldier Radio
- Combat Net Radio
- Ground-Air-Ground
- SATCOM
- BLOS connectivity



SDR VQ1  
Vehicular 4 Channels

## SW Applications

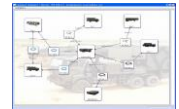
### Off-the-field

- Waveform Upload
- Software Update
- Test Tool
- Mission Configuration Planning



### On-the-field

- Network Management System (Planning, EMS, NMS)
- MIB/SNMP Manager
- Waveform plug-in



### Communication Services



SDR MB1/VB1  
ManPack & Vehicular  
2 Channels



Multi-Channel SDR  
Infrastructural Naval



# Role of the Waveforms in SDR Military Business

## Selex ES SDR Waveform Target Products Portfolio (partly GFX)

### SWave® HH



### SWave® VM3

#### VULOS

VHF 30-88 MHz; UHF 225-400 MHz with 25 KHz bandwidth;  
G2G Voice and Data communication up to NATO Restricted

#### MIL 188-220 C

30-512 MHz;  
IP Data communications support for VHF and UHF Waveforms

#### SelfNet SBW

225 ÷ 512 MHz with 1.3 MHz bandwidth;  
G2G ad-hoc MANET waveform with Voice and Data Communications up to NATO Restricted

#### SelfNet EASY II

Basic: VHF 118 ÷ 174 MHz, UHF 225 ÷ 400 MHz  
Extended: VHF 30 ÷ 88 MHz, UHF 225 ÷ 512 MHz  
25 MHz bandwidth; Voice and Data Communications up to NATO Restricted

### SWave® MB1



#### VULOS

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#### SINGGARS

30-88 MHz with 25 KHz bandwidth;  
GAG interoperability with Voice Communications up to NATO Secret

#### HaveQuick I/II

225-400 MHz, with 25 KHz bandwidth;  
GAG interoperability with Voice communications up to NATO Secret

#### TACSAT

bandwidth: 5KHz NB; 25 KHz WB;  
Communications amongst nodes assured inside satellite footprint Point-to-Point & Point-to-Multipoint voice and data

### SWave® VQ1



#### VULOS

VHF 30-88 MHz; UHF 225-400 MHz with 25 KHz bandwidth;  
G2G Voice and Data communication up to NATO Restricted

#### MIL 188-220 C

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#### TACSAT

bandwidth: 5KHz NB; 25 KHz WB;  
Communications amongst nodes assured inside satellite footprint Point-to-Point & Point-to-Multipoint voice and data

#### ESSOR HDR

225-400 MHz; 1.25 MHz bandwidth;  
Throughput 1 Mbps; SC-FDMA

#### STANAG 4285

2-30 MHz; 25 KHz bandwidth;  
JF interoperability with data exchange from 75 up to 3600 bpd

#### MIL 188-220 B

2-30 MHz; HF Data Modem up to 4800bps;  
Frequency hopping modem IAV MIL-STD 188-148 (s); Robust serial tone mode for degraded HF links

#### STANAG 4538

2-30 MHz; Technical standard for an automatic control system Data Link with ARQ

#### STANAG 5066

2-30 MHz; Profile for HF Radio Data communication; reliable email and data over HF

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## **Conclusions**





# Operational use cases vs Waveform Product

## Summary

SELEX ES Waveform portfolio covers a wide range of operational requirements.

The following list of scenarios are identified by focusing on such operational needs and solutions.

- ✓ Scenario 1: *Multi-service wideband communications for Dismounted Squad*
- ✓ Scenario 2: *(Very) critical simultaneous voice and data communications for Dismounted Squad*
- ✓ Scenario 3: *Voice and Data Communications for Dismounted Squad (saving of band, integration of legacy radios)*
- ✓ Scenario 4: *Land Mobile Backbone Communications (Light multirole /armored vehicles)*
- ✓ Scenario 5: *Land "Coalition" Backbone Communications*
- ✓ Scenario 6: *SAT Assisted Land & Airborne*
- ✓ Scenario 7: *(Long Distance) Land & Maritime*

# Operational use cases

## Scenario 1: Multi-Services wideband communications for Dismounted Squad - *Description*

### *Squad Network*

- Dismounted soldier scenario at squad/multi-squad level with soldier-to-soldier and soldier-to-vehicle communications
- Two squads, each one composed by one vehicle and four dismounted soldiers
- Need to support wideband traffic
- On-the-move, meshed topology communications in rural, suburban, urban environments
- CNR Capabilities required : Group Voice Calls and Super-Lan (W-LAN)



# Operational use cases

## Scenario 1: Multi-Services wideband communications for Dismounted Squad - **Solution**

### **Soldier Broadband WF (SBW)**

#### Frequency band:

- 225-512 MHz
- 1.3 MHz bandwidth

#### Up to 50 nodes

#### Up to 500 kbps user data

#### Network:

- Self-forming, Self-healing, Multi-hopping
- Merging, Splitting, Late entry

#### Intranet Addressing:

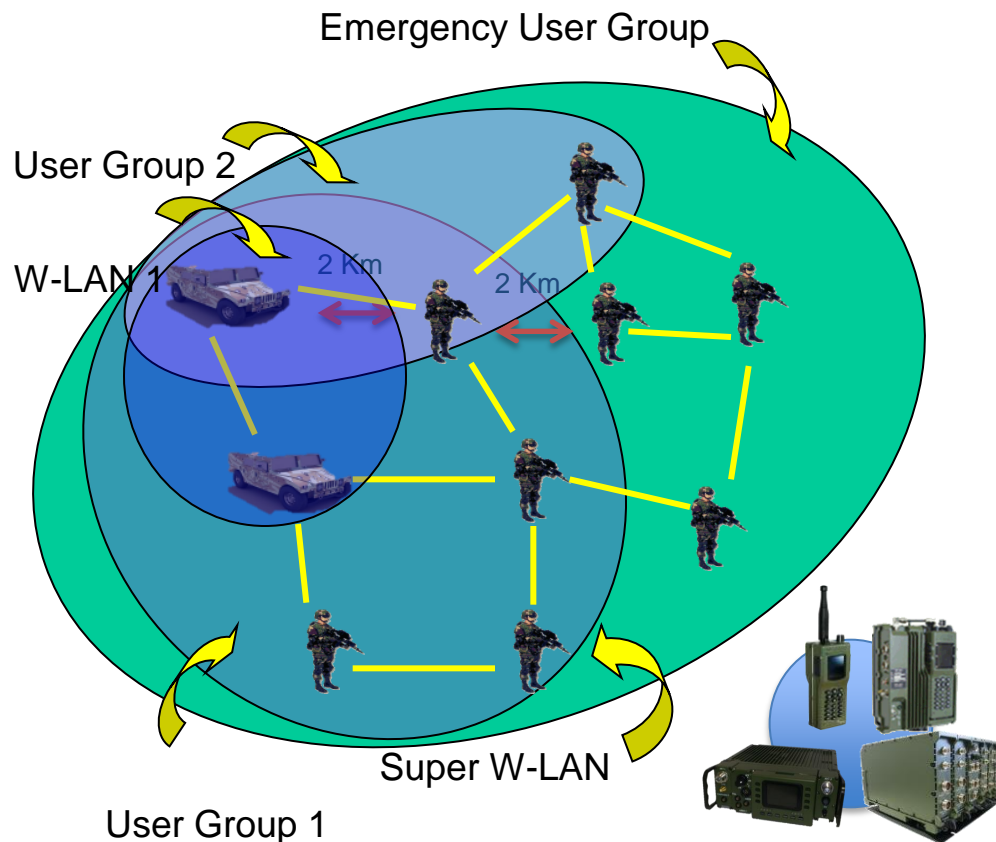
- Unicast, Multicast, Broadcast

#### Programmable COMSEC

#### Upgradable TRANSEC

#### Multi Services:

- Voice Emergency group
- Up to 9 Voice User group
- Super W-LAN
- Up to 9 Data User group (WLAN)



# Operational use cases

## Scenario 1: Multi-Services wideband communications for Dismounted Squad – *SBW Datasheet*

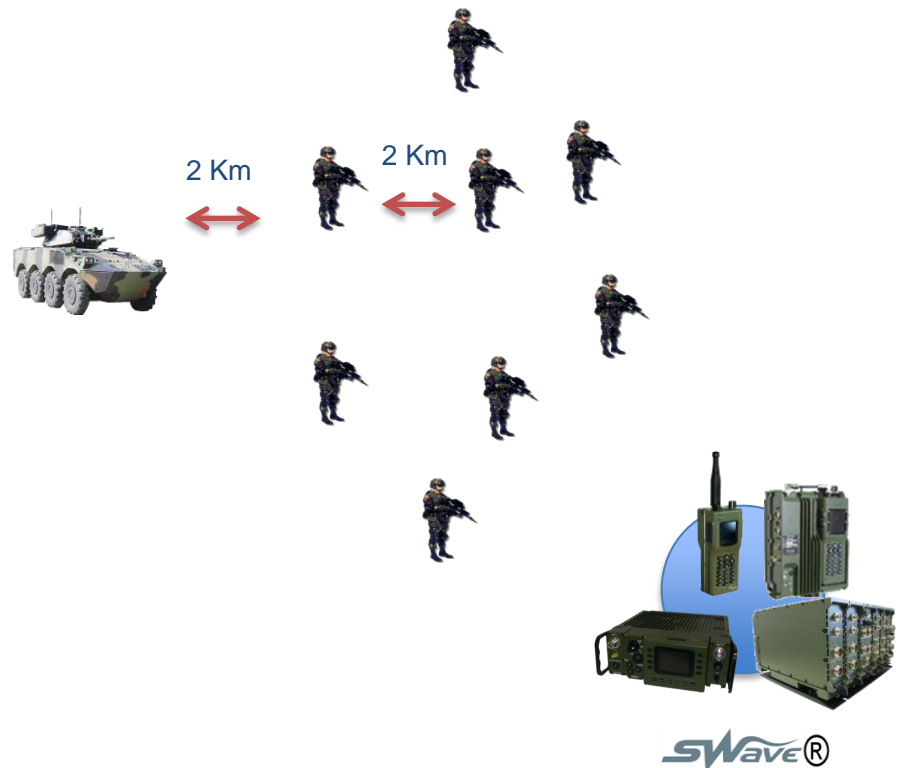
GENERAL		Voice service	
Channels:	1, half-duplex	Type of services:	Unicast, multicast, broadcast
Frequency range:	225 ÷ 512 MHz	User Groups:	up to 9 Voice Groups up to 3 simultaneous groups up to 50 nodes per group up to 2 voice groups per node
Channel bandwidth:	WB: 1.3 MHz	Emergency voice group with highest priority	
Physical Layer:	SC-FDE with BPSK and QPSK modulations	Voice priority VS Data	
Range:	up to 3 Km (soldier-to-vehicle)	Data service	
Performance:	up to 50 nodes up to 500 Kbps user data Set Up Time < 2s route recalculation/optimization < 200ms Relaying with 2 QoS classes	Type of services:	Unicast, multicast, broadcast Voice, Data, Video
SW environment:	SCA 2.2.2 / SCA ESSOR IPv4 stack Text messaging support Situation Awareness support	User Groups:	up to 9 VLANs Super VLAN available up to 2 simultaneous VLANs per node
Capabilities:	Network self-forming and self-healing Merging, Splitting and Late Entry Emergency Channel Multi-hopping Radio Silence	dataflows priority, user-level priority, QoS management	
		SECURITY	
		Modes:	Voice and Data Encryption

# Operational use cases

## Scenario 2: *(Very) critical simultaneous voice and data communications for Dismounted Squad - Description*

### *Squad Network*

- Dismounted soldier scenarios at squad/multi-squad level in critical operations with soldier-to-soldier and soldier-to-vehicle communications
- Two dismounted soldiers squads composed by four units and one vehicle
- Point-to-Multipoint connectivity scheme
- Voice and data transmissions between vehicle and soldiers in proximity of the fireline



# Operational use cases

## Scenario 2: (Very) critical simultaneous voice and data communications for Dismounted Squad - *Solution*

### Squad Network

#### *Easy II WF*

#### Frequency band:

- Basic: VHF 118-174 MHz; UHF 225 – 400 MHz
- Extended: VHF 30-88 MHz; UHF 225-512 MHz
- N\*25 KHz bandwidth

#### G-2-G PmP Communications

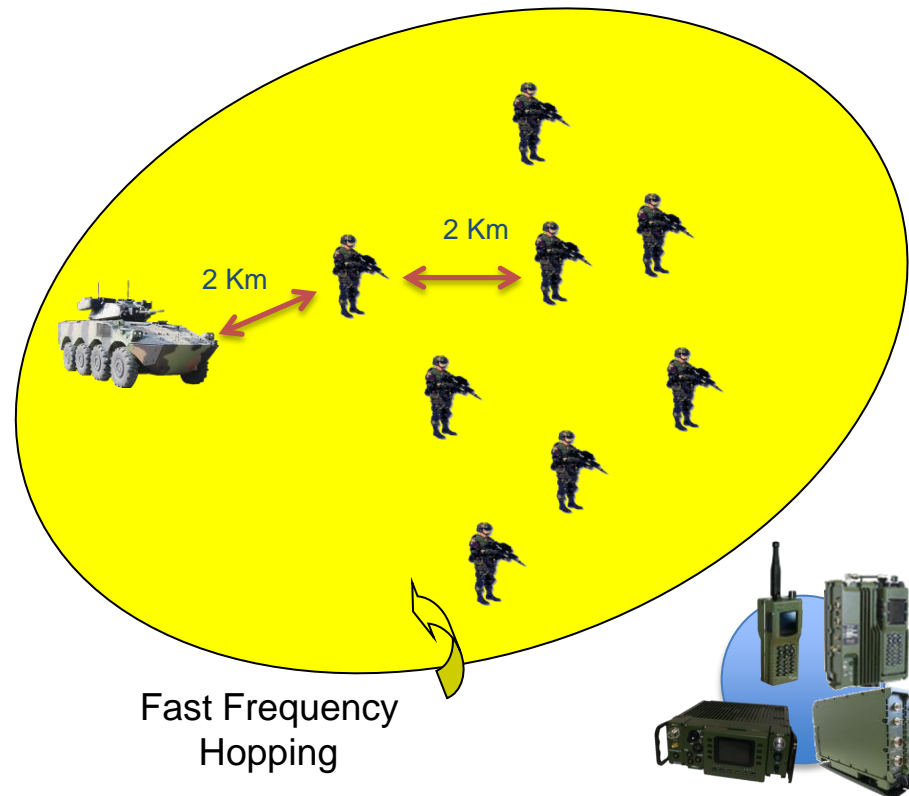
Protocol Layers (e.g. MIL-188-220C) built on top

#### VOICE & DATA Services:

- Voice point-to-multipoint comms
- Digital Voice (CVSD) at 16Kbps
- Data point-to-Multipoint comms
- 1.2/2.4/16 kbps data transfer

#### Programmable COMSEC

#### TRANSEC Fast FH





# Operational use cases

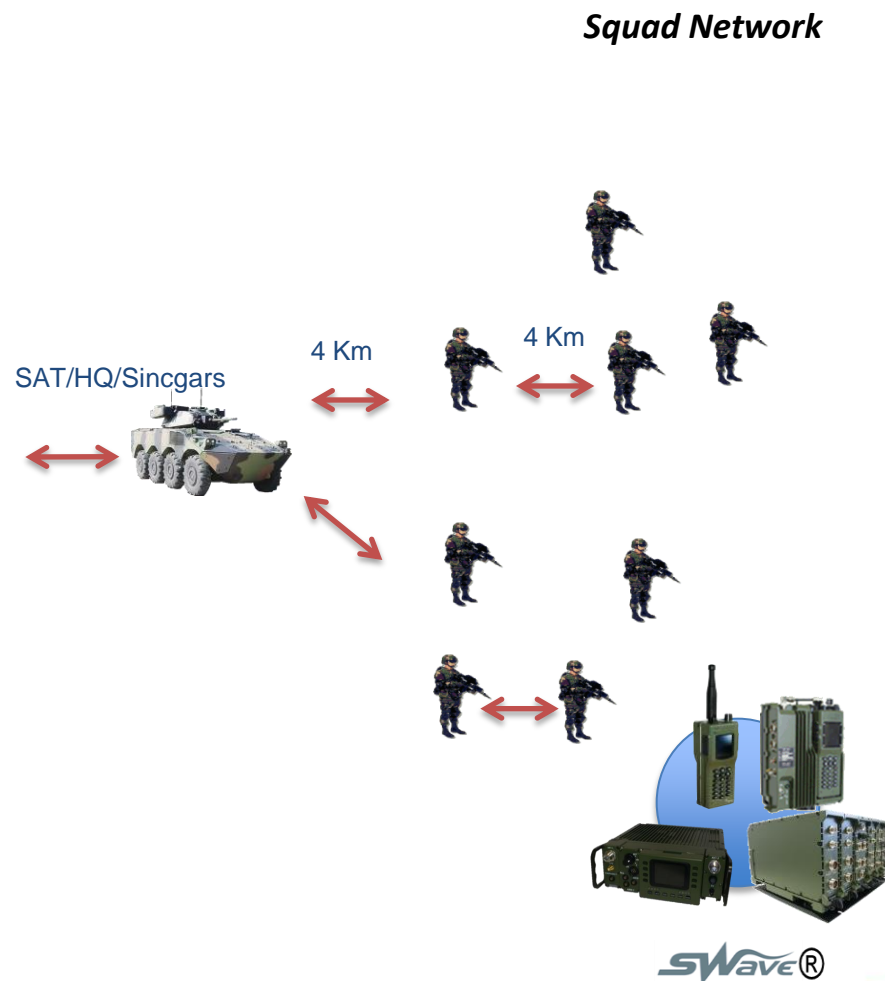
## Scenario 2: (Very) critical simultaneous voice and data communications for Dismounted Squad – *EASY II Datasheet*

GENERAL		SECURITY	
Channels:	1, half-duplex	Modes:	TRANSEC: Fast Frequency Hopping (FFH) COMSEC: either with WF algorithm or with external cipher
Frequency range:	Basic: VHF 118÷174MHz, UHF 225÷400MHz Extended: VHF 30÷88MHz, UHF 225÷512MHz		
Channel bandwidth:	NB: 25kHz		
Physical Layer:	MSK, AM (for TOD exchange)		
Capabilities:	Digital Voice (CVSD) at 16 kbps Data Transferring Frequency Hopping		
SW environment:	SCA 2.2.2 / SCA ESSOR		
		Voice service	
		Type of services :	Point-to-multipoint communications 16kbps rate Digital voice transmission according to CVSD algorithm
		Data service	
		Type of services :	Point-to-multipoint communications 16kbps, 2.4kbps, 1.2kbps both plain text and cipher text

# Operational use cases

## Scenario 3: Voice and Data communications for Dismounted Squad (Saving of Band, Integration of legacy radios) - Description

- Dismounted soldier scenarios at squad/multi-squad level with soldier-to-soldier and soldier-to-vehicle communications
- Two dismounted soldiers squads composed by four units and a vehicle
- Need to reduce the “Mhz” in “Khz” (crowded spectrum)
- Voice and data transmissions
- On-the-move, meshed topology communications in rural, suburban, urban environments
- CNR Capabilities required : Group Voice Calls and Data Lan (W-LAN)
- Need to “internetwork” in vehicles



# Operational use cases

## Scenario 3: Voice and Data Communications for Dismounted Squad (Saving of Band, Integration of legacy radios) - *Solution*

### *NarrowBand WF*

#### Frequency band:

- 30-400 MHz
- 25, 50, 75 KHz bandwidth

#### CPM modulation

#### NATO, Joint Coalition, National

**Nodes** Squad/Platoon (network cardinality can be increased)

#### Self-forming, Self-healing MANET

#### Intranet Addressing:

- Unicast, Multicast, Broadcast

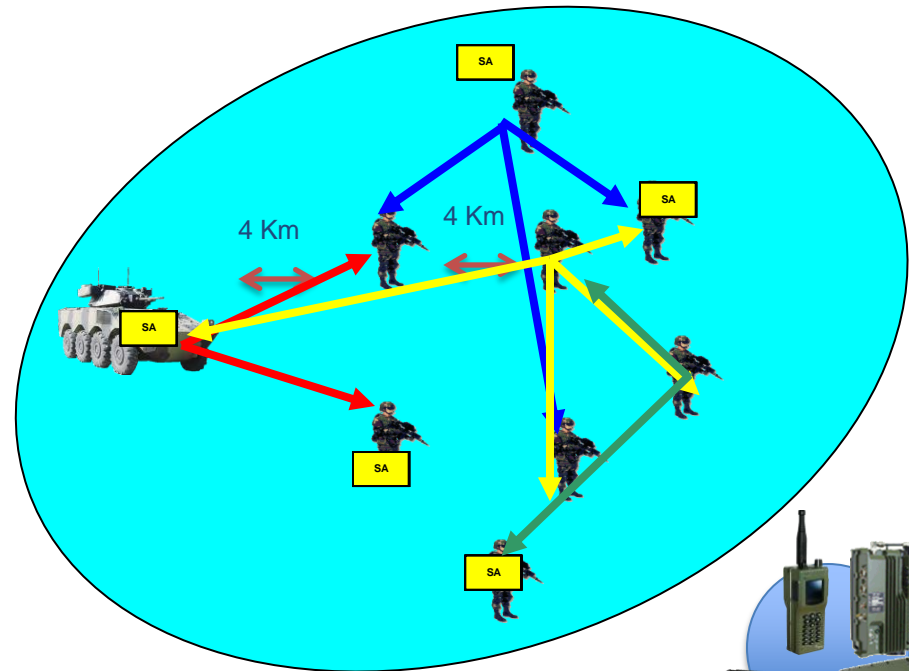
#### Embedded SA information sharing mechanism

#### VOICE & DATA Services:

- Simultaneous Voice and Data transmissions
- Up to 4 Voice comms and 1 data comm simultaneously with 20 Kbps user rate (Basic)
- User/Service Priority

#### Proprietary COMSEC/TRANSEC

#### Squad Network



# Operational use cases

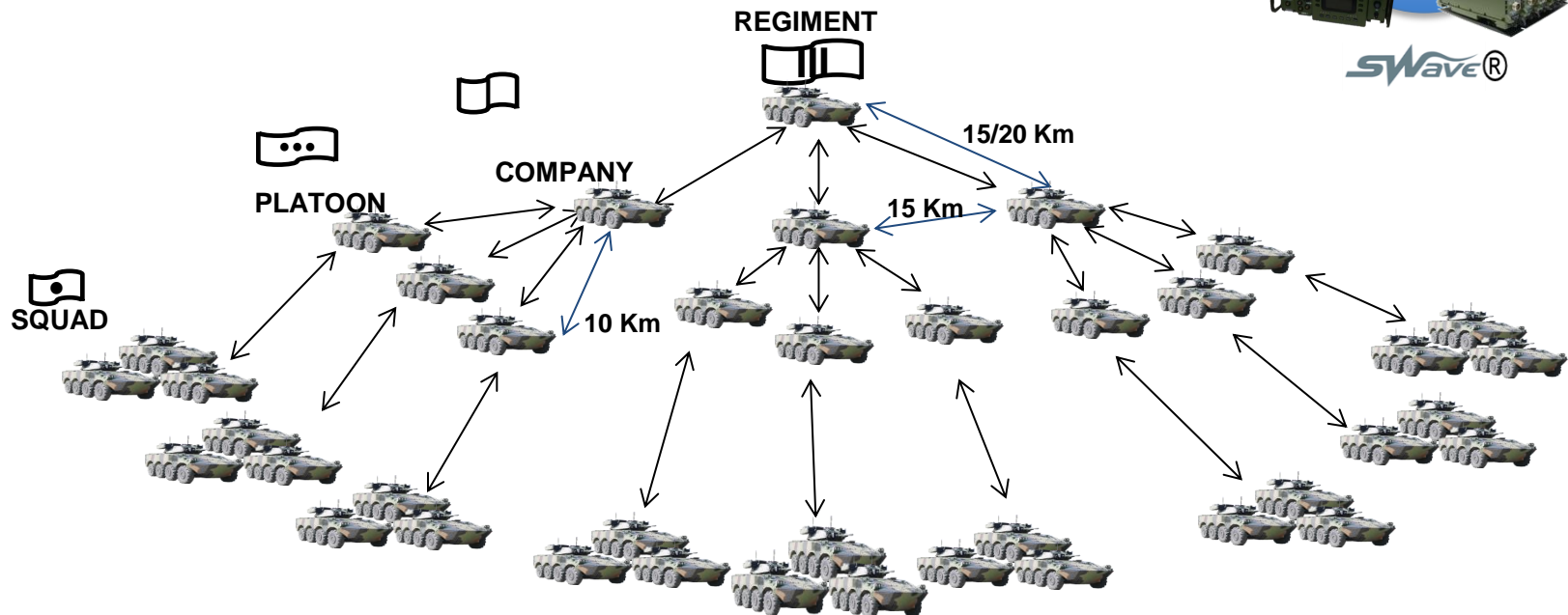
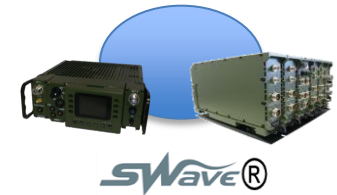
## Scenario 4: Land Mobile Backbone Communications - *Description*

Vertical/Horizontal Multi-Level & Multi-Service Communications in Mobile Backbone Segment

Units are:

- Light Multirole Armored vehicles
- Armored vehicles
- Shelters, fixed units (Command Posts)

Network cardinality is order of magnitude 100 nodes



# Operational use cases

## Scenario 4: Land Mobile Backbone Communications – *Solution*

### *ESSOR HDR WF*

#### Frequency band:

- NATO Band I - 225-400 MHz
- 1.25 MHz CHANNEL bandwidth
- $n \times 1,25$  MHz network bandwidth ( $n=1, \dots, 8$ )

#### Typical network composed by 80 nodes

Up to 200 nodes

Up to 1 Mbps user raw throughput

#### Network:

- Self-organizing, Self-healing, Multi-hop
- Merging, Splitting, Late entry
- External network interoperability

#### Intranet Addressing:

- Unicast, Multicast, Broadcast

#### DATA Services:

- static/dynamic IPv4 multicast groups
- Simultaneous active groups
- Text messaging support, Situation Awareness Support
- Data transfer, user level priority, traffic classification on multiple queues

#### COMSEC (up to NATO S)

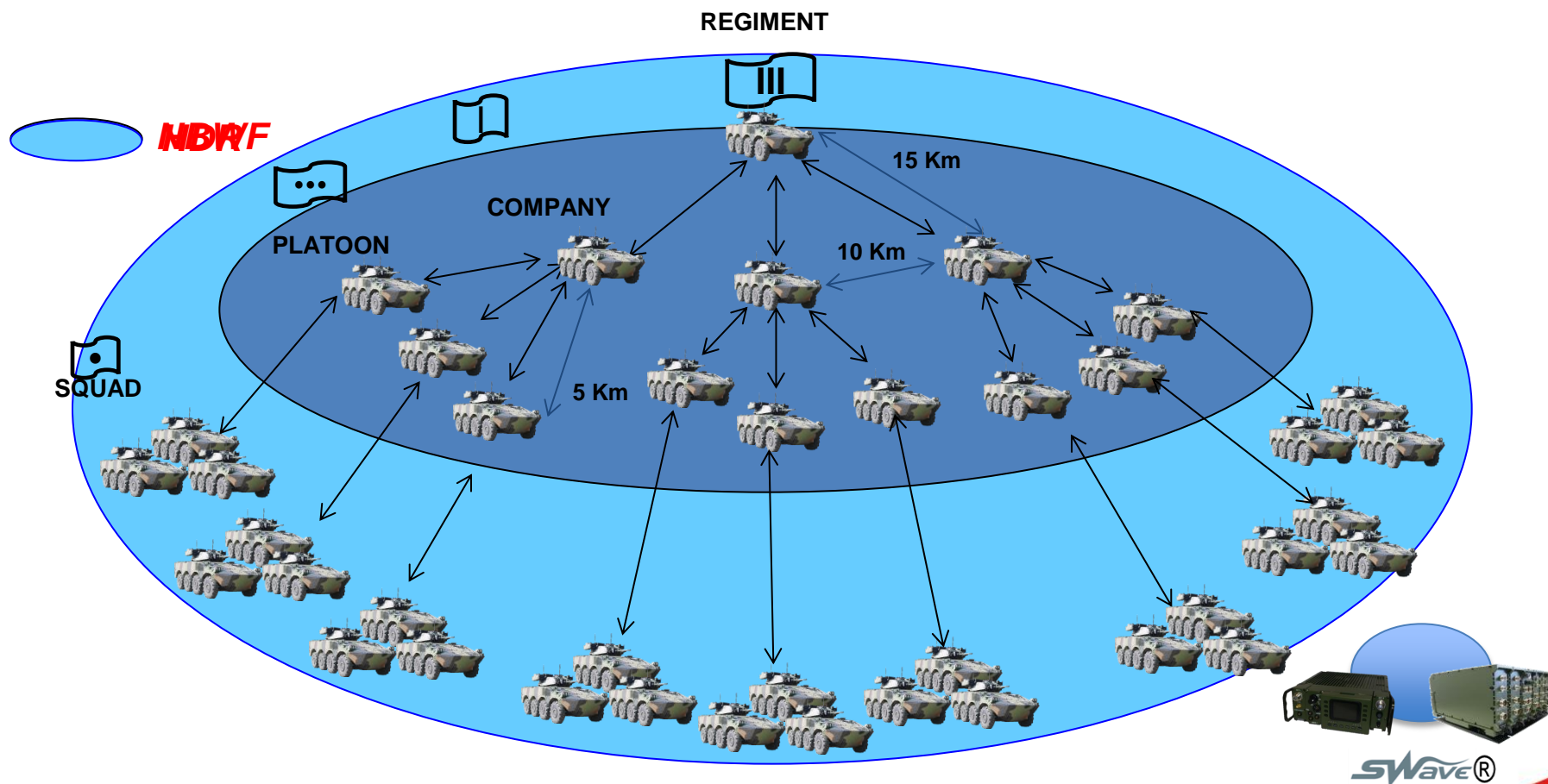
#### TRANSEC

# Operational use cases

## Scenario 4: Land Mobile Backbone Communications - *Solution*

**NBWF** allows for user services, usually conveyed by traditional radios

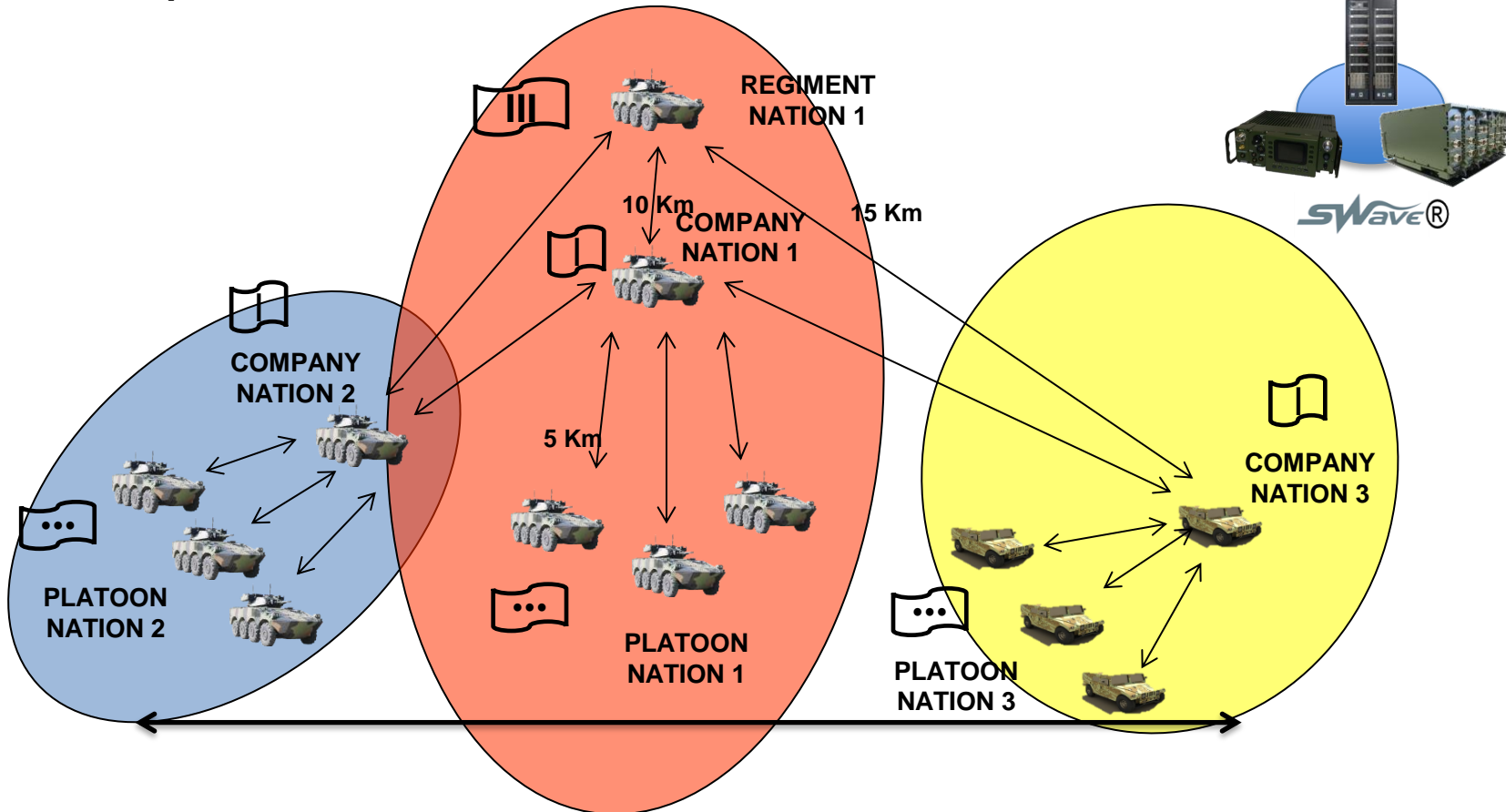
**ESSOR HDR WF** additional capabilities can be used among most of the Backbone





## Scenario 5: Land “Coalition” Backbone Communications - *Description*

### Scenario 4 + Companies Unit from different Nations



Transverse service connectivity is required to Coalition Forces operating in the same theatre

## Scenario 5: Land “Coalition” Backbone Communications - *Solution*

### *ESSOR HDR*

#### Frequency band:

- 225-400 MHz with
- 1.25 MHz CHANNEL bandwidth
- $n \times 1,25$  MHz network bandwidth ( $n=1, \dots, 8$ )

#### Typical network composed by 80 nodes

Up to 200 nodes

Up to 1 Mbps user data

#### Network:

- Self-organizing, Self-healing, Multi-hop
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- External network interoperability

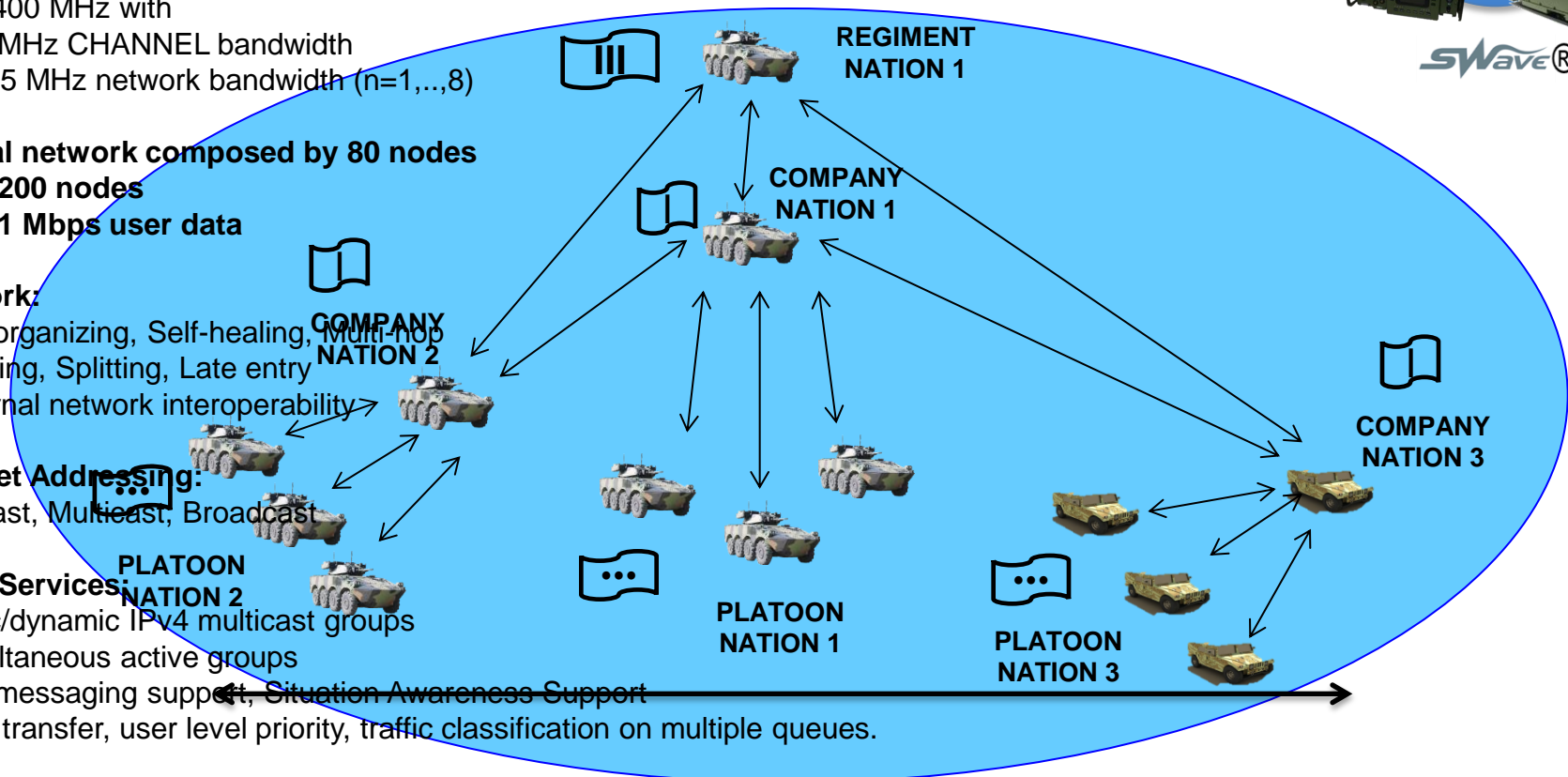
#### Intranet Addressing:

- Unicast, Multicast, Broadcast

#### DATA Services:

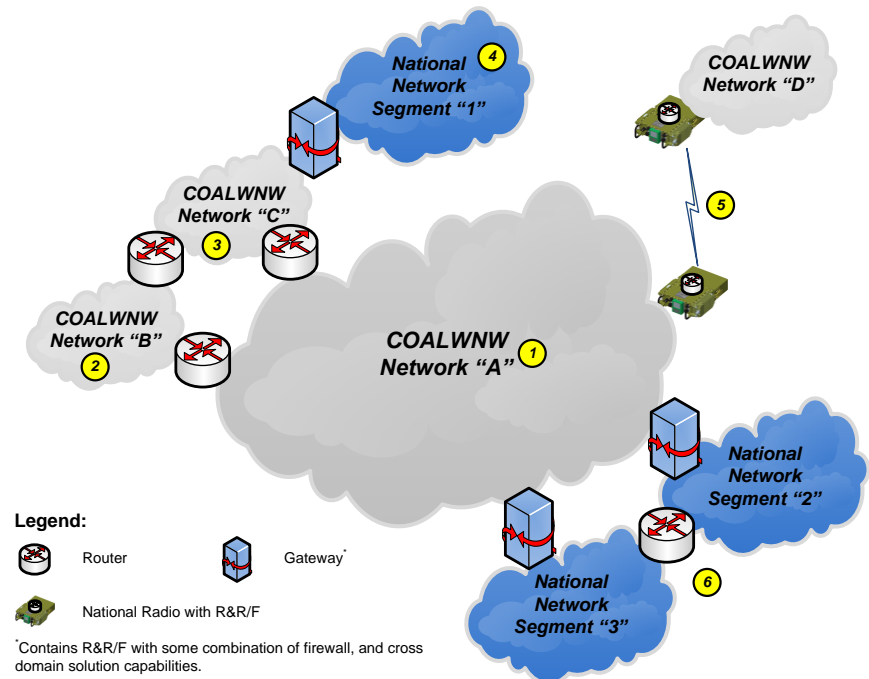
- static/dynamic IPv4 multicast groups
- Simultaneous active groups
- Text messaging support, Situation Awareness Support
- Data transfer, user level priority, traffic classification on multiple queues.

**COMSEC encryption**  
**TRANSEC**



## Scenario 5: Land “Coalition” Backbone Communications – *Future perspectives*

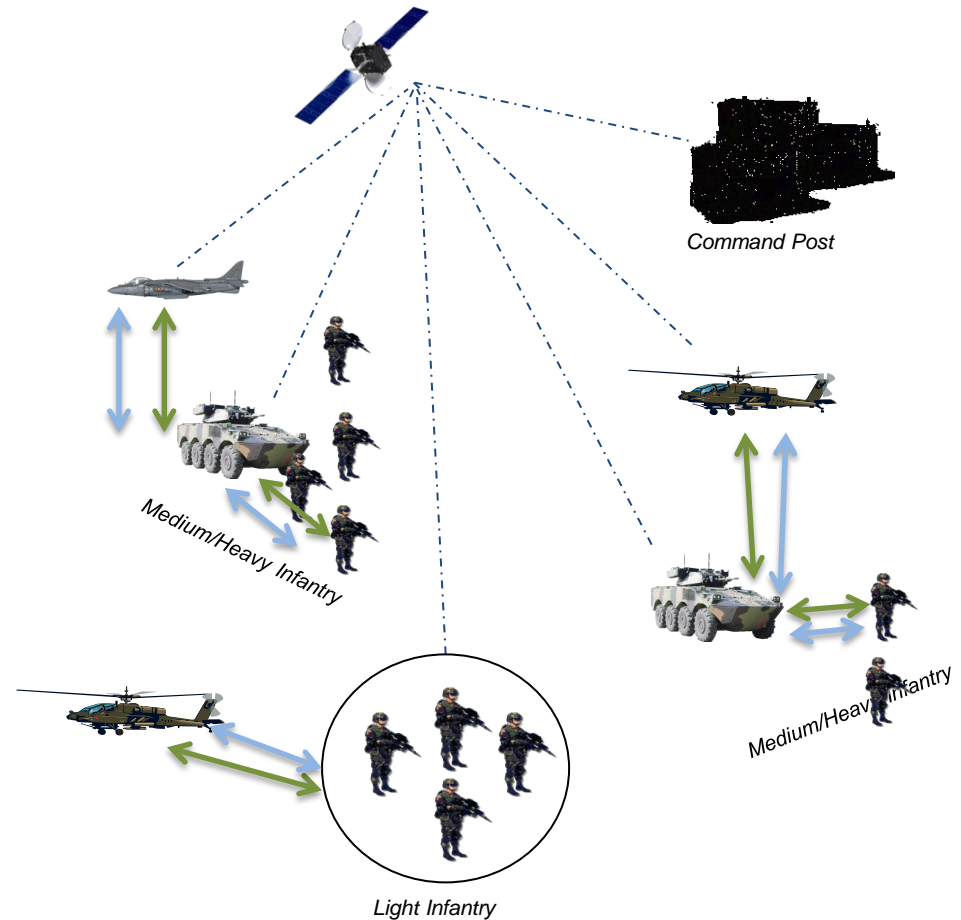
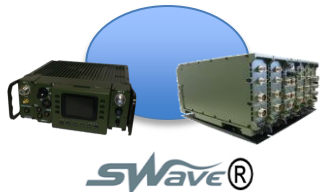
- **COALWNW** is a coalition between participant nations aiming to identify a solution for secure communication in tactical operation with **SDR networking WF**
- **COALWNW** will address Joint/Combined scenarios
- **COALWNW** will provide tactical networking capabilities amongst coalition entities
  - Fixed Center
  - Mobile Center
  - Mobile Platform
- **And will enable**
  - Coalition Net-Centric Operations
  - Joint and Combined Maneuvers
  - Effective Engagement
  - Expeditionary Operations
  - Enhanced CIMIC (Civil Military Communications)
  - Integrated Logistics
  - NNEC (NATO Network Enabled Capability)
- **NATO Narrow Band WF**, enabling long range transmission employing the VHF 25 kHz channelization is currently defined at NATO within the NATO Line of Sight Communications Capability Team.
  - The NBWF will be mainly used in Combat Net Radios (CNR) for interoperability on the lower command levels. Currently there is no secure and networking capable CNR waveform available as a NATO Standard, since legacy versions of the NBWF are available as national waveforms only.
- **COALWNW WF and NATO NBWF are a target for supporting scenario 5 - Coalition Backbone Communications**



# Operational use cases

## Scenario 6: **SAT Assisted Land & Airborne (BLOS)** – *Description*

- Typical **Integrated Land & Airborne** Battlefield scenario
  - Land units may be Light or Armored Vehicles
  - Infantry may be either light or Medium/Heavy
  - Helos/fighters airplane in CAS
  - Command Post
  - Secure Communications
  - Voice and Data are required
  - Real Time/Time Critical/ Offline Communications



# Operational use cases

## Scenario 6: SAT Assisted Land & Airborne (LOS) - **Solutions**

### **SINGARS**

#### Frequency band:

- 30-88 MHz
- 25 KHz bandwidth

#### G-A-G interoperability

#### National/Joint Coalition

#### Intranet (according to MIL-STD 188-220C)

#### Addressing

- Unicast, Multicast, Broadcast

#### Relaying node

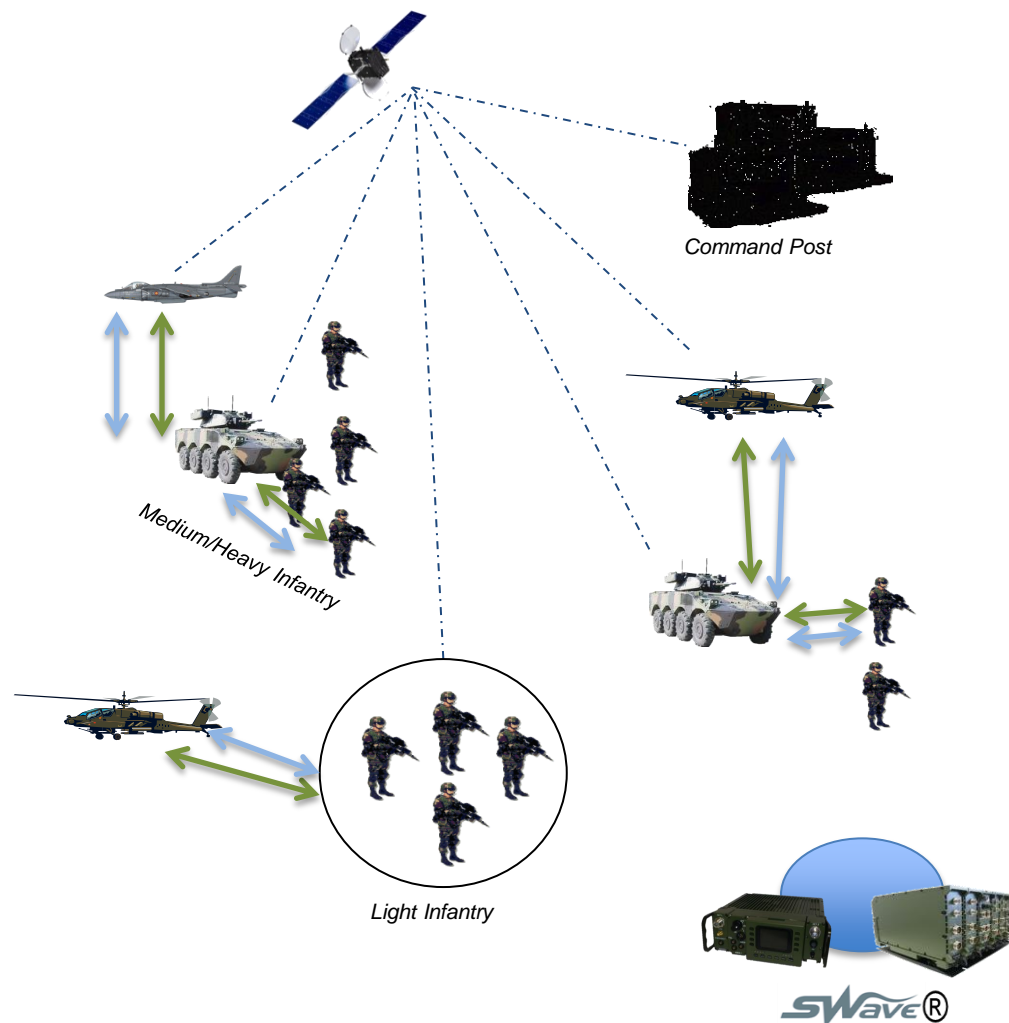
#### VOICE & DATA Services:

- digital voice CVSD at 16 Kbps
- VOICE priority over DATA
- Digital Data rate: 600 bps, 1.2, 2.4, 4.8 ,16 Kbps

#### COMSEC (up to S)

dedicated ciphering algorithm.

#### ECCM FH protection



# Operational use cases

## Scenario 6: SAT Assisted Land & Airborne (LOS) - *Solutions*

 *HaveQuick I/II*

### Frequency band:

- 225-400 MHz
- 25 KHz bandwidth

### AM modulation

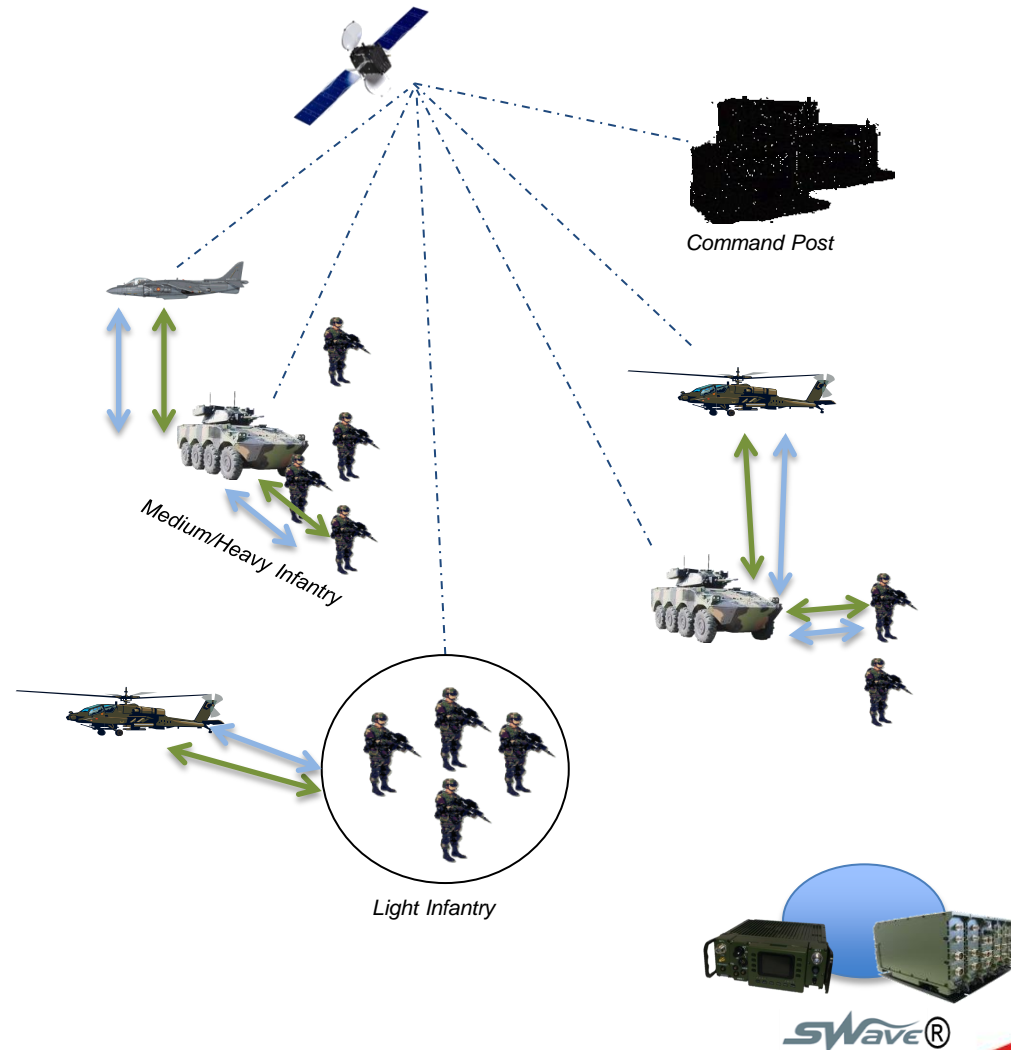
G-A-G interoperability  
National/Joint Coalition

### VOICE Services:

- Voice conferences
- Management of channel contention between two contemporary communications.

COMSEC (up to NATO S)

ECCM protection FH



**SWave®**



# Operational use cases

## Scenario 6: SAT Assisted Land & Airborne (LOS) - *Solutions*

**TACSAT**  
*Dama and/or Dedicated*

**Channel bandwidth:**

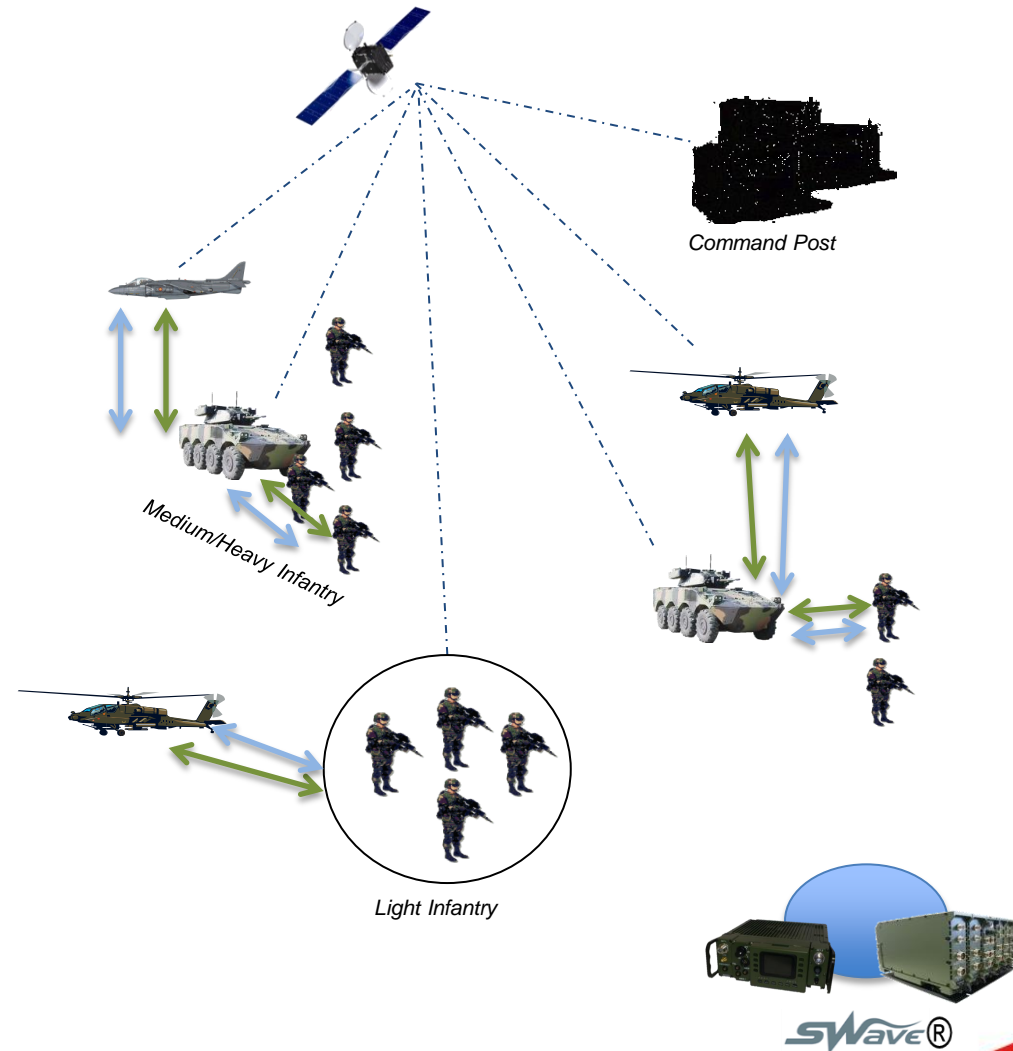
- 5 KHz NB
- 25 KHz WB

**Point-to-Point & Point-to-Multipoint communications**

**VOICE & DATA Services**

**Communications amongst nodes assured inside satellite footprint**

**COMSEC (up to NATO S)**



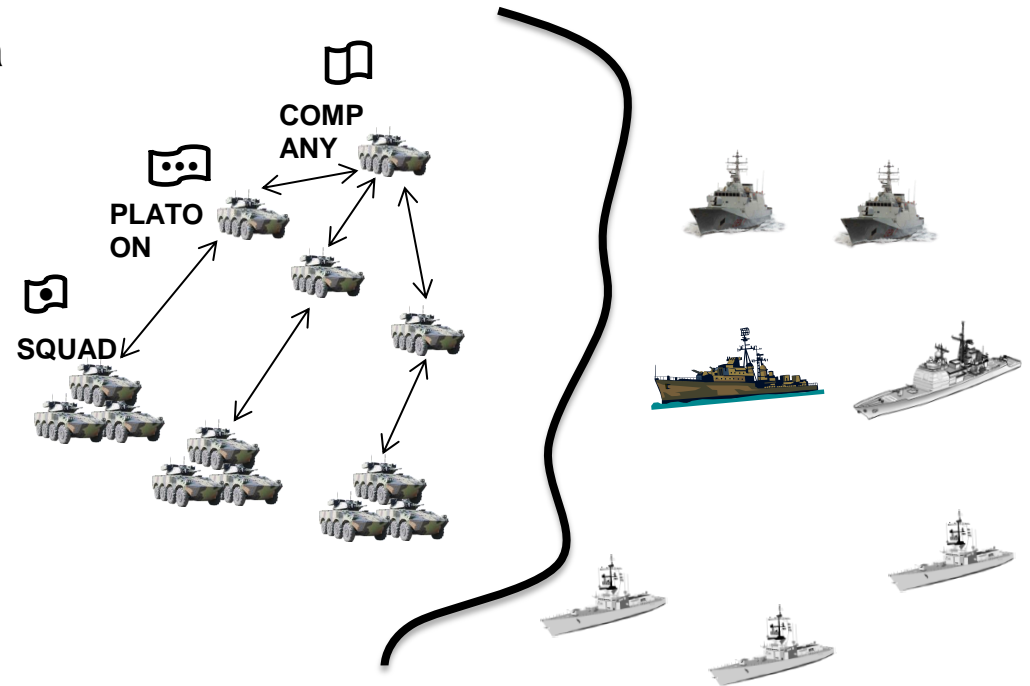
# Operational use cases

## Scenario 7: (Long Distance) Land & Maritime - *Description*

- *Scenario 4* or *Scenario 5* or *Scenario 6* in Land domain plus Naval Units (e.g. landing, sailing in open sea) in Maritime domain
- Maritime and Land units need to coordinate themselves in operations
- IP services are needed, voice and data
- Long distance communications
- Automation of the HF Communications



**SWave®**



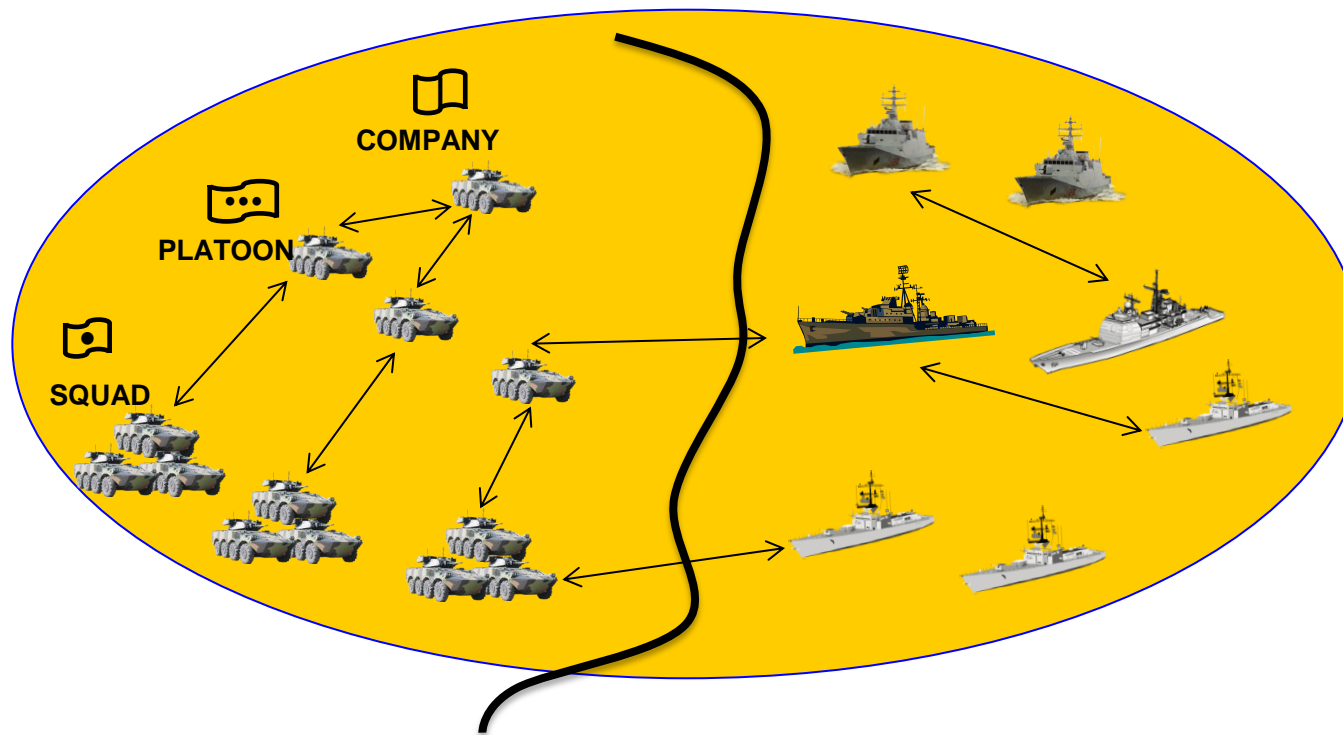
# Operational use cases

## Scenario 7: (Long Distance) Land & Maritime - *Solution*

### **SUITE HF WFs**

- MIL STD 188-110 B
- Mil-Std 188-141B (SSB/ISB Voice and Data AM Voice)
- Stanag 4538 (ALE 3G e ALE 2G)
- Stanag 5066

### **WB HF WF**



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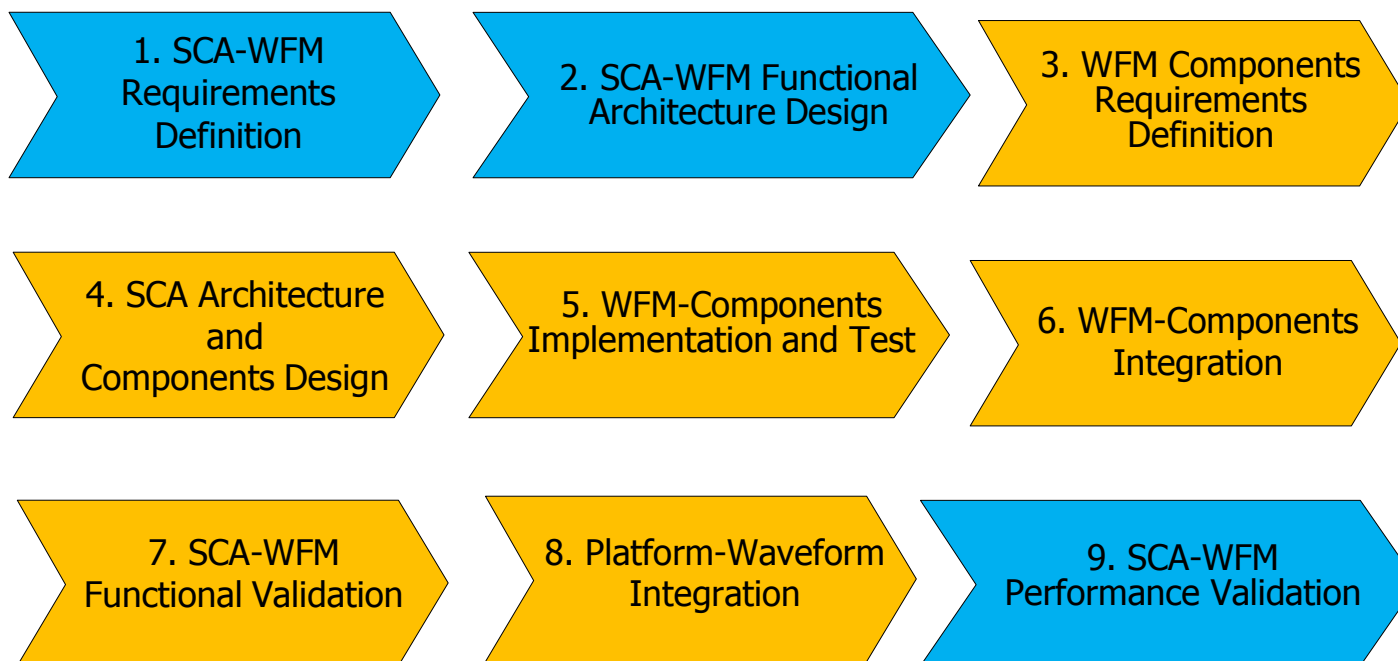
## **Conclusions**





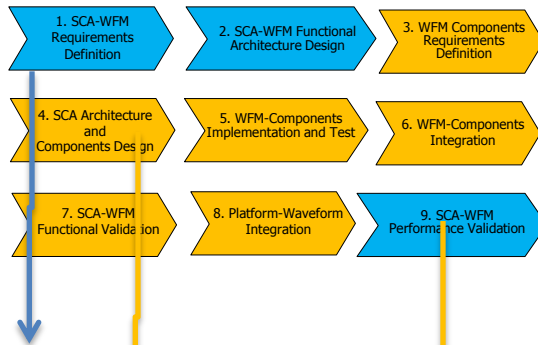
# A Software Factory for developing National Waveforms

- Development and Porting principles
- Waveforms Development /Porting WorkFlow



The unified common design/implementation and testing process allows to develop a SCA Waveform ready to run on any SDR Swave<sup>®</sup> family radio.

# A Software Factory for developing Waveforms



- Selex Es is willing to support the porting of customer's Waveforms on its "Swave<sup>®</sup> Platforms, in any phase of the WorkFlow

WF Requirements Definition (functional req. and performance criteria)

- *From the early stage phase in new or never ported Legacy WFs* -

SCA Architecture and Components Design

(Design of WF Architecture in terms of SCA Components (CF::Resource) provided with ports according to APIs prescribed in CF, RS and RD)

- *For already existing WFs requirements* -

SCA WF Components Integration (Validation of deployed WF components in terms of OE/RS/RD and mutual APIs interconnection)

- *For porting of SCA WFs deployed in other platforms* -



# A Software Factory for developing Customer Waveforms

## Waveforms Development Kit

A workbench may be setup at customer premises, for being used by Sw Engineers. It is composed by:

### SW : SCA Framework

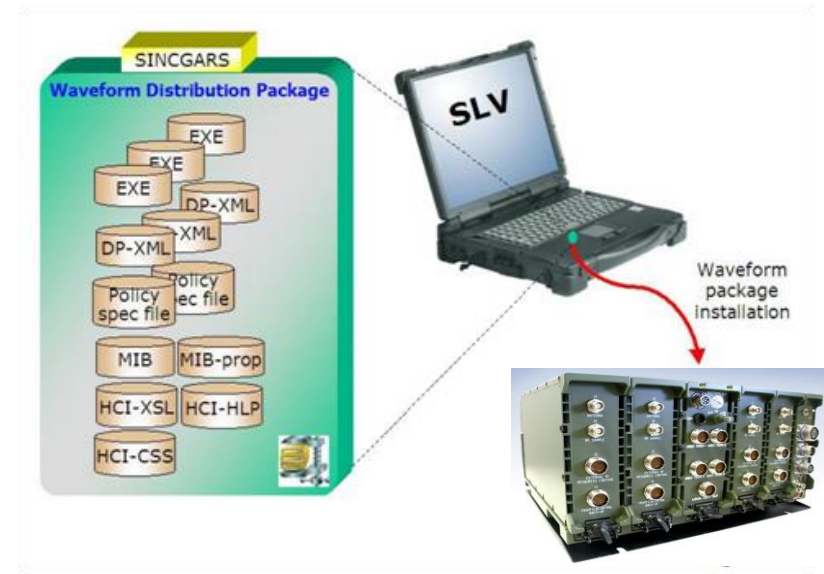
- SCA Core Framework
- Real Time ORB and basic CORBA services (Naming, Event, Log)
- Real Time Operating System
- AEP POSIX standard APIs (DSP)
- PLT specific Transport Library (PE-to-PE\*)

### SW/FW Development Tool

- SCA Modelling
- OS & Development environment
- DSP Development environment
- FPGA (Xilinx & Altera latest tools)

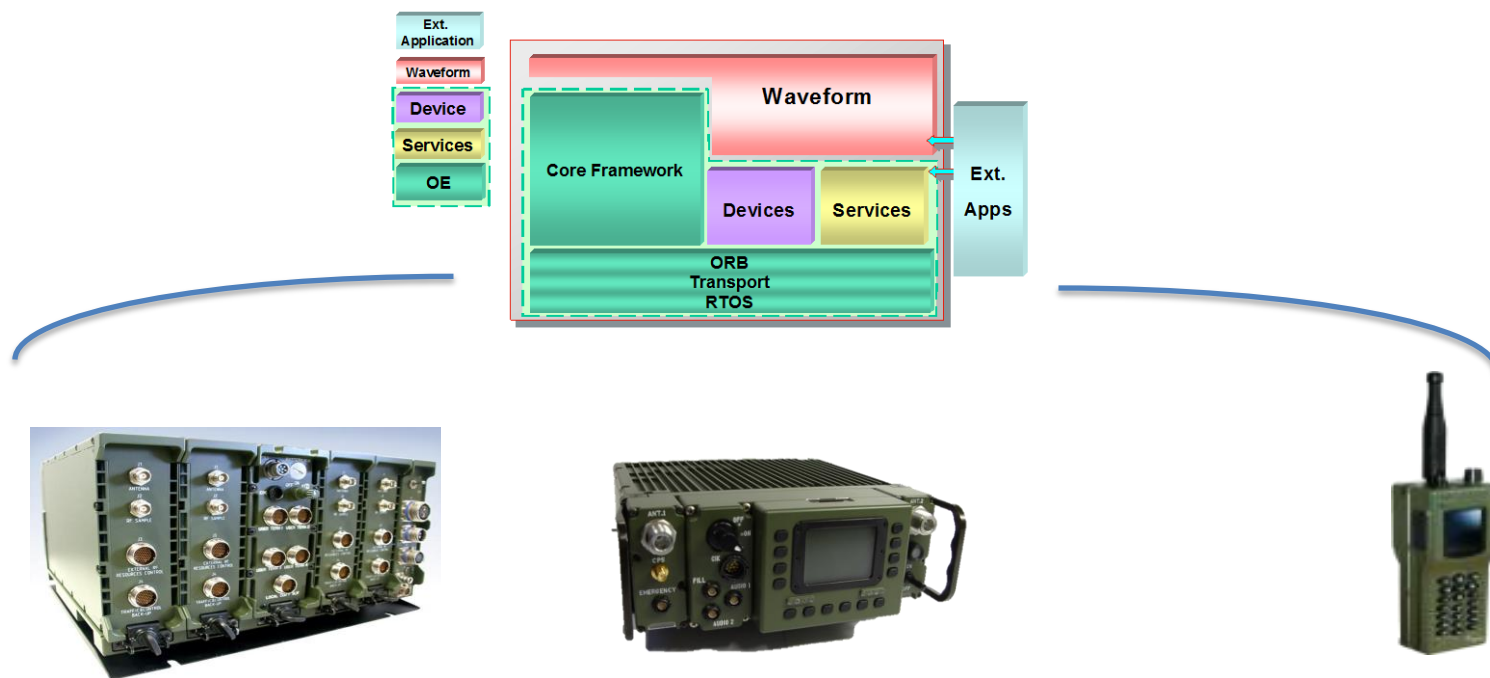
### HW

- WF Development/Porting platform (with Tracing/Log library and debug/probe ports), based on target.



# SCA Core Framework vs WF Software Factory

- SCA Core Framework provided a mechanism and interfaces for deploying (Waveforms and Applications on top of the Swave platforms), mainly composed by
  - Development and Porting Principles
  - SCA Framework
  - Complete set of APIs used for customization needs



- The Waveform development Factory is successfully used by Selex ES and it complies with the customer requirements of the Italian programs.



# Selex ES approach to SDR International Markets

## Conclusions

Achieving rapid and cost effective **portability** is a 'must' for the near future success of the SDR business

This challenge involves providing facilities for porting customer's waveforms onboard: the international battlefield is **plenty of dedicated/national legacy radios**

The availability of the **WFs Software Factory** is a concrete opportunity to achieve this goal, when relying on a wide expertise and products

Selex ES Software Factory takes advantage of the available portfolio of Swave® family and is proved by the long series of successful waveform porting experiences.



THANK YOU FOR YOUR ATTENTION

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