SDR Open Architecture
- A European Defence Perspective

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Outline

- ➢ Political background
- ➢ Current European Defence Market
- ➢ Operational Requirements
- ➢ Open System Architecture
- ➢ Reconfigurable Radio Systems and Networks
- ➢ Evolution of the European Market
- ➢ Conclusions

Political Background

➢ Recent events in the Gulf, Bosnia, Kosovo, East Timor, Sierra Leone confirm military need for tri-service, multinational interoperability to embrace:

- *Rapid Reaction Force - a UK tri-service initiative*
- *European Rapid Reaction Force - a European Community initiative*
- *NATO - interoperability through standardisation*
- *US/UK - "Special Relationship"*
- *Information Exchange with "Forces Other than War" (e.g. Red Cross)*

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European Interoperability - Vision

European Rapid Reaction Force: key figures

- *13 Nations*
- *10 Languages*
- *>30 Services*
- *Single Command*
- *Security Levels*
- *STANAGs ?*

Current European Market

➢ Industry delivers turn-key validated telecom products and systems

➢ In contrast to US (JTRS), no major procurement projects mandate (or recommend) SDR with in service dates out to 2006

    ■Current SDR R&D programmes are national or bi-national

    ■There is no Euro-JTRS

➢ Legacy Waveforms are mainly developed on a national base:

    ■ No established GFE catalogue of waveforms

    ■ Many waveforms - IPR issues

➢ National Security aspect is a major issue:

    ■ Various national crypto and levels of security

    ■ Linked intimately with waveform definition

➢ Current Interoperability loosely based on STANAGs

    ■ But implementation is under Industry responsibility

➢ Greater pressure on business case within European defence industry than in US.

European Defence Agencies

- ➢ **UK MoD**
  - ■ Joint, combined and coalition operations require C4I by LOS and BLOS transmissions
  - ■ Not seeking to to define radio architecture but encouraging waveform portability
    - ● Requires architecture to enable MoD to download its own waveforms
    - ● COTS waveform capture tool-set to enable software portability in an open environment
  - ■ Internal studies in progress with CESG to review INFOSEC:
    - ● Common - humanitarian exercises
    - ● Coalition forces
    - ● National requirements for National traffic
  - ■ Procuring SDR within Type 45 Destroyer Programme

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# European Defence Agencies

- ➢ **France DGA**
  - ■ SDR will replace all H/V/UHF radios by 2010 and contribute significantly to battlespace digitisation
  - ■ Requirement for Information Interoperability
    - ● Data exchanged between systems (Carthage & PR4G by 2008)
    - ● Interoperability between media
    - ● Systematic renewal programme 2010.
  - ■ Interoperability between command structures
    - ● France wishes to be capable of adopting Command role in Coalition Force
  - ■ Impediment is current autonomous procurement programmes
  - ■ Industry's exploitation of COTS and IP technologies to produce COTS systems is a rallying point

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Current European SDR R&D Programmes

➢ **UK (2000 - 2003)**

  ■ Waveform Description Language (WDL) initiative perceived as COTS waveform capture tool-set. Phase 1 complete 2000.
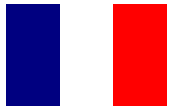
➢ **F (2000 - 2003)**

  ■ Joint funding of Multiband Multirole Radio (MMR_ADM) programme - Focus on radio functionalities

➢ **Ge (2000 - 2003)**

  ■ Joint funding of (MMR_ADM) programme

For more information, refer to:
SDR Forum Meeting September 2000, Paris - France
WDL Workshop, November 2000, Rome N.Y. - USA

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Operational Requirement

- ➢ **Tri Services Interoperability**: Air, Naval, Ground
- ➢ **Network Centric Operations**
  - ■ Networking of information between disparate systems
- ➢**Enhanced Services**
  - ■ Multimedia applications: Voice, Data, Image
  - ■ Situation awareness
  - ■ Positional awareness
  - ■ Precision targeting
  - ■ Increase of data rate
  - ■ Rapid tasking of assets
- ➢ **Future-proofing**
  - ■ Expandability

Security - INFOSEC

- **Interoperability Levels** : National, NATO, Coalition
- **European initiatives**:
  - QACISIG - Quadra-National (US, UK, F, D) Communications INFOSEC Interest Group
    - Common Waveforms for Interoperability
  - BATON - A NATO Common INFOSEC Algorithm
  - PIM - A UK Programmable INFOSEC Module enabling the reconfiguration of an INFOSEC algorithm
  - "de facto" Standards
    - Tactical comms: KG84 (US and NATO), BID1650 (UK)
    - Shore to Ship: KWR46 (NATO - NACISA)

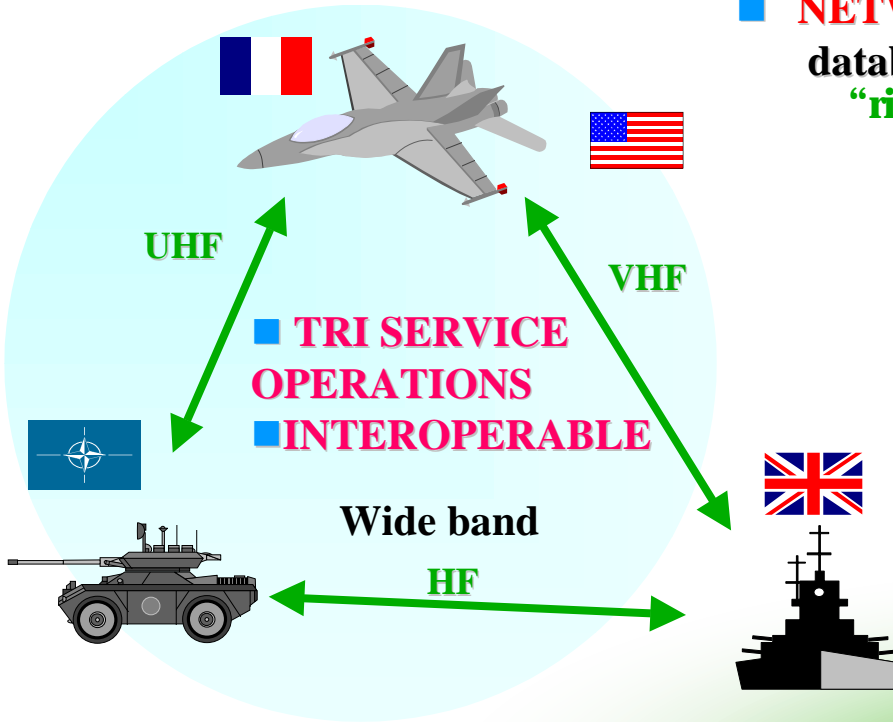*Current Policy would preclude running different levels of security on the same hardware*
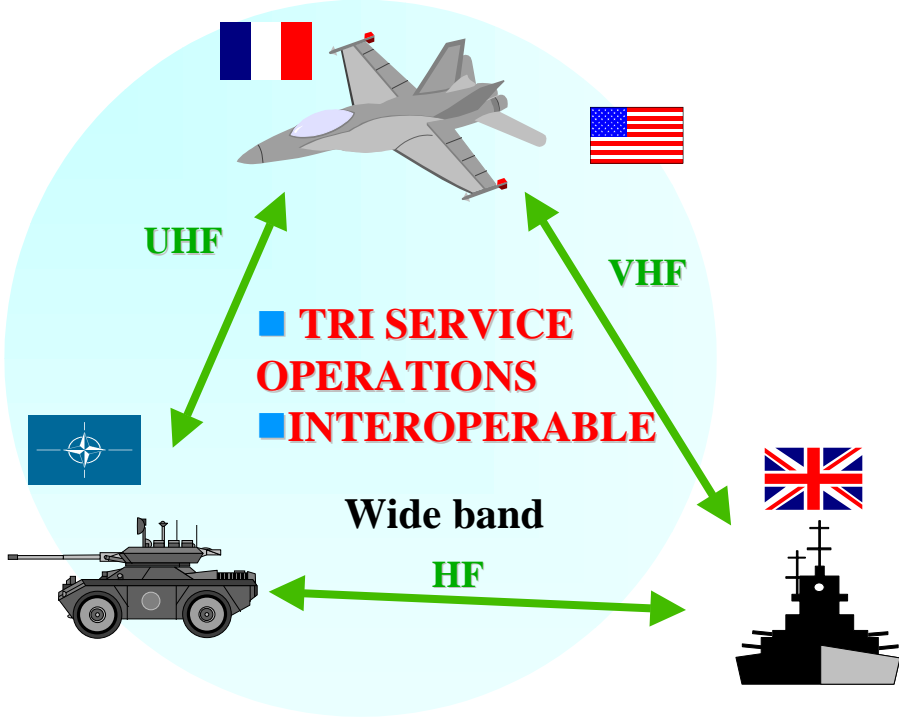
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Battlespace Major Changes to 2010

UHF

VHF

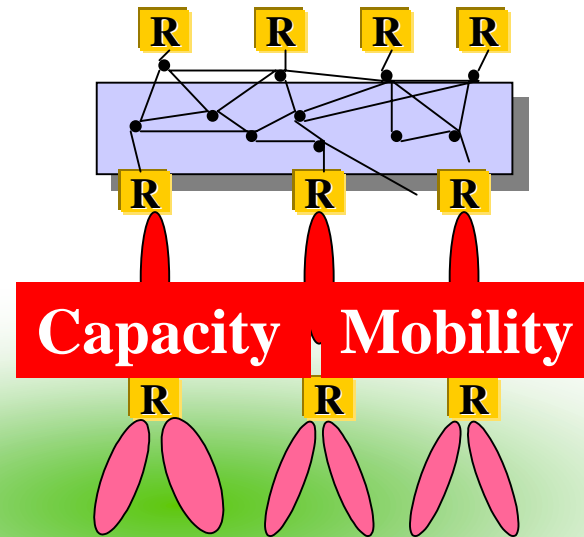■ **TRI SERVICE OPERATIONS**

■**INTEROPERABLE**

Wide band

HF

Battlespace Major Changes to 2010

■ **NETWORK CENTRIC OPERATIONS**
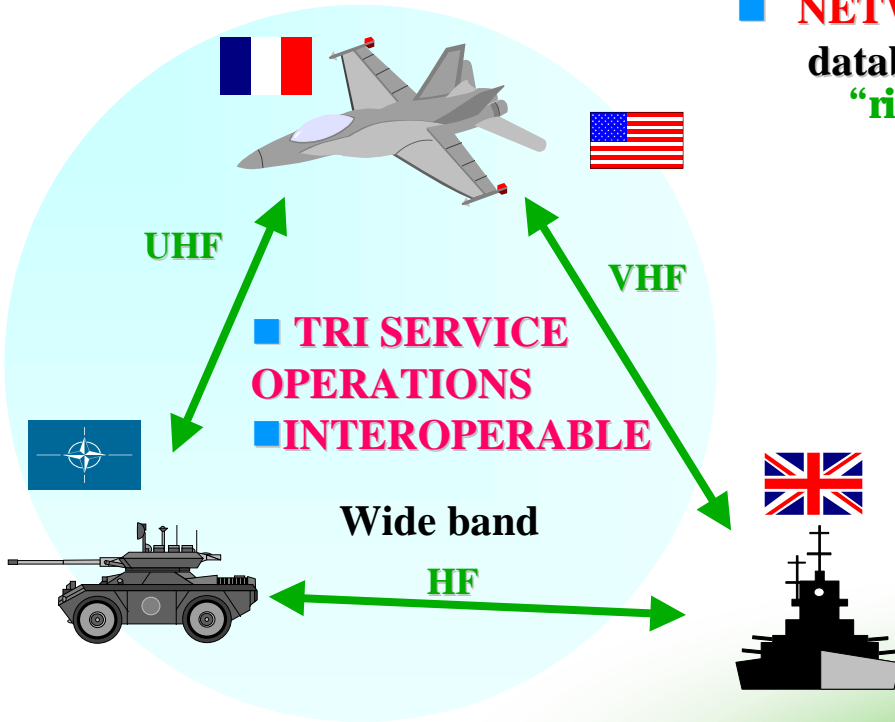**database access - situation awareness -**
"right data to the right place"

UHF

VHF

■ **TRI SERVICE OPERATIONS**
■**INTEROPERABLE**

Wide band

HF

IP Tactical Net

R R R R

R R R

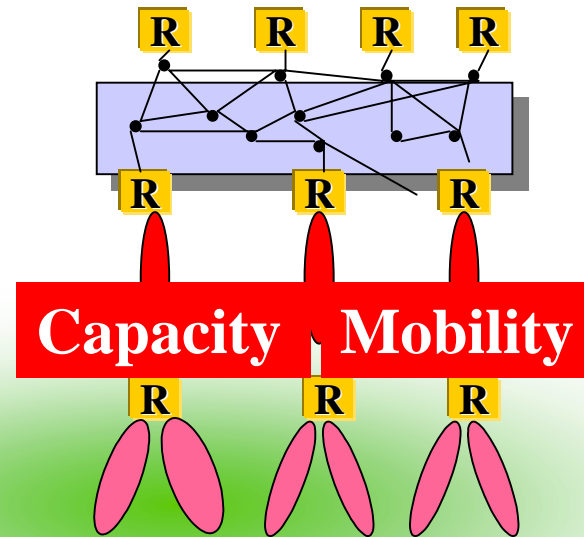**Capacity   Mobility**

R R R

HIGH DATA RATE

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Battlespace Major Changes to 2010

■ **NETWORK CENTRIC OPERATIONS**

**database access - situation awareness - "right data to the right place"**

UHF

VHF

■ **TRI SERVICE OPERATIONS**
■ **INTEROPERABLE**

Wide band

HF

IP Tactical Net

R R R R

R R R

Capacity   Mobility

R R R

HIGH DATA RATE

■ **OPERATIONS OTHER THAN WAR - CIVIL TECHNOLOGY - Private Mobile Radio, Bluetooth etc.**

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Bandwidth Requirement

➢ **For Military SDR, focus on HF-VHF-UHF bandwidths supported services (1.5 MHz - 600 MHz)**
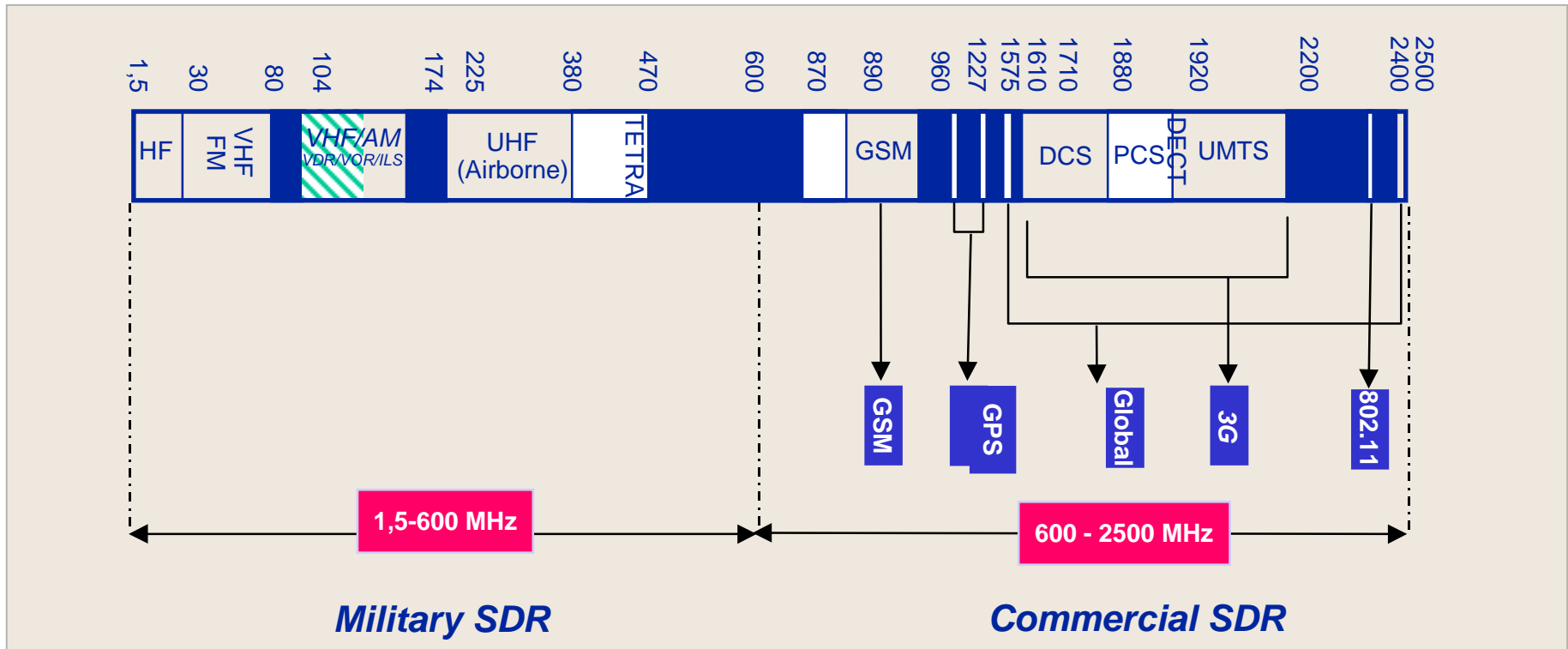
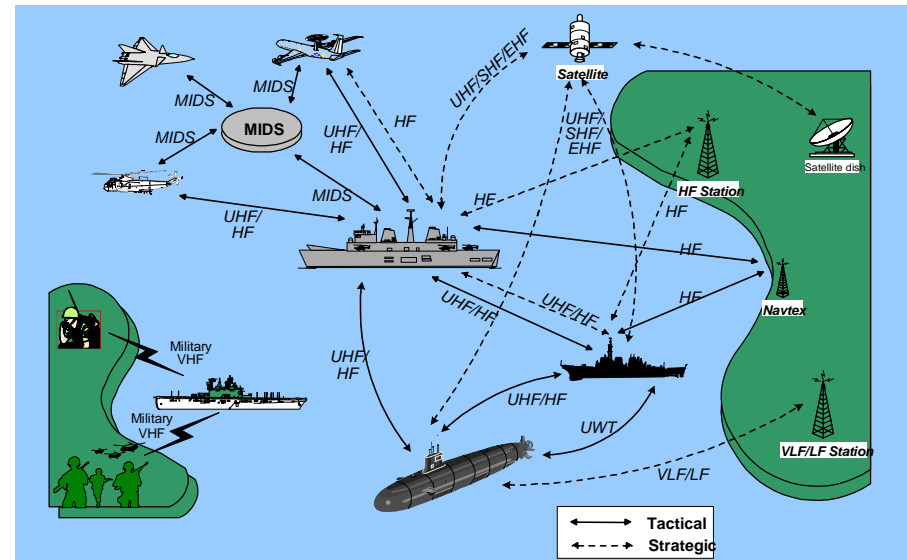# Vision 2010 - Future Naval ICS

- *Interoperability*
  - Email - band independent
  - Internet - terrestrial to complement Satcom
  - Large file transfer
  - Videoconferencing
  - Co-operative Engagement
- *Expanding Services*
  - New HF/UHF Waveforms
  - HDR LOS Comms
- *Incremental acquisition*
  - Provide expansion capability
  - Software radio for ease of implementation
  - NATO STANAGs

Vision 2010 - Future Digital Battlefield

➢ *Interoperability*
  - Between CNRs
  - Between Multi-national Nets
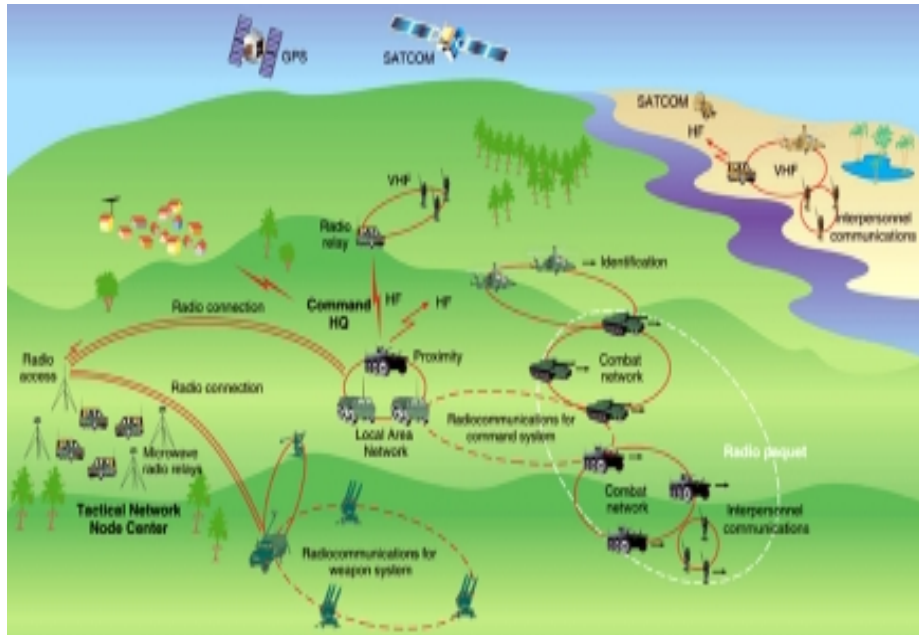
➢ *Expanding Services*
  - New HF/UHF Waveforms
  - Tactical Internet
  - Full Mobility - Networks on the move

➢ *Incremental acquisition*
  - Take into account legacy CNR base
  - Rigorous waveform capture process

➢ *Cooperative Engagement,Network Centric Warfare*
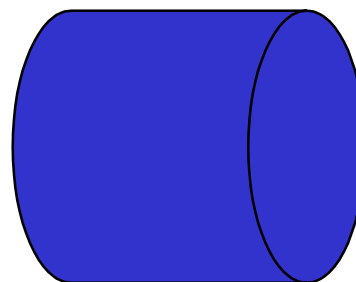
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Vision 2010 - Wideband Systems

➤ *Expanding Services*
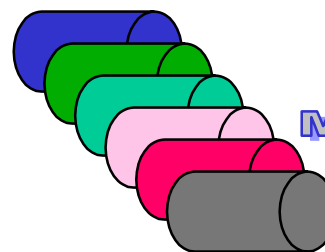 - Networks (LAN/WAN) Architecture
  - Supporting Multimedia Services
    - Voice, Data, Image
    - Internet

➤ *Evolving Technologies*
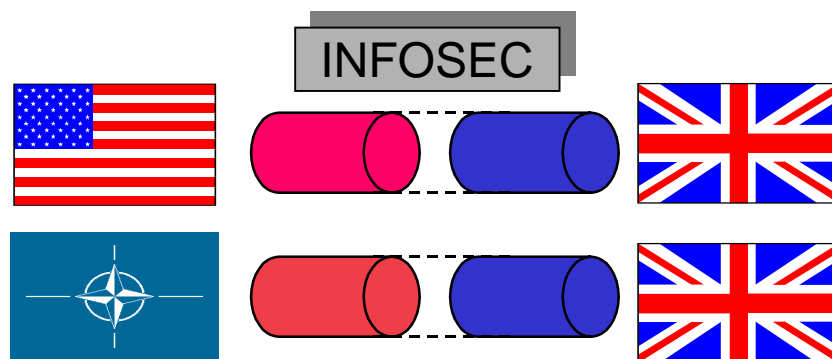 - Multi Band / Multi Channels Radios
  - Higher Data rate
  - Automation (Reduced Manning)
  - Dynamic Line Allocation

➤ *Infosec Interoperability*
  - COMSEC / TRANSEC

Higher Data Rate

MULTI BAND
MULTI CHANNEL
HF/VHF/UHF

INFOSEC

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System Requirement

> *In Summary:*

- Services, new and old, are required to be delivered any time, any place, any band, any mode
- Requires end to end seamless military communications with interconnected tri-service, multi-national networks
  - Security integrity
  - Survivability
  - Complex cosite environment with increased data rates
  - Global Networks Open Architecture based on Standards

Open System Architecture

➢ *An Open System Architecture is*:

  ■ "A system in which the physical modularity and functional partitioning is aligned to facilitate the replacement of specific sub-systems and components without impacting others."

➢ *Is interpreted as:*

  ■ A solution to interoperability

  ■ Providing cost-competitive, multiple-sourced, COTS technology for military applications

  ■ A software only solution to future-proofing

  ■ Promoting competition, technology insertion, quick upgrades, software reuse, extendibility, and scalability

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Open System Architecture

➢ *It is an evolving concept:*

- From SDR initial concept:
  - Ease of introduction and future upgrades of waveforms

- to the enlarged (Inter-) Networking vision:
  - Adaptable and Reconfigurable Networks
    - Dynamic interaction between radio, networking and application support layers in secure modes

- Ease introduction of New Services and Applications at System and Network levels
  - Transparent Service Provision
  - Application updates / Services enhancements / Personalisation
  - Application level is mandated to become open (IP, Email,…)

Open System Architecture
Migrates Towards
Reconfigurable Radio Systems & Networks

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Architectural Overview

Increasing degrees of openness

Application
Adaptation
Transport
Network
Network Interface
Physical

Application
Middleware/OE
Adaptation
Physical
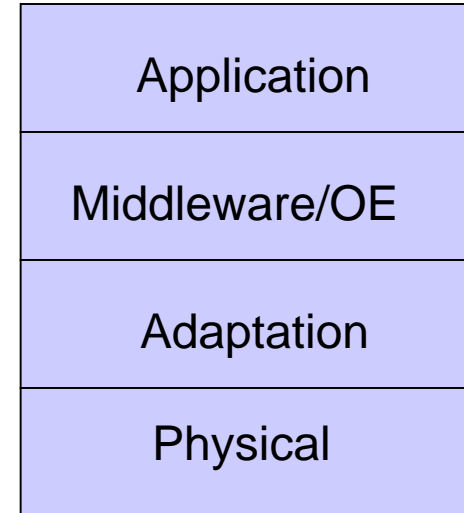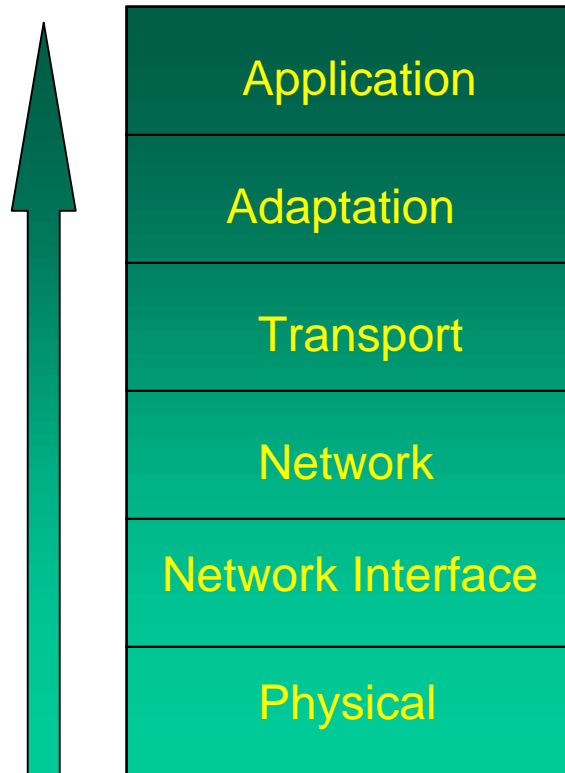
SDR Conceptual Model

Architectural Overview

Increasing degrees of openness

Mandatory →

Desirable →

	Application
	Adaptation
	Transport
	Network
	Network Interface
	Physical

| Application |
| Middleware/OE |
| Adaptation |
| Physical |

SDR Conceptual Model

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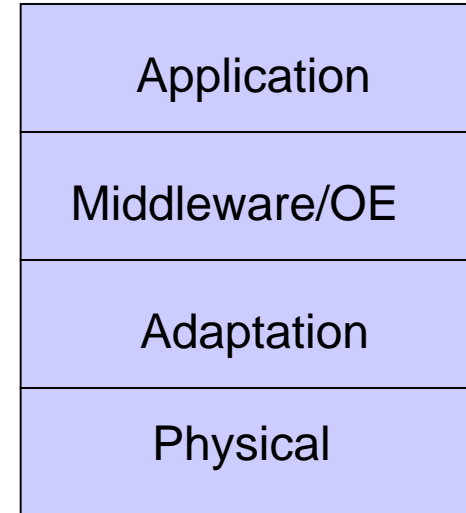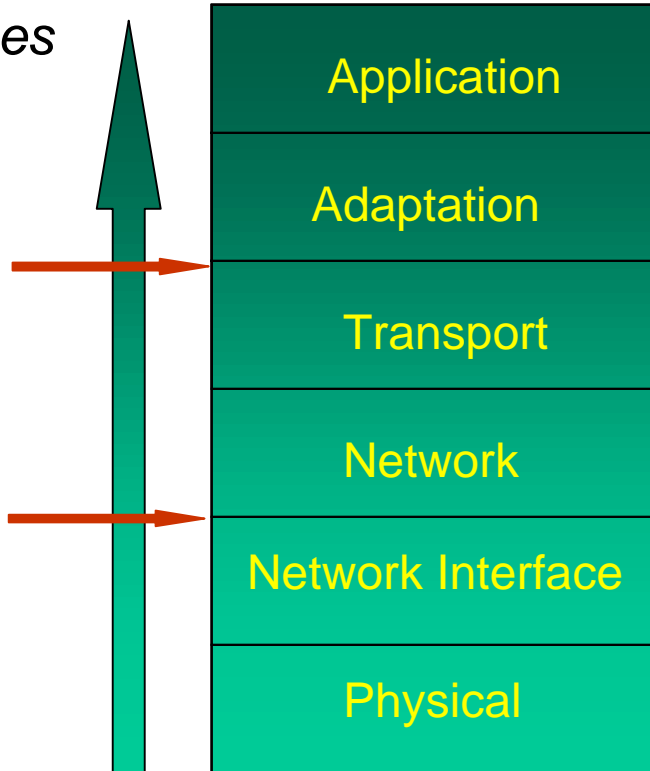
System Integration of the Software Radio

Global Net Mgt & Plans, Directory, Addressing...

MILSATCOM UHF - EHF

TACTICAL IP NETWORKS

CIVIL SATCOM

HDRR

SWR Nodes

Config Nets & Security...

LAS

LOCAL NET

SRN

PROCESS MGT

End to end seamless comms. services

VHF

UHF

HF

**SWR Terminals
Download WF, Freq. Nets, User Profiles...**

CNR

URBAN WARFARE

PMR

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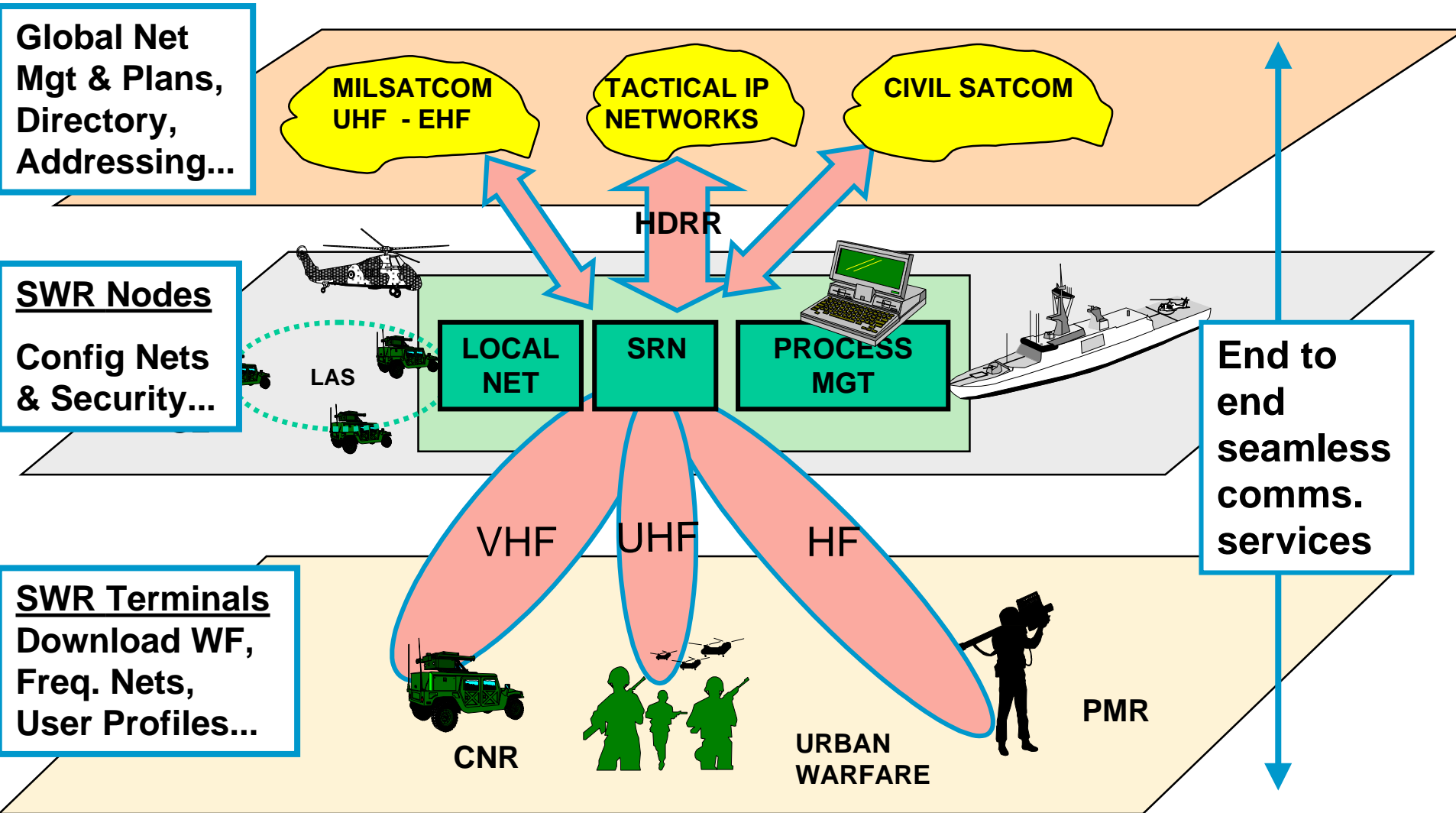
Open System Architecture

NEW ACQUISTION STRATEGY - A NEW BUSINESS MODEL

UPGRADE OF SERVICES & APPLICATIONS

END TO END SEAMLESS INTERCONNECTION

⟵──────────────────────────────────⟶

RECONFIGURABLE NETWORKS

SOFTWARE RADIO ACCESS NODE

SOFTWARE RADIO TERMINALS
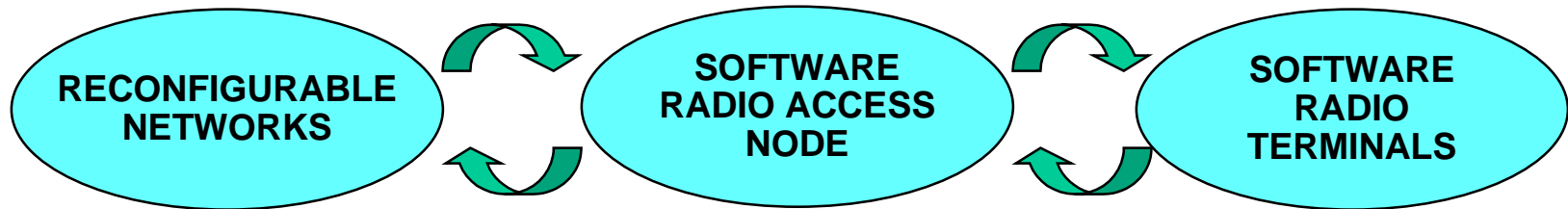
**ENABLING TECHNOLOGIES
(MIDDLEWARE; INTEGRATION (RF, DIGITAL); ANTENNAS,…)**

End to End Seamless Interconnection based on Standards: ISO, STANAG, SDR...

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Reconfigurable Radio Systems & Networks

➢ *Imposes a redefinition of "Reconfigurability"*

- ■ Reconfigurability through Software Download
  - ● Elements of the Networks / Services / Applications
- ■ Reconfigurability cuts across Heterogeneous Networks:
  - ● Wireline (IP, ATM,…); Multiband Wireless: HF, VHF, UHF…
- ■ Reconfigurability takes into account the "Defence Wireless Environment"
  - ● Full Mobile operations with no pre-deployed infrastructure or fixed base stations
  - ● Environment is subject to significant changes: Jamming, link quality (QoS), variable connectivity
  - ● Interoperability
  - ● Security
  - ● Survivability

Reconfigurable Radio Systems & Networks

➢ *Technology issue*

- Multimode / Multiband / Multichannel radio
- Adaptable transmission capability
  - Real time flexible Network Spectrum Manager
  - Dynamic bandwidth allocations
  - Real time flexible Network Management / Network Planning
- Procedures to update functionalities and manage the process:
  - Secure downloading procedures

➢ *Short / Medium / Long term issue*

- Evolution taking into account the legacy infrastructure
- Progressive introduction of new services and applications inside Defence Networks and Radio Systems

➢ *Standards issue*

- ISO, STANAG, SDR...

From Procurement Strategy to Business Model

➢ Competitive market requires that industry delivers turn-key Radio Systems:

- MoD procurement demands Interoperable Radio Systems
- System Integrator has final responsibility in term of functionalities and performances
- System Integrator builds Interoperable Radio Systems with Radio Platforms and Waveforms provided by its subcontractors
- Interoperable Radio Systems definition needs to take into account the various legacy waveforms with their security constraints
- Small independent market for COTS Form, Fit, Function Radio Modules

➢ Interoperability and new services implementation are the basic drivers in term of Standard Open Architecture requirements.

➢ "Smart Acquisition" must recognise change in emphasis of industry's added value for a Business Model to develop.

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Evolution of European Market

➢ *Political*

OCCAR (Organisation for Joint Armaments Co-operation (UK/F/It./D))

- It is OCCAR's mission to become the best multinational defence procurement agency

➢ *System*

Common Definition of an Open Architecture

- NATO STANAGs offer potential of open architecture at waveform level
- Not the panacea e.g. many different implementations of SATURN waveform
- Unique Waveform Description Language may resolve inadequacies

➢ *Product*

SDR Product Validation

- Design Acceptance Process
- Process of Accreditation for Interoperability
- Creation of a Recognised Certification Body

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Design Acceptance Process
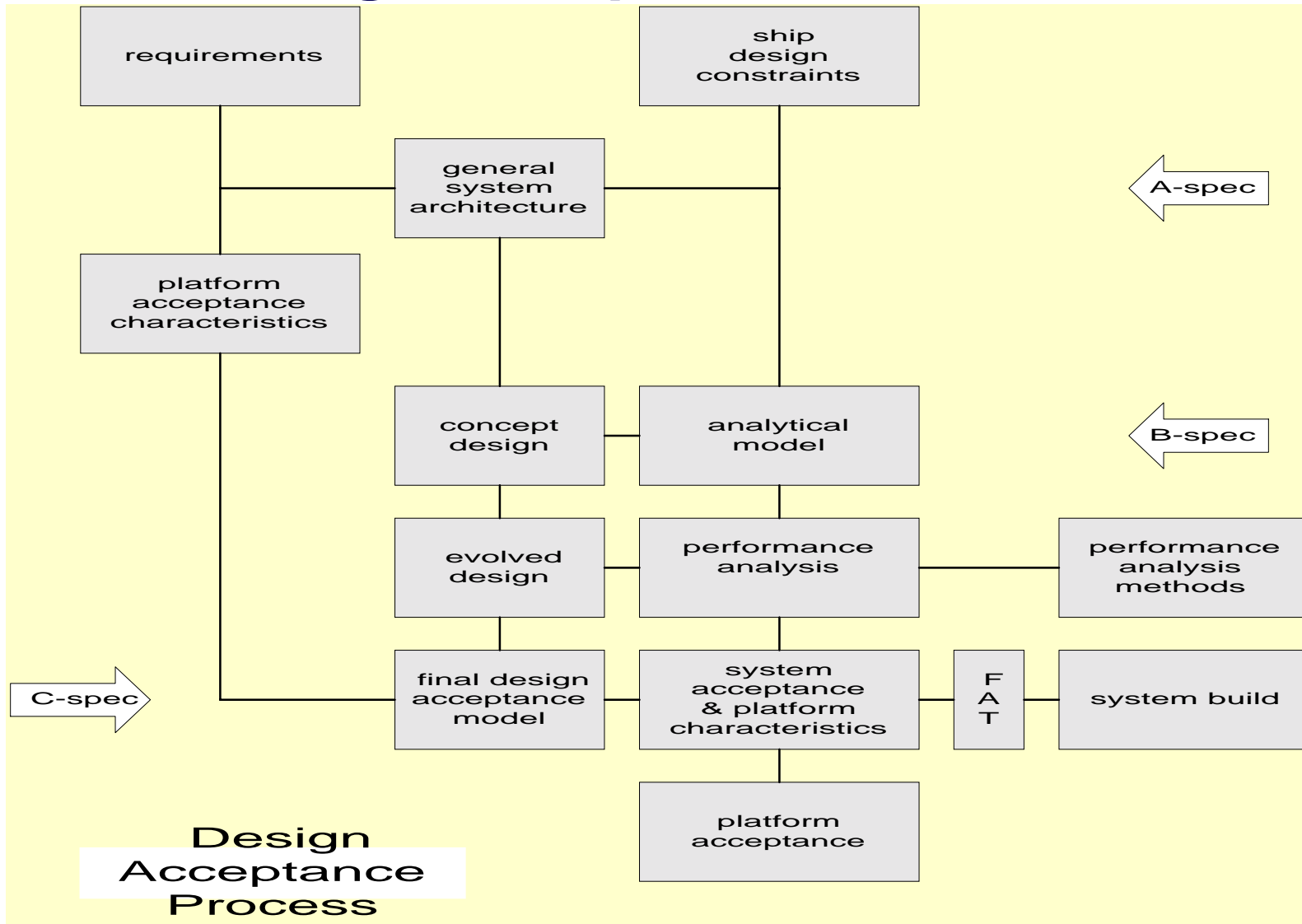
Joint Interoperabilty Certification Components

Joint Interoperabilty testing should be conducted throughout a systems lifecycle.

Document Interoperability Approval **+** Standards Conformance **+** Joint Interoperability Testing **=** Joint Interoperability Certification
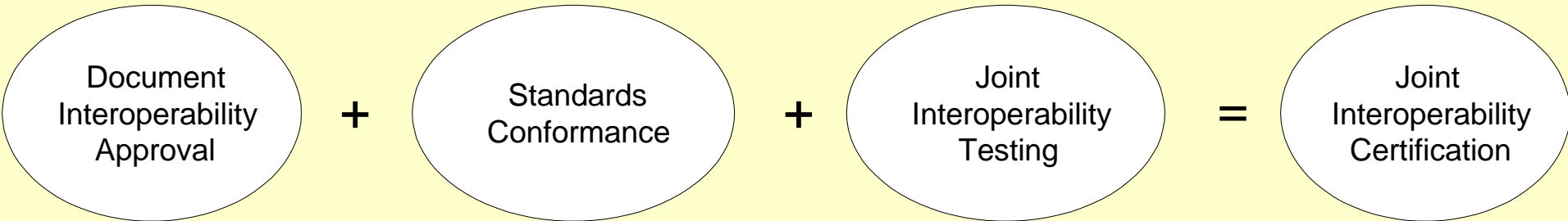
Document Interoperability Approval	Standards Conformance	Joint Interoperability Testing	Joint Interoperability Certification
# Mission Needs Statement (MNS)	# Usually part of system development	# Can be part of an operational test	# JCS/J6 determination that a system meets the requirements for joint and combined use
#Operational Requirements Document	# Products can be tested by the JOTC or developer	# End-to-end when possible	
#Capstone Requirements Document (CRD)	# JTA standards conform once identified in the TEMP	# HW and SW must be identified and stable	
#C4I-SR Support Plans	# DISA/D631 is DISA focal point for TEMP approval	# Realistic test environment	
#Non-Operational Docs.	# DISA-JIEO/JEB is the DISA focal; point for standards profiles	# Adequate to provide level of confidence	
# CONOPS	# Absense of standards conformance testing limits certification scope to interfaces and modes of operation tested	# Data to address joint interoperability issues	
# Advanced Concept Technology Demonstrator		# JITC provides interoperability certification to JCS/J6, DOT&E and test sponsor	
# JCS/J6 Provides Interoperability Approval			
#DISA/D631 is the DISA focal point for comment consolidation			

Evolution of European Market

Does SCA (Software Communication Architecture) meet European Requirements?

➢ Current SCA definition appears to be a realistic framework for pursuing Global Standardisation effort.

➢ But... current SCA definition must be widened to address:

■ Reconfigurability at the various levels: Network, Sub-System, Radio,...

■ Various national Security constraints (Crypto,…)

■ Waveform Description Language

● UK WDL initiative to improve waveform description / implementation / portability

■ All the related standardisation effort: RT_CORBA (OMG),...

➢ But…current SCA definition work must also take into account new emergent technologies

■ JAVA as a complement CORBA,…

➢ And... performances, cost and IPR impacts remain unresolved issues.

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Short / Medium / Long Term Vision

➢ Short Term (2000 - 2003)

■ Policy of incremental acquisition to capitalise on the installed base

■ Advanced R&D programmes to prepare the future

■ Define interoperability needs and security constraints

■ European "Open Architecture & Standard" initiative to be launched between Industry and MoDs based on current SCA definition to address specific outstanding issues

➢ Medium Term (2004 - 2007)

■ Interoperable Software Defined Radio products compliant with "Open Architecture Standard (V1)"

➢ Long Term (2007 - 2010)

■ Reconfigurable Radio Networks compliant with "Open Architecture Standard (V2)"

Conclusions

➢ Turn-key delivery by Industry of affordable Systems and Products will remain the baseline for foreseeable MoDs procurement policy

➢ Interoperability between various national forces is the key driver for the European market
   - ■ Must be addressed at various level: Network, Subsystem, Radio….
   - ■ Will integrate STANAG implementation
   - ■ Influenced by the speed with which Procurement Agencies recognise the requirements and the changing model (e.g. OCCAR)

➢ Will remain a cost driven market
   - ■ **Service provision** versus acquisition cost
   - ■ **Cost of acquisition** versus through life cost

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Conclusions

➢ SDR technologies are a basic enabler to answer to these requirements

➢ Current SCA definition is a realistic framework for pursuing Global Standardisation efforts

➢ European "Standard Open Architecture Initiative" must be launched and promoted under European Industry leadership and MoDs support:
- to address the multi-national security aspects
- to define legacy and new waveform portability
- to define, evaluate and promote the related key technologies

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