ISSN 2239-2122

The transformation of the armed forces: the Forza NEC program

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IAI RESEARCH PAPERS

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Acknowledgements
This research has been carried out with the support of Selex Sistemi Integrati.
We would like to thank the *Stato Maggiore dell'Esercito*, and particularly the *Dipartimento per la Trasformazione Terrestre*, and the *Direzione Armamenti Terrestri* within the *Segretariato Generale della Difesa/Direzione Nazionale Armamenti*, for their information and suggestions.
We would like to tank also Clare Roberts for the English translation's review.

First published 2012 by Edizioni Nuova Cultura

For Istituto Affari Internazionali (IAI)
Via Angelo Brunetti 9 - I-00186 Roma
www.iai.it

ISBN: 9788861348790
Cover: by the author
Graphic Composition: by the author

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Executive Summary

In an ever-changing strategic context, some factors appear to steadily influence the structure and use of military power; the changing nature of scenarios requires the Armed Forces to be effective in both qualitative and quantitative terms, flexible, mobile, modular and deployable, able to respond promptly to a crisis; the strong joint and combined character of international military operations requires high interoperability standards with a wide range of partners; the economic constraints significantly limit defence budgets and dictate choices which are increasingly based on a cost/benefit analysis; technological change, particularly in Information Technology (IT) and force protection fields, means that systems become quickly obsolete, making a constant updating and upgrading process essential.

In particular, IT has been instrumental in connecting civil society, by proving unprecedented speed of communication, ease of information dissemination, and the ability to exchange and share data in various formats, all at a relatively inexpensive cost. This "revolution" has been crucial to many areas of social interaction, and the military is no exception: a real race towards digitization of the army has now been underway for years in several countries. As frequently happens in the military technology field, it was the US that made the first move in this direction, nearly two decades ago, while Great Britain and France have made similar efforts in more recent times. In 2002, at the NATO Summit in Prague, some important steps were taken in this direction; for example, the Allies' commitment to acquire a set of core capabilities, including a Network Enabled Capability (NEC) to implement the transformation progress. Through the "NEC" acronym, NATO planned to combine diverse traditional, procedural, technical, organizational and human elements,

from different organizations, into a single network, with the objective of enabling interaction in order to achieve and maintain significant strategic superiority. This was a less disruptive choice than the one taken in the US, but equally efficient, preferred by NATO and several other countries such as Italy. In recent years the US was forced to partially abandon its initial approach, due to the unacceptable rise in the costs of their ambitious program.

The core element of netcentric theory is the networked interconnection of "sensors", namely technical or human elements which detect natural and human activities, "decision-makers", in other words personnel who make decisions on the basis of the available information, and "actuators", those that deliver the effect of the decisions taken. All these elements are integrated into a single structure, to exploit information and operational capabilities to achieve outcomes that are coherent with the desired goals. Only through connection to the network and the ability to access and share information, it is possible to gain a Shared Situational Awareness, a real force multiplier. In comparison with traditional armed forces, a netcentric force is able to operate in a wider geographical area, with fewer resources, better distributed, with greater precision, scope and survivability, in a synchronized way and with an accelerated reaction time. Therefore, a netcentric force is proportionally more efficient and has more chance of success than a traditional one.

Another element of the new netcentric philosophy is the so called "spiral approach". This approach implies an acquisition program structured through several phases, to gradually achieve the ultimate capability while preserving the flexibility to adapt it through the life of the program. This approach also allows the first "spirals" to be deployed into operations more quickly than otherwise. In reality, it would be impossible and not desirable to bring all the forces to the same level of netcentricity and equipment upgrade. Upgrading through a spiral process is to a certain extent endless, because technology evolution is constant, especially in areas such as electronics - it would not be sensible to complete an upgrade and wait for a next one five to ten years later.

With regards to Italy, the reflection on netcentric capabilities was expressed as a policy guideline by the "*Nuovo Concetto Strategico*" (New Strategic Concept) of the Defence Staff (2005). It stated: "The ability to

gather, organize and share acquired data, by means of a robust netcentric C4I[1] system, will make it possible to transform the organizational structures of the units, formations and Commands in order to make them more capable of managing future operations". It is clear that this transformation of the military should adopt a joint approach, able to connect the future military capabilities, and to integrate them with current projects and with existing assets and platforms (legacy assets). In 2006 the Italian Defence Staff (*Stato Maggiore Difesa,* SMD) published "*La trasformazione net-centrica: il futuro dell'interoperabilità multinazionale e interdisciplinare*" ("The net-centric transformation: the future of multinational and interdisciplinary interoperability), evidenced not 'whether' to acquire NEC capabilities, but rather 'when', 'how' and 'how much'.

In January 2007, the "Forza NEC" procurement program was launched to enable the military to operate better in a joint and multinational way, and retain Italy's ability to operate alongside its main European partners. An Army-led joint procurement program, the project was intended to ensure that all the Armed Forces would achieve netcentric capability. This approach raises particularly difficult technical challenges for the Army, with its greater focus on a soldier fighting force. Deploying at the soldier level is particularly complex, compared with enabling ships or aircraft. Within this innovative approach aimed at transforming the military, digitization is the starting point, or rather the only way to achieve and develop netcentric capabilities. Digitization implies the use of digital systems and technologies in the operational domain to gain, exchange, correlate, and use the information quickly. The "Digitization of the battlespace" is the process enabling the elaboration and transfer of a variety of information amongst different players in the field in real time, or in near-real time.

For the past 20 years Italy has made a significant contribution, some in leading roles, to international military missions, including some of the most complex and difficult. Examples include the First Gulf War (1991), three missions in Somalia, land operations in the Balkans, airstrikes

[1] *Command, Control, Communications Computers and Intelligence*.

against Serbia in the '90s, missions in Afghanistan and Iraq following 9/11, the renewed UNIFIL effort in Lebanon, and finally the recent NATO operations in Libya. All missions have stressed the need for better coordination of forces and, in particular, the need for advanced communications, command and control, capabilities to achieve overall situational awareness of its own forces and of the allies and the enemy. Another important lesson learned was the need to improve the ability to communicate effectively with allied units engaged in multinational operations, in order to simplify and aid the mission management. Also emerging from field experiences was the need to increase the protection of the deployed troops, not only through passive intervention, but also by providing the best Common Operational Picture (COP), which should be shared, detailed and updated as frequently as possible.

Considering the constant wear of the materials used in various and sometimes simultaneous missions, and the stagnation of the Italian defense budget, there is a risk that the Italian Army of the future could lose interoperability with forces of its partners. This would be very serious and detrimental both to the ability to conduct an active foreign policy and to the international status of our country. Today a leading role in foreign policy involves the ability to contribute to collective and international security using, where appropriate, national military capabilities. If these capabilities do not exist or do not meet the standards set by leading countries and then modeled on concrete experiences, Italy certainly cannot aspire to a leading role, as it did years ago with the ALBA mission in Albania, with the command of NATO forces in Kosovo, in Afghanistan with ISAF command or in Lebanon with UNIFIL II command. The "Forza NEC" program, aims to achieve a netcentric capability for the Italian Armed Forces and to ensure their interoperability with NATO partners, as well as a netcentric capability shared by the Italian Armed Forces.

The 2010-2030 Army Operational Concept, (*Concetto Operativo dell'Esercito 2010-2030*) based on the guidelines for the Army General Planning Process (*Processo di pianificazione generale dell'Esercito*), addresses the transformation issue in a more organic way. On the basis of the Operational Concept, the 2013-2032 Modernisation Plan (*Piano di Ammodernamento 2013-2032*) details the procurement needs, the requirements for different systems/platforms, the necessary amount of

equipment, and the schedule of its acquisition, structured on three spirals. In this way, the activities and actions under the Forza NEC program have been organized into in a more balanced a structured framework to upgrade equipment and operational and logistic platforms, amplifying the scope of the program and improving its effectiveness. It was necessary for a program such as Forza NEC to be aligned, before its launch, with other modernization and procurement programs being developed by the Ministry of Defence, to avoid duplications and inefficiencies resulting in a waste of resources. Forza NEC aims to integrate, under a single and comprehensive umbrella, other systems and programs such as: the Army Command and Control System (*Sistema di Comando e Controllo dello Stato Maggiore dell'Esercito* SIACCON); the a Command, Control and Navigation System for the digitization of combat platforms *(Sistema di Comando, Controllo e Navigazione* - SICCONA); the Future Soldier *(Soldato Futuro*) program; the Blue Force Situational Awareness (BFSA), a system to identify friendly units; the Software Defined Radio (SDR), a new type of communication equipment.

The total cost of Forza NEC has been estimated at €22 billion over 25 years. Currently, for the two year period 2010-2011 an initial funding amount of almost €325 million has been provided, while for the period 2012-2016 there is a second tranche of €475 million, for a total of €800 million. The cost of the first spiral, which extends over the period 2007-2018, is estimated at around €9.5 billion. The regularity and certainty of funding is essential for the success of the procurement program, because Forza NEC requires constant and parallel progress in the various subprograms, as a setback of any of these would have an immediate negative impact on the others.

The program covers a period from 2007 to 2031, with a spiral approach similar to that experienced by other NATO countries. A process of this scope, involving the full spectrum of land capabilities, from the dismounted soldier to the main command levels, requires a staggered approach to the acquisition of capabilities. The immediate acquisition of all the netcentric assets would not be sustainable in terms of cost, and the equipment would become out-of-date quickly due to the rapid evolution of technology.

The Forza NEC program includes the following phases:

- The feasibility study, completed in 2007;
- The Project Definition (PD) phase, which includes the initial design of the force as well as initiating activities for the implementation of the Integration Test Bed (ITB);
- The Concept Development and Experimentation (CD&E) phase;
- The implementation phase of the first spiral, which includes: the completion of the ITB, the link between the joint Modeling and Simulation (M&S) initiatives, the creation of the first Digitized Medium Brigade (Brigata Media Digitalizzata), the digitization of the amphibious Landing Force, the digitization of 50% of the so-called enablers (tactical-operational and tactical-logistical support);
- The implementation phase of the *second* spiral, which includes the creation of the second Digitized Medium Brigade and the digitization of an additional 25% of enablers;
- The implementation phase of the second and third spiral, which completes the program digitization.

Other defense procurement programs usually move directly from the Project Definition to the production phase and distribution of various materials and capabilities. However, due to the complexity of Forza NEC and the huge financial commitment, a new phase was inserted between the PD and the subsequent production phase. This further step serves as a "capacity bridge" between two phases, and is called Concept Development & Experimentation (CD&E). The CD&E is an important element to evaluate the coherence and effectiveness of the various systems to be adopted prior to their production. Formally, this specific phase began with the contract n.1.219 on June 9, 2010, for an implementation period up to 2013.

The Integration Test Bed (ITB) plays a central role in the CD&E. It is composed of a series of interconnected sites, which support the validation activities, the verification of system integration and the testing to address later developments. ITB is the practical application of Modeling and Simulation, which will be undertaken throughout all the program's spirals to test the various capabilities. The ITB takes place on a number of Italian Air Force, Navy and Army sites, the latter providing the majority and the hub of coordination established at the Army's Center for Simulation and Evaluation (*Centro di Simulazione e Valutazione dell'Eserci-*

to CESIVA), the first site to be created. The ITB also involves some innovation in training. For example, defence industry staff operate closely with military personnel in testing the techngologies provided. In addition, when a new vehicle is deployed, the fact that civilian and military personnel work together side by side facilitates the learning process by the end user.

The next step of CD&E was to identify a suitable structure in terms of location, size and capacity, able to become the Experimental Digitization Unit (*Unità Sperimentale per la Digitalizzazione* - USD), for the Italian Army. Rather than creating a special unit from scratch, the 31 Tank Regiment in Altamura was tasked to study and test the new capabilities. The CD&E also includes the design and development of Command, Control, Communications Computers and Intelligence (C4I) systems, and the telecommunications "backbone" which will manage the flow of information among the various systems.

With regard to the industrial issues, the NEC concept adopted by NATO will inevitably influence the procurement and defense market in coming years. The basic ideas of this concept have imposed a series of new requirements for which industry has had to adapt: modularity, interoperability, flexibility, industry-military cooperation, are just some of the new keywords that mark the evolution in the defense market. The need for a holistic approach to NEC has led to a series of considerations within both the civil and the military environments that led, for example, to the introduction of CD&E and the ITB.

The intervention of the industrial sector in supply, testing, simulation and verification of systems and technologies, which occurs also throughout the ITB, may appear easy. But a variety of assets are needed to equip a divisional level unit, including logistics, electronic warfare and various support units, in addition to the traditional combat functions. Therefore, several suppliers are required. If these suppliers were operating without mutual connections, this could compromise the utility of the netcentric architectural design. A second complexity is that a plurality of suppliers requires a series of different contracts with the Ministry of Defence (MoD), which may create further difficulties for end-users and increases the number of administrative actions required for each individual contract. As a result, the industry has agreed to provide the

customer with an integrated solution that is ready-to-use, rather than a series of elements to be integrated by the customer. The customer remains responsible for planning what to buy, the requirements, the amount of equipment and the purchase timeframe. The supplier has the task of integrating all the necessary hardware and software. The complexity of the integration process has driven the MoD to choose Selex Sistemi Integrati as the unique industrial partner with the role of systems integrator. To solve the second problem, i.e. the number of parties and contracts, Selex Sistemi Integrati has been identified also as prime contractor, to act as a coordinator between the various industrial partners in a position of *primus inter pares*, representing all the other companies with the MoD. Leading Italian security and defence companies are amongst the industrial partners.

One of industry's tasks in Forza NEC consists in updating and digitalizing the Army's vehicles. For example, analogical armoured vehicles such as *Centauro*, *Dardo* or *Ariete* are digitized with the upgrade of the Command, Control and Navigation System SICCONA. With further improvements to be introduced on the next generation armoured vehicles *Freccia*, Forza NEC plans to adapt SICCONA to *Freccia*'s specifications, for example, introducing a broadband radio. The individual soldier, who plays a key role min theatre, requires special attention. In order to fully integrate every soldier in the C4I architecture, he or she must be provided with an extra load, in addition to the standard equipment. For this reason, the project *Soldato Futuro,* created in 2003, has been integrated into Forza NEC and will provide the basic equipment for the dismounted soldier. The soldiers, albeit on a smaller scale, will be equipped with digital capabilities such as individual computers and radios, now developed by industry with special attention to the issue of power consumption.

In order to better deal with such a relevant transformation process, it is also important to consider the experience of two countries such as France and the United Kingdom. The French Armed Forces have adopted a NEC approach to lead the netcentric transformation of its military. Its joint network is based on the satellite communication system SYRACUSE and software defined radios, while strategic and operational level connectivity relies on SICA. In 1999 the French Army launched a battlespace digitization program, based on the multi-level communication

network RITA, to be completed by 2020. Within this framework, the SCORPION program aims to deliver netcentric Army equipment, while the FELIN program is particularly focused on the dismounted soldier. So far the French experience has confirmed the benefits of the netcentric transformation, but it has also highlighted problems of interoperability, training and management of information flow. The French Air Force's network has been developed mostly through the command and control system SCCOA, which will be integrated with the corresponding NATO systems, in the new version currently being developed. The French Navy uses SIC-21 system, which integrates different communication networks, as well as operational and intelligence tools and instruments necessary for naval operations management. Finally, the French Ministry of Defence is developing a plan to gather various systems together into a single joint system of systems. This project is very ambitious, and presents many interoperability challenges.

Since the mid-90s, the United Kingdom has been transforming the Armed Forces into a fully digitized and interconnected military force, but the process has been slow. Today there are still some important systems which are "isolated" or which have rudimentary connections to other national or Allied assets. The British Armed Forces in the last ten years have experienced a clear revolution in digitization of individual capabilities and parts of equipment, but achieving a full and complete netcentric capability for the British Army, Royal Navy and Royal Air Force is still a real challenge. Budgetary issues, setbacks in procurement programs and, in particular, a sustained and massive commitment in Afghanistan and Iraq have all contributed to making this process more difficult. The Bowman communications system remains the cornerstone of the command and control system of the British Army, while the ELSA package and the ROVER terminal are important elements of the updating process. The British Army also has a specific program dedicated to the dismounted soldier, FIST. For historic and structural reasons, as in the French case, the Air Force and the Navy in the UK are more integrated into the netcentric environment than the Army, but there are also critical issues and interoperability problems. The progressive adoption of the Link-16 from the various platforms is certainly an important step towards a resolution of these issues.

Foreword

In the last decade the strategic framework has changed dramatically, determined by a radical evolution of the threats and the challenging budgetary constraints facing the Armed Forces in the near future.

The need to adapt to an ever-changing operational environment has required an extraordinary effort, which is ongoing, to transform the Italian Army and provide it with adequate structures, capabilities and doctrines in order to effectively operate in the current complex scenarios.

The Italian Army has undertaken several programs in order to modernize, adapt and acquire capabilities. These projects are based on a strong technological base, which is necessary not only to meet the growing Situational Awareness and force protection' requirements, but also to continue to ensure full interoperability of our military with allied forces. In this context, I can say with confidence that we have been able, through forward looking planning and wise choices, to bridge the technological gap with those armies which initiated significant up-scaling projects ahead of us.

I refer in particular to the "Forza NEC" program which is aimed at creating, initially, a divisional level force, able to be deployed and to operate in a digitized battle-space, ensuring interoperability at a joint and multinational level. It is an ambitious project, extraordinarily innovative, and represents the cutting-edge of the entire modernization program of the Italian Army.

Furthermore, "Forza NEC" is a real example of a synergic and integrated civil-military effort, providing a model for the planning and definition of military requirements, to ensure the most efficient use of resources and the optimal collaboration between the Armed Forces and the defence industry.

In conclusion, "Forza NEC" is the essential tool in terms of approach, capabilities, structures and procedures, to successfully operate in today's operational scenarios and is – I am absolutely certain – the best way that the Italian Army can respond to future challenges.

The Army Chief of Staff
Gen. C.A. Giuseppe Valotto

Introduction

This study assesses the transformation process of European Armed Forces and particularly the Italian "Forza NEC" procurement program. It is the latest example of a long-standing IAI tradition of studies in this field including both - security and defence policies and technological innovation. In this context, the trends and dynamics analyzed have a dual dimension. On one hand, they have a strategic dimension as far as they influence national and international security; on the other, they have an economic dimension as they determine the conditions of the defence market, for example with regards to procurement programs. Several factors play a crucial role in these dynamics. The Armed Forces aim to develop the best military capabilities within the available resources; the political decision-makers have to choose and match objectives and resources for the military; the aerospace, security and defence industry has to meet the military requirements in line with available funds, operating in an increasingly internationalized and competitive market.

All these players also have a crucial role in the "Forza NEC" program, which has a strategic and economic dimension and is situated at the frontier between policy and technology. "Forza NEC" aims to modernize the equipment of the Italian Army by networking current and future systems and platforms through communications, command and control systems, by leveraging a *Network Enabled Capability* (NEC). It is of strategic importance because it maintains the effectiveness of the Italian Armed Forces', protects national and international security, in a context of rapid technological evolution. Inevitably, it is also a program with a big economic impact on the defense budget – the total cost of "Forza NEC" has been estimated at 22 billion euro over 25 years.

This study has been conducted by a research team within the IAI Security and Defense Area formed by Michele Nones (Director), Alessandro Marrone (Coordinator), Stefano Silvestri and Stefano Felician, with the collaboration of Andrea Nativi, Nick Brown (for the British case), Philippe Gros (for the French case) and Alessandro Ungaro (for translations). The study lasted nine months, and during that period the "Forza NEC" program continued to evolve. The IAI team has adopted its traditional scientific approach in managing the study, based on three pillars:

1. the dialogue with military and industrial counterparts, aimed at identifying their requirements, their the internal dynamics and the relationship between the two.
2. the international perspective, considered fundamental in a context of European and/or transatlantic cooperation in the defence field. This led to the inclusion in the study of two case studies on similar procurement programs in France and Great Britain, produced by well-regarded international experts.
3. the critical, pragmatic and independent approach to the analysis, highlighting both opportunities and challenges of the "Forza NEC" program.

The purpose of this approach and of the whole study is to provide the policy-makers, practitioners and experts, as well as the wider audience, with the tools to assess the program and to make rational and thoughtful decisions. These decisions are important as they will have a strategic impact on the Italian military for the foreseeable future, and therefore require adequate consideration.

(MN and AM)

List of Abbreviations

AAC	Army Air Corps'
AASM	Armement Air Sol Modulaire
ABC	Apache Bowman Connectivity
ACCS	Air Command and Control System
ACT	Allied Command Transformation
ADAWS	Action Data Automation Weapons System
ALARM	Air-Launched Anti-Radiation Missile
ALTBMD	Active Layered Theatre Ballistic Missile Defence
AM	Aeronautica Militare
AMN	Afghan Mission Network
ARTIST	Advanced Radar Technology Integrated Systems Testbed
ASAC	Airborne Surveillance and Control
ASB	Ambiente Sintetico di Base
ASTOR	Airborne Standoff Radar
ASTRIDE	Accès par Satellite et par Transmission hertzienne au Réseau de zone et de l'Intranet
ATLAS	Automatisation des Tirs et des Liaisons de l'Artillerie Sol/sol
AVES	Aviazione dell'Esercito
AWACS	Airborne Warning and Control System
BCIP	Bowman Combat Infrastructure and Platform
BFSA	Blue Force Situational Awarness
BIT	Brigate Integrate terrestri
BMD	Ballistic Missile Defence
BOA	Bulle Opérationnelle Aéroterrestre

BPC	Bâtiments de Projection et de Commandement
BTID	Battlefield Target Identification Device
C2	Command & Control/Comando e Controllo
C2I	Command, Control, Intelligence/Comando, Controllo, Informazioni/Intelligence
C2PC	Command and Control Personal Computer
C3	Command, Control, Communications/Comando, Controllo, Comunicazioni
C3M	Centre de coordination et de contrôle mobile du SCCOA
C4	Command, Control, Communications, Computers/Comando, Controllo, Comunicazioni, Computer
C4I	Command Control Communications Computers and Intelligence/Comando, Controllo, Comunicazioni, Computer e Informazioni/Intelligence
C4ISTAR	Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition, Reconnaissance/Comando, Controllo, Comunicazioni, Computer, Informazioni/Intelligence, Sorveglianza, Acquisizione obiettivi, Ricognizione
CAMM	Common Anti-air Modular Missile
CART	Centre d'Accès Radio et de Transit
CAS	Close Air Support
CBRN	vedi NBC/NBCR
CCII	Command and Control Information Infrastructure
CDL	Common Datalink
CDC	Centre de Détection et de Contrôle/Detection and Control Centre
CD&E	Concept development and experimentation
CEAM	Centre des expérimentations aériennes militaires
CEC	Cooperative Engagement Capability
CEMP	Capacité.d'Engagement Multi-Plate-Forme
CEPOLISPE	Centro Polifunzionale di Sperimentazione dell'Esercito
CESIVA	Centro di Simulazione e Valutazione dell'Esercito
CFAT	Commandement des forces d'action terrestres

CHF	Chaîne hertzienne des forces
CICDE	Centre interarmées de concepts, doctrines et d'expérimentations
CII	Coalition Information Infrastructure
CIO	Consorzio Iveco Fiat/Oto Melara
CIS	Communications and Information Systems
CLB	Casualty Locating Beacons
CLEW	Conventional Link-11 Waveform
CLR	Commander's Lightweight Radios
CMAI	Centre Multiservice d'Accès et d'Interface
CNOA	Centre national des opérations aériennes
COIN	Counterinsurgency
COMFOSBARC	Comando delle Forze Anfibie
COMLOG	Comando Logistico dell'Esercito
CONTACT	Communications Numérisées Tactiques et de Théâtre
CONUS	Continental United States
COP	Common Operating Picture/ Common Operational Picture
COTIE	Comando Trasmissioni e Informazioni dell'Esercito
COTS	Commercial Off The Shelf
CP	Command Post
CPCO	Centre de Planification et de Conduite des Operations
CPX	Command Post Exercise
CRoBLE	Control Room Battle Lab Enabler
CSV	Centro Sperimentale di Volo
CTRT	Centre Radio de Télé-exploitation et de Transit
DAT	Direzione Armamenti Terrestri
DCC	Dismounted Combat Capability
DE&S	Defence Equipment and Support
Def Stan	Defence Standard
DGA	Délégation Générale pour l'Armement
DII	Defence Information Infrastructure
DLAN	Deployable LAN
DOTMLPFI	Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities, Interoperability

DSA	Dismounted Situational Awareness
DTT	Dipartimento per la Trasformazione Terrestre
EBO	Effect Based Operations
EBRC	Engins Blindés de Reconnaissance et de Combat
EEI	Escadron d'Eclairage et d'Investigation
EES	Elicottero da Esplorazione e Scorta
EHF	Extremely High Frequency
EI	Esercito Italiano
ELINT	Electronic Intelligence
ELSA	Enhanced Low-Level Situational Awareness
EMIA-FE	État-Major Interarmées de Force et d'Entraînement
ESIXS	Enhanced SSN Information Exchange System
ESSOR	European secure software defined radio
EW	Electronic Warfare
FAMAS	Fusil d'Assault de la Manufacture d'Armes de St-Etienne
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat System
FELIN	Fantassin à Equipements et Liaisons Intégrées
FFAA	Forze Armate
FIST	Future Infantry Soldier Technology
FIT	Forza Integrata Terrestre
FLAADS	Future Local Area Air Defence System
FOB	Forward Operating Base
FOBEX	Forward Operating Base Exercises
FREMM	Frégate Européenne Multi-Missions
GAM	Groupement Aéromobile
GBA	Generic Base Architecture
GCV	Ground Combat Vehicle Program
GFE	Government Furnished Equipment
GII	Global Information Infrastructure
GPS	Global Positioning System

GRANITE	Gestion du Renseignement et Analyse des Informations Transmises par les Equipes
GrATS	Ground Asset Tracking Systems
GRAVES	Grand Réseau Adapté à la Veille Spatiale
GSA	Generic Soldier Architecture
GTIA	Groupement Tactique Interarmes
GVA	Generic Vehicle Architecture
HCDR	High Capacity Data Radio
HeATS	Helicopter Asset Tracking Systems
HMS	Her Majesty's Ship
IBS	Integrated Broadcast Service
ICT	Information and Communication Technology
IDM	Improved Data Modem
IdZ	Infanterist der Zukunft
IED	Improvised Explosive Device
IFOR	Implementation Force
IFV	Infantry Fighting Vehicle
INTSUM	Intelligence Summaries
IP	Internet Protocol
ISTAR	Intelligence, Surveillance, Target Acquisition and Reconnaissance
IT	Information Technology
ITB	Integration Test Bed
JADOCS	Joint Automated Deep Operations Coordination System
JBC-P	Joint Battle Command – Platform
JC2SP	Joint Command and Control Support Programme
JDNB	Joint Data Networks Backbone
JFAC	Joint Force Air Component
JHF	Joint Helicopter Force
JOCS	Joint Operational Command System
Joint STARS	Joint Surveillance Target Attack Radar System
JTAC	Joint Terminal Attack Controller
J-TAS Mk II	Joint-Target Acquisition System Mk II
JTIDS	Joint Tactical Information Distribution System

KFOR	Kosovo Force
LAN	Local Area Network
LEAPP	Land Environment Air Picture Provision
LF	Landing Force/Forza Anfibia
LOSA	Land Open Systems Architecture
LPD	Landing Platform Dock
LPM	Loi de programmation militaire
LVT	Low Volume Terminal
MAESTRO	Module Adapté aux Échanges Sécurisés, aux Transmissions et au Raccordement des Opérationnels
MARICENPROG	Centro di Programmazione della Marina Militare
MARITELE	Centro di telecomunicazioni e informatica della Marina Militare
MARTHA	Maillage des Radars Tactiques contre les Hélicoptères et les Aéronefs à voilure fixe
MBIT	Megabit
MBT	Main Battle Tank
MCCIS	Maritime Command and Control Information System
MD	Ministero della Difesa
MELCHIOR	Moyen d'Élongation pour Les Communications en Hautes fréquences Interarmées et OTAN en Réseau
M&S	Modelling and simulation
MESAR	Multifunction Electronically Scanned Adaptive Radar
MIDS-LVT	Multifunctional Information Distribution System-Low Volume Terminal
MiSE	Ministero Sviluppo Economico
MM	Marina Militare
MoD	Ministry of Defence
MRAP	Mine Resistant Ambush Protected
M-TADS	Modernised Target Acquisition Designation Sight
M-TADS/PNVS	Modernised Target Acquisition Designation Sight/Pilot Night Vision Sensor
NATO	North Atlantic Treaty Organisation
NC3A	NATO Consultation, Command & Control Agency

NCO	Network Centric Operations
NCW	Network Centric Warfare
NEADS	Networked Enabled Airspace Defence and Surveillance
NEB	Numérisation de l'Espace de Bataille
NEC	Network Enabled Capability
NEST	Naval EHF/SHF SATCOM Terminal
NGIFF	New Generation Identification Friend or Foe
NNEC	NATO Network Enabled Capability
NUMALAT	Numérisation de l'Aviation Légère de l'Armée de Terre
NUMTACT	Numérisation Tactique
OA	Operational Analysis
OCCAR	Organisation Conjointe de Coopération en matière d'Armement
OE	Opération d'Ensemble
OEF	Operation Enduring Freedom
OHQ	Operational Headquarters
OR	Opérations en Réseaux
ORBAT	Order of Battle
OSPR	Own Station Position-Reporting
PCC	Prague Capability Commitments
PD	Project Definition
PR4G	Poste Radio Quatrième Génération
PRR	Personal Role Radio
PSO	Peace Support Operations
PSP	Pôle Stratégique Paris
RACSA	Reparto Addestramento Controllo Spazio Aereo
RAF	Royal Air Force
RD	Risk reduction
ReGISCC	Reparto Gestione ed Innovazione Sistemi Comando e Controllo
R&S	Ricerca e Sviluppo
ReSTOGE	Reparto Supporto Tecnico Operativo Guerra Elettronica

RI	Régiment d'Infanterie
RIB	Rigid Inflatable Boats
RIFAN	Réseau Intranet des Forces Aéro-Navales
RISTA	Reconnaissance, Intelligence, Surveillance, Target Acquisition
RISTA-EW	Reconnaissance, Intelligence, Surveillance, Target Acquisition and Electronic Warfare
RITA	Réseau Intégré des Transmissions Automatiques
RLC	Royal Logistics Corps
RM	Royal Marines
RN	Royal Navy
RNCSS	Royal Navy Command Support System
ROVER	Remote Optical Video Enhanced Receiver
RSTA	Reconnaissance, Surveillance, Target Acquisition
RTI	Raggruppamento Temporaneo di Imprese
RTOF	Recoverable Tethered Optical Fibre
RTTS	Royal Air Force Transportable Telecommunications System
RUSI	Royal United Services Institute
SA	Situational Awareness
SA2R	Surveillance, Acquisition, Reconnaissance Et Renseignement
SCARABEE	Système de Communication Aéroterrestre, de Restitution, d'Acquisition et de Bibliothèque Embarquée Évolutif
SCCOA	Système de Commandements et de Conduite des Opérations Aériennes
SCORPION	Synergie du Contact Renforcé par la Polyvalence et l'Infovalorisation
SCoT	Secure Communications on Tornado
SCUCAV	Scuola di Cavalleria
SCUF	Scuola di Fanteria
SCUTI	Scuola Trasmissioni e Informatica
SDR	Software-Defined Radio
SDSR	Strategic Defence and Security Review

SEAD	Suppression of Enemy Air Defences
SENIT	Système d'Exploitation Navale des Informations Tactiques
SFOR	Stabilization Force
SHF	Super High Frequency
SG/DNA	Segretario Generale/Direttore Nazionale Armamenti
SIA	Système d'Information des Armées
SIACCON	Sistema Automatizzato di Comando e Controllo
SIACCON MLO	SIACCON Minori Livelli Ordinativi
SIC 21	Système d'Information et de Communication du 21e siècle
SICA	Système d'Information et de Commandement des Armées
SICCONA	Sistema di Comando, Controllo e Navigazione
SICF	Système d'Information et de Commandement des Forces
SICRAL	Sistema Italiano per Comunicazioni Riservate ed Allarmi
SI/CS	Système d'Information et de Combat SCORPION
SIGINT	Signals Intelligence
SIR	Système D'information Régimentaire
SISTA	Synergistic Individual Surveillance and Target Acquisition
SIT	Système D'information Terminal
SIT COMDE	SIT combattant débarqué
SLEW	Single-tone Link-11 Waveform
SMA	Stato Maggiore Aeronautica
SMD	Stato Maggiore Difesa
SME	Stato Maggiore Esercito
SMM	Stato Maggiore Marina
SOA	Services Oriented Architecture
SoSE	System of System Engineering
SSA	Shared Situational Awareness
STA	Surveillance and Target Acquisition
STC	Socle Technique Communs
STDL	Satellite Tactical Datalinks

STRIDA	Système de Traitement et de Représentation des Informations de Défense Aérienne
SYRACUSE	Système de RadioCommunication Utilisant un Satellite)
TACP	Tactical Air Control Party
TACTIC	Technologies et Architecture du Combat Aéroterrestre aéro-terrestre Info-valorisé au Contact
TB	Tactical Base (TB)
TDL	Tactical Data Link
TIEC	Tactical Information Exchange Capability
TIGR	Tactical Ground Reporting
TNG	Tactical Network-layer Gateway
Tornado CUSP	Tornado Capability Upgrade Strategy (Pilot)
TSMP	Tenue de Situation Multi-Plate-Forme
UAV	Unmanned Air Vehicle
UGV	Unmanned Ground Vehicle
UHF	Ultra High Frequency
UOR	Urgent Operational Requirement
USD	Unità di Sperimentazione della digitalizzazione
VBCI	Véhicule Blindé de Combat d'Infanterie
VBM	Veicolo Blindato Medio
VBMR	Véhicules blindés multirôles
VHF	Very High Frequency
VMF	Variable Message Format
VPT	VHF Portable Transceiver
VTLM	Veicolo Tattico Leggero Multiruolo
VTMM	Veicolo Tattico Medio Multiruolo
VUIT-2	Video from Unmanned systems for Interoperability Teaming Level 2
WAN	Wide Area Network
WDL	Weapon Datalink

1.
The new requirements and *Network Centric Warfare (NCW)*

1. THE DIGITIZATION RACE AND THE NCW

In the last two decades, the end of the Cold War and of the bipolar system, the eastern enlargement of NATO and the emergence of new regional tensions, have disrupted the old geopolitical balance, which was relatively stable. This inevitably affected also the military balance. A number of factors increasingly influence military operations, which are ever more frequent, are conducted all over the world, and often last so long as to be considered almost "permanent".

These factors include:

- the ever-changing security environment, which requires Armed Forces to be effective in quantity and quality terms, flexible, mobile, modular and deployable, as well as being able to respond promptly to crises;
- the combined and cooperative nature of operations, not only conventional, but especially *Peace Support Operations* (PSO) and humanitarian relief require high interoperability standards with a wide range of partners, as is often the case with these missions;
- economic constraints significantly limit the defense budgets and imply choices increasingly based on a cost/benefit analysis;
- technological progress, particularly in Information Technology (IT) and force protection, forces early obsolescence and makes constant updating and upgrading necessary.

The relevance of these factors has led the NATO countries to launch a transformation process of their military forces to better address changes in the global geo-strategic scenario.

In this context, a real race for digitization was initiated several years ago and is taking place in several countries. As happens frequently in the field of military technology, the first moves in that direction came from the US. In 1991, the US observed that their Army, which was well trained and equipped to fight a high-intensity war in Europe, held a significant superiority against an army, in this case the Iraqi one, which was organized, armed and guided according to the Soviet model. Nevertheless, it became clear that conventional heavy forces presented several features that made their use ineffective in a changing and unpredictable threat environment. In addition, despite the substantial advantages acquired with respect to potential adversaries, several modernization programs launched during the Cold War had yet to be fully implemented.

In the years that followed the first Gulf War, ground forces were engaged primarily in stabilization and peacekeeping missions. It was acknowledged that these operations involved a significant effort, not only in terms of quantity of armed forces, but especially in terms of duration. Despite the initial illusion, the timeline of military operations would be measured in decades rather than in years. The so-called "peace dividend" dream vanished and several armed forces began to think about equipment and material updating programs, following a traditional approach without remarkable innovation.

The US, however, began to study a new theory in the field of organization, equipment and doctrine regarding the use of ground forces, aimed at creating an Army with real strategic mobility, much "lighter" than the '90s standard. Such an Army should also have a greater flexibility, in order to handle a wide range of threats and respond to different needs/requirements. At the same time, it should also gain an overwhelming qualitative advantage over any opponent, through the introduction of new technologies and truly innovative systems. The first elements of this theory can be traced back to the document named "System of Systems" drawn up by Admiral William Owens. This referred to the utilization of advanced sensors and command and control systems, as well as precision weapons to achieve *Situational Awareness*, and at the same time to detect targets more easily and more effectively. In the following years, the US continued to study and refine these revolutionary ideas with the publication of further works, including the document

"Joint Vision 2010" (1996), by the Department of Defense. The most important document illustrating the new theory was *"Network Centric Warfare",* authored by Admiral Arthur K. Cebrowski and John Garstska, two of the most prominent developers of this new approach. The Network Centric Warfare (NCW) approach became the key element of the new doctrine.

The rationale behind the NWC concept did not come from the military but rather from economic dynamics that marked world economic development in the last decades of the 20th century. The starting point was Information Technology (IT), the new technological frontier which was the main engine of innovation of the modern economy, in particular in the US. IT opened to the civilian sector new horizons of opportunity. It provided unprecedented speeds of communication, wide and easy diffusion of communication and information, the possibility to exchange and share data in various formats, and finally it made all these actions relatively inexpensive. Such "revolution" has been game changing in many areas of social endeavor and today is one of the most advanced and promising research areas in the world. Significant trade investments in the IT industry allowed the large-scale introduction of computers in business and in domestic life, as well as the dissemination of Internet, intranets, browsers, search engine, routers and other systems and technologies that rapidly deliver and share data and information. It provided the basis for the ongoing revolution in the fields of economics, communications and social life. According to Metcalf's law, the power of a network is greater than the sum of its parts: it is in fact proportional to the square of the number of its "nodes", i.e. its interconnected elements. This simple assumption has driven a radical transformation in the military as well. Armed Forces were indeed interested in the advantage created by the network in terms of improvement and dissemination of knowledge, reduction of decision making and communication times, and the ability to coordinate and synchronize the actions of forces physically dispersed towards a common goal. The Internet became a "real" phenomenon when the connection involved a critical mass of users: as this threshold was exceeded, the instrument's value has increased exponentially and, to date, has yet to reach its full development. The same – U.S. theorists thought – had to apply to the NCW: once a critical part of a

force had been firmly connected to the network, the benefits would grow exponentially and the transformation effort would become irreversible.

For a while the U.S. moved towards NCW alone, while other countries, including those devoting more attention and resources to the Armed Forces, conducted only preliminary studies and research with low priority. Moreover, in the wake of 9/11, all countries have had to deal with terrorist threats, contributing to a new wave of stabilization and peace enforcement operations, if not "regime change" ones. Suddenly every state with sufficient available funds launched initiatives to revolutionize their military instrument.

2. THE NATO NETWORK ENABLED CAPABILITY (NNEC)

During the Prague Summit in November 2002, NATO countries launched some important initiatives in this direction aimed at achieving, a range of essential capabilities including netcentric ones, in a short time frame. The establishment of *Allied Command for Transformation (ACT)* and the implementation of *NATO Response Force (NRF)*, were among the important initiatives taken to increase the NATO ability to respond to the challenges of the new security environment. Member countries committed themselves to develop various capabilities through the *Prague Capability Commitments (PCC),* including the *Network Enabled Capability (NEC)* for implementation of the transformation process. Using the "NEC" acronym, NATO conveyed the idea of enabling the combination in a single network of different doctrinal, procedural, technical, organizational and social elements, from different organizations, to achieve their interaction and thus retain prominent strategic superiority. In September 2003, twelve countries (Belgium, Canada, Denmark, France, Germany, Great Britain, Italy, Netherlands, Norway, Spain, USA and Turkey), adopted the NATO NEC (NNEC) concept, which expressed the ambition to fulfill the net centric capability, and decided to launch a study, called *NNEC Feasibility Study*, to set common requirements. This study was assigned to *NATO Consultation, Command and Control Agency (NC3A)* and ended in June 2005 with the specification of a roadmap to develop

and introduce capabilities that would offer participating countries the ability to carry out joint netcentric operations. The study identified four phases with which to accomplish NNEC capability: *deconfliction, coordination, collaboration, coherence*. In parallel, it established short-term (2008), medium-term (2012) and long-term objectives (2020)[1]. An important contribution for the development of net-centric capabilities was also offered by ACT where a NNEC integrated *Project Team* was created.

However, NATO did not endorse the full U.S. Network Centric Warfare (NCW) approach, but opted for the similar NEC one. The basic concept of the two initiatives remained the same, where the exploitation of information technology for the creation of a network able operation was regarded as a force multiplier for the assets involved in military operations. The NCW concept is a more radical approach, based on a rapid and complete acquisition of netcentric capabilities in order to overhaul the entire military structure in a short space of time. The NEC concept, on the other hand, was aimed at the acquisition of the same capabilities in a more gradual and sustainable way, also by enabling elements of the existing platforms and systems to operate in the network. It was a less radical but more effective choice, preferred by NATO and several other countries, including Italy. It is worthy to note that in the past few years the U.S. has had to abandon part of their radical approach because of unsustainable costs, and opt for a more prudent approach which shares many similarities with the NEC philosophy.

The digitization programs started in Europe, and not only in countries used to modernization such as France, Germany, Great Britain, Greece, Italy, Netherlands, Spain, Sweden and Switzerland, were also launched in Central Europe, for example in Poland and Czech Republic. Further, this race toward digitization was not limited to NATO or the European area, as similar projects were initiated in example Australia, Canada, Israel, Singapore, South Africa and even in China and in Russia.

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[1] Stato Maggiore della Difesa (SMD), *La trasformazione net-centrica,* Piedimonte Matese, Imago Media Editrice, pp. 17-19, http://www.difesa.it/SMD/CaSMD/Trasformazione_net-entrica/Documents/70258_Documento%20completo%20%28File% 20Pdf%202,73% 20Mb%29pdf.pdf.

3. THE CORNERSTONES OF A NETCENTRIC FORCE

Regardless of the size and sophistication of the various projects, all of them had accepted the substance of U.S. theories, perhaps opting for a different terminology, most suitable to the local military doctrine.

According to American thinkers, the concept of Network Centric Warfare (NCW), sometimes also referred to *Network Centric Operations (NCO)*, identifies a combination of doctrinal, procedural, technical, organizational and human elements which are properly connected – network centric or netcentric – which interact to achieve the Armed Forces' strategic superiority over the opponents. The core element of netcentric theory is the networking of sensors, namely technical or human sources which perceive and detect natural and social behaviors, decision-makers, which make a decisions based on available information, and actuators or effectors, as weapons or soldiers which implement the decisions taken. All the elements are integrated into a single structure, to exploit in synergic way information and operational capabilities to achieve outcomes that are coherent with the desired goals. Only through netcentric capabilities it is possible to manage the so-called *Effects Based Operations (EBO*), another key element of the new doctrine. The EBO aims to achieve the desired effect on the target through the synergic, simultaneous and cumulative use of all available capabilities at the tactical, operational and strategic levels.

A further core element of NCW is information superiority, by which Shared Situational Awareness (SSA) is achieved. Information superiority is not only a powerful force multiplier, but also a key factor for success, especially in joint and combined operations. It also becomes a decisive advantage as it speeds up the decision-making process and changes the initial conditions with a series of rapid moves, in order to prevent the opponents reacting promptly enough and finally paralyzes them. information superiority can be achieved only through networking and the consequent information access and sharing, which makes the SSA a true force multiplier.

Military operations take place in three fundamental domains:

- physical domain, including land, maritime and space domains where troops and systems are deployed and operate;

- information domain, where the information is created, elaborated, communicated and shared;
- cognitive domain, where operator factors such as leadership, training, tactics, procedures, strategies, etc. prevail.

Armed Forces with NCW capabilities can be more effective because:

- in the physical domain, all the elements (sensors, actuators, and decision-makers) are seamlessly connected;
- in the information domain, the entire force has the ability to collect, distribute and share information to gain a decisive advantage over the opponent;
- in the cognitive domain, all elements have the opportunity to develop and share a better situational awareness, to be informed about the commander's intentions and to synchronize their actions.

With contribution from all these elements, a netcentric force is able to operate over a wider geographical area, with fewer and more distributed resources, with greater accuracy, range and survival abilities. In addition, it operates in a synchronized way, with an extremely short decision cycle compared to a conventional force, thus increasing proportionally its effectiveness and its opportunity for success. Shared Situational Awareness allows the force to quickly adjust to changes in the battlespace, increases the autonomy of mid-rank officers improving their reactivity, and facilitates the implementation of the commanders' orders as they are immediately and clearly shared with all of the appropriate network nodes.

Technology is fundamental in creating the system and the network: operating in a network involves a coordinated and synergic effort between people and organizational elements such as commands, units, support structures, etc. Military personnel exploit the network's potential to collect analyze and share information, by transforming information into a decisive advantage in the conduct of operations. The human element – and not the technology per se – is still firmly at the center of the network, because it is conceived, designed, used by individuals who are integral to and an interactive part of it.

The NEC concept and its doctrine exploit four precepts:

- networking improves the distribution and sharing of information;
- information sharing improves its quality and SSA;

- SSA facilitates collaboration and synchronization, improving sustainability and response of command and control;
- the above factors, combined and integrated, exponentially increase the action's overall effectiveness.

In several countries, the definition process of national NEC doctrines, at least at the beginning, was carried out before testing theories in the field, and indeed many countries lacked even the most basic experience in challenging operational missions. Recent experiences in Afghanistan, Iraq, Libya and Lebanon are obviously influencing the operational requirements, technology development priorities, as well as short, medium and long term goals.

4. THE SPIRAL APPROACH AND THE CHANGES IN DEFENCE PROCUREMENT

The changing threat environment faced by soldiers in ongoing missions requires that systems and equipment need to be provided and deployed as quickly as possible, accelerating the development, testing and validation processes. In this context, the new netcentric doctrine introduces a further helpful concept, that of the so called *"spiral approach"*. In this approach, a procurement program is structured through several phases, the spirals, to gradually achieve the desired outcome and have greater flexibility to sustain possible adjustments and/or corrections during in the course of implementation. This also allows for the first "spirals" to be deployed in theatre more quickly than through traditional acquisition.

The spiral approach, adopted in all NCW/NEC projects, would provide advanced systems packages more in line with operational requirements, and simultaneously allow regular updates of equipment. This assumes that all equipment will never be at the same level of upgrade. In fact, the spiral renewal process is endless, because technological improvements are constant, especially in sectors such as electronics and information technology. Therefore, it is not conceivable to abandon inserting new technologies only because the modernization process has been concentrated in certain periods and the next insertion years hence.

The main platforms may remain the same, but their content or sub systems need to continue to evolve, as do the materials, weapons and soldier equipment.

The pressure to deploy as quickly as possible the best available capabilities requires more agile procurement alongside spiral development. Although agility often creates logistical, doctrinal and operational issues, it can respond more appropriately to the Urgent Operational Requirements (UOR) emerging from theater and can often be met through "crash" programs that lead to the off the shelf acquisition of products or technologies available immediately on the marketplace. In some countries, like the United Kingdom, UORs have represented an important source of investment in modernization. Obviously such an approach can be maintained only during large-scale and prolonged military operations, and cannot represent an alternative to the traditional model, provided the latter is streamlined and accelerated.

It should be noted that netcentric capability benefits apply not only to combat troops, but concern significantly the logistics footprint. In fact, logistics can address different operational needs in a more effective, timeline and tailored way thanks to an updated and comprehensive knowledge of the situation in the theatre, including the flow of supplies, as well as the maintenance and repair work. Also the turnover in troops and the administrative and strategic commands benefit from the introduction of netcentric capability, as each part is heavily dependent on the combined use of Information Technology and Communications.

Some countries, including Italy, have already evidenced the opportunities and advantages offered by an approach with netcentric elements during operations in Afghanistan, Iraq, Balkans and Mediterranean. A trial was also held in NATO exercises such as *First Wave*, which in 2004 involved the air forces of seven countries using networked simulators, in a joint and multinational context. Italy participates actively to the most significant activities of these simulations, such as *Coalition Warrior Interoperability Demonstration* and *Combined Endeavors*.

The race for technological innovation in the Industry does not happen at the same pace and intensity in all countries. In fact, several countries focus their efforts in specific areas. Moreover, whilst major countries would try to develop all the necessary systems, including under-

pinning technologies, platforms, equipment and weapons, autonomously, most others will have to rely on collaboration with more advanced countries or will have to procure *off-the-shelf* from these countries.

5. THE LIMITS OF NETCENTRIC TRANSFORMATION: THE U.S. CASE

The benefits of transformation are clear, its necessity is acknowledged, and the path towards the introduction of NCW capabilities has been drawn. However, many difficulties remain and *Network Centric Warfare* is not a "magic formula" that can resolve all problems. The use of NCW, EBO and information superiority is not sufficient to ensure success in operations that remain, beyond any doctrinal and technological transformation, a complex dynamic phenomenon. It is not possible to determine the outcome of a military operation. You can only push towards the desired direction by exploiting the favorable factors. The guiding principles of netcentric force have not replaced the classical criteria that underpin the conduct of military operations: critical mass, objectives, maneuver, unity of command, etc. However, netcentric elements provide the added value necessary for effective operations' management in current circumstances, both in the military sector and in internal security, as well as Peace Support Operations (PSO), humanitarian relief and the deterrence against various forms of threat.

The adaptation and transformation efforts are also scrutinized by potential adversaries, including those determined to exploit the potential of asymmetric conflicts, terrorism and weapons of mass destruction. In other words, NCW presents several weaknesses and constraints which may be leveraged by potential adversaries. It should not be forgotten that, when everyone has NCW capabilities, a situation of equilibrium could emerge in the future. In this case the advantage will result from the capacity to adapt, assimilate and change doctrines, organizations and technologies faster than the opponent.

With regards to the United States, the leading country in NCW, in 2003 the U.S. Army launched the Future Combat System (FCS) program, the most ambitious Army modernization project. The U.S. program was

designed to transform the U.S. Army and also part of the Marine Corps. The Pentagon had decided on a very innovative and ambitious approach. It contracted the program's management to an industrial team led by Boeing and SAIC, experiencing notable technical and managerial problems which were partly inevitable considering the scale of the program. The two prime contractors were responsible for the supply of the whole FCS system, and were free to choose their suppliers (25 major ones, in total around 600 companies involved) as well as the individual systems, subsystems and technologies. Of course the Pentagon maintained close oversight of progress, retaining management, financial and technical control. However, industry was responsible to provide the final output, an approach never adopted for such a large, complex and ambitious procurement program. The US Government hoped that this approach would achieve the desired results faster and more cost effectively than a traditional approach.

The FCS program was too big and it was draining too many resources: a spend of $21 billion was planned just for the programs first phase Research and Development (R&D) activities, whilst the estimated cost to rebuild and equip a first tranche of 15 U.S. Army Brigades exceeded $150 billion. The Pentagon has reshaped the program several times in order to save money, such as reducing the rate of unit re-equipment/transformation, or postponing the development and deployment of some elements. The whole program initially included 18 major systems, plus the soldier equipment and the backbone of the entire FCS. Finally in 2009, due to the increased costs of operations in Iraq and Afghanistan and to the budget cuts, the Pentagon was compelled to close the FCS.

An alternative and less ambitious set of programs was launched, part of the Army Brigade Combat Team Modernization Program. This new initiative better utilizes the experience gained in the theatre in order to define the requirements and priorities. It plans to upgrade 73 Army Brigade Combat Teams through a series of capability packages, the first to be introduced between 2013 and 2014. In practice it is carried out by implementing part of the FCS: the program is working on the network (*FCS Network)*, on the equipment to increase the capacity of the single soldier (*Future Force Warrior)*, and finally on Unmanned Aerial Systems (UAV) and Unmanned Ground Vehicles (UGV). The set of light mecha-

nized vehicles, renamed MGV, has been completely abandoned and replaced by a new program called Ground Combat Vehicle Program (GCV), which involves the production of a new multi-role, armored fighting vehicles for the infantry, much heavier compared to the MGV and intended to replace the M-113 and the BRADLEY.

Generally speaking, the entire FCS concept was revised and partly abandoned. The Rumsfeld's dogma of technological transformation also included the forces' projection from bases largely in Continental United States (CONUS), therefore bases in Europe and East Asia could be dismantled while maintaining credible global force projection. To this end Armed Forces should be extremely light, to allow the limited resources for air and naval strategic transport to move significant force packages at a distance of thousands of km within a few days. However, "lightness" doesn't imply "protection", as has been bitterly learned on the battlefields in Iraq and Afghanistan. The Pentagon then spent tens billions of dollars to adopt hyper protected, super heavy and thus unstable fleets of vehicles in order to enhance protection of all combat vehicles. The Mine Resistant Ambush Protected (MRAP) program is the symbol of this process. Of course, with the increase in weight, volumes and dimensions, strategic mobility is gone. Pre-positioning and forward operating bases are back in the limelight, waiting for technology to become able to resolve current logistics obstacles.

Other key problems are the weight of equipment brought by soldiers and their battery autonomy. As stated by an American officer on the field, "200 pounds of 'light' equipment always weighs 200 pounds". Today soldiers should carry heavy loads of materials, armors, weapons, computers, ammunitions, etc. Even though such a high-tech soldier will have technological superiority, he may face difficulties in the face of an insurgent who runs in carrying just an assault rifle, ammunitions and some food while the NATO "starship trooper" would look like and astronaut who can only walk slowly. Many soldiers on the field prefer to regain mobility by refusing to carry the expensive and sophisticated technology kits assigned. Weight is one of the main challenges to be addressed. Another is energy consumption: in the event that computers, radio, fire-control systems fail due to lack of battery they could become just a useless burden.

Furthermore, when the NCW was conceived in the U.S., it met the requirements for conventional high-intensity conflicts, which should have been fought and won in record time thanks to technological advantage. According to this so-called "five minute war", it was assumed that relatively small forces would succeed against opponents who were more numerous but equipped inferiorly, armed and guided by outdated doctrines. Many considered the Iraq war in 2003 the decisive test case of new the concepts, although the more advanced U.S. division, the 4th Infantry Division, had not taken part in operations due to the veto of Ankara for transit of US troops which aimed to attack Iraq from the north. The success of the most technologically advanced but less numerous US forces against the Iraqi army was overwhelming and relatively quick. However, controversies immediately arose about the number of soldiers, considered too limited thus allowing for prolonged heavy battles. After the war a more difficult and bloody insurgency came about and the number of troops on the ground increased, despite technological advantages.

The U.S. has learned lessons from operational theater and has tried adjusting NCW concepts, considering that large-scale and prolonged counterinsurgency operations may be necessary in the future, in spite of Americas' desire for disengagement. NATO and Allied countries have also adapted their vision and their goals accordingly. And the "five minute war" concept has fortunately disappeared.

2.
The Italian case study

1. Reflection within the Italian armed Forces

With regards to Italy, reflection on netcentric capabilities was expressed as a policy guideline by the New Strategic Concept (*Nuovo Concetto Strategico*) of the Chief of Defence Staff (2005).[1] It clearly stated:

> The capability to gather, organize and share acquired data, by means of a robust netcentric C4I[2] system, will make it possible to transform the organizational structures of the units, formations and Commands in order to make them more capable of managing future operations. A key element for success is the full exploitation of opportunities offered by emerging technologies. They constitute force multipliers and tools for rapid reconfiguration of devices, in order to maintain a technological and operational advantage able to produce the desired effect when requested.[3]

The "Nuovo Concetto Strategico" highlighted the role of netcentric capabilities as one of the Armed Forces long-term goals."[4] It is clear that this transformation of the military should adopt a joint approach, able to connect the future military capabilities, to integrate them with current projects and the asset legacy. In 2006 the General Staff of Defense (*Stato*

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[1] Stato Maggiore della Difesa (SMD), *Il Concetto strategico del Capo di Stato Maggiore della Difesa,* Piedimonte Matese, Imago Media Editrice, 2005.

[2] *Command, Control, Communications Computers and intelligence*.

[3] SMD, *Il Concetto strategico del Capo di Stato Maggiore della Difesa,* cit., pp. 38-40.

[4] SMD, *Il Concetto strategico del Capo di Stato Maggiore della Difesa,* cit., p. 81.

Maggiore della Difesa, SMD) issued the document "The net-centric transformation: the future of multinational and interdisciplinary interoperability". (*La trasformazione net-centrica: il futuro dell'interoperabilità multinazionale e interdisciplinare*), According to the Chief of Defence Staff at that time, Admiral Giampaolo Di Paola, the document was devoted not to "whether" to acquire NEC capabilities, but rather to "when", "how" and "for how much" they should be acquired.[5] On May 2006, Admiral Di Paola stated that

> the netcentric transformation of the Italian Armed Forces was an absolute and inescapable priority [in order to avoid the] loss of interoperability during international military operations, which will increasingly be the focus of military support for Italy's contribution, in accordance with the international community, to international security and stability.

A modern military without adequate capabilities to deal with new operations would be an obstacle rather than a means for defence and foreign policy. The programmatic statement of Chief of Defence Staff outlined the need to initiate the Italian Army transformation's process in the NEC direction in order to "maintain and enhance the interoperability of the Italian military with Allied forces". This is possible by extending "the netcentric approach to homeland security (…) and, more generally, to state departments operating in the security and humanitarian field".

For the Italian Armed Forces, the NEC transformation means a network of "sensors", namely technical or human elements which detect and survey natural and social activities, "decision-makers", personnel who adopt a decision based on the information available, and "actuators", weapons or soldiers that implement the decision taken. All these elements are integrated into a single structure, to exploit synergies and operational capabilities to achieve effects which are coherent with the desired goals. Only through the network and information access and sharing, is it possible to gain a *Shared Situational Awareness*, a real force multiplier particularly in joint and multinational frameworks.

[5] SMD, *La trasformazione net-centrica,* cit., p. 2.

Technology, and particularly *Information Technology*, is vital to create the network of sensors, decision makers and actuators. Operating a network involves a coordinated and synergic effort between people and organizational elements such as commands, units, support structures, etc. "Battlespace digitization" is the process aimed at enabling the elaboration and transfer of multiple information amongst different players on the field in real time, or in nearly-real time. This information allows various command levels to maintain an accurate and clear view of the situation, and to support planning and conduct of the mission.

In January 2007 the "Forza NEC" procurement program was launched to initiate the NEC transformation of the Italian Army. It also aimed to make the military more able to operate in a joint and multinational framework, in order to fully maintain Italy at the same level as its main European Allies. Forza NEC plans to make all Armed Forces completely netcentric, and in substance is an Army-led joint procurement program. The netcentric approach raises technical challenges of particular difficulty for the Army, which must make NEC tens of thousands of individual soldiers and items. This challenge is not simple, especially if compared to the networking of dozens of Navy (*Marina Militare* - MM*)* ships or hundreds of Air Force (*Aeronautica Militare* - AM) aircraft. The Army fully recognizes this is one of the most critical issues. After all, a ship already has a complex integrated system, a network *per se*. Navy fleets have had integrated networks connected via data links for decades. In the air domain, in recent years the Italian Air Force has conducted combat operations by fully exploiting the potential of the data exchange system Link-16. However, the joint and combined air campaigns implies the connection of no more than a few hundred items, although the high speed of such items makes this more difficult. The Italian Army, on the other hand had less familiarity with networks than the Navy and the Air Force, and has many more nodes. Moreover, the nature of land space of maneuver, for example, mountains, forests or urban environment, makes communications more difficult than in the air or maritime domain.

To a certain extent, the Italian Army has learned from the mistakes made by other countries. It closely scrutinized the failure of U.S. Army FCS program, a costly debacle which left American soldiers' equipment without concrete improvements despite tens of billions of dollars in-

vested in projects regarded as too ambitious, complex and technologically risky. This example has prompted the Italian Army to proceed with caution and to constantly check the results obtained and progresses made. This holistic approach dealt with transformation by taking into account each aspect with regards to doctrines, operations, organizations, training and logistics whilst continuing to perform real operations. In this way, with a slower start compared to the "Top Tier" countries has allowed them to avoid others' errors. This is particularly important because regarding defense procurement the U.S can afford, to a certain extent, to fail and start again, but a medium-size country Italy cannot afford such failures and the related costs. The Italian Army and the national industry have implemented the "lessons learned" not only from operational experience but also from the industrial, managerial, technical and technological field. Italian Armed Forces are not really behind their most advanced NATO partners, provided that Italy now moves at regular pace in this direction. It should also be noted that the Navy was fully involved from the start in the Army digitization process, thanks to the joint nature of Italian amphibious forces. These forces include fully integrated Army and Navy units, and which are also integrated with the ships that transport, land, support and recover them.

2. THE ITALIAN EXPERIENCE IN INTERNATIONAL OPERATIONS

Over the past 20 years Italy has constantly contributed to international military operations, including the most complex ones, with a large number of troops and sometimes with leading roles. The most complex and important operations in terms of troops involved have been land and air operations. Maritime operations, although complex, have proved to be less difficult because of the nature of sea domain. In fact, the maritime environment does not lend itself to asymmetric conflicts such as insurgency, with the partial exception of piracy and terrorism, and major European countries including Italy have not been involved in traditional conflicts in the maritime domain in the last two decades.

With regards to air and land missions, with the exception of the Italian experience in Lebanon in the '80s, the bulk of Italy's participation in international operations has taken place since the '90s.

The first complex and difficult deployment, although involving a relatively small contingent, was the First Gulf War in 1991, namely the Desert Storm Operation. The Italian contribution was mainly provided by the Italian Air Force through the Tornado IDS fighter, as part of the Italian Locust (*Locusta)* mission which involved 700 soldiers. These aircraft successfully carried out 2,100 combat missions, attacking 226 targets in Iraq near Basra. At that time, the Italian Army's involvement was marginal, mainly because the system of recruitment based on conscription was still in force and this created political constraint to it's in the field utilization. The 1991 experience made clear that it was necessary to implement a mixed system as a move from conscription towards professional army based on voluntary recruitment. It also stressed the need to enable the Army to conduct the full spectrum of military operations.

Then the three missions IBIS 1, IBIS 2, IBIS 3 conducted within the framework of UN operation in Somalia UNOSOM from 1992 to 1995, constituted the first real test-case for the Italian Army deployment in joint and multinational operations. In Somalia, in fact, all Italian services were successfully involved and integrated: the Army, the Navy and the Air Force. In the second peacekeeping mission, our contingent exceeded 2,500 men largely provided by the Italian Army and it was the third largest behind the Pakistani and U.S. contingents. At the time the conscription mechanism was still largely in force. In Somalia one of the first cases of *mission creeping* took place. The UN peacekeepers were forced to conduct combat missions on a large scale, especially counterinsurgency, even in urban areas. Italy also contributed to combat missions, and suffered casualties among its military as a result. The features of more complex international missions emerged for the first time in Somalia. The lessons learned from such experience were crucial to the evolution of the Italian military and particularly of the Italian Army.

In the late '90s, Balkans operations represented the first paradigm of stabilization and peace support operations, which then become a frequent exercise for the international community including Italy. Peacekeeping operations in the Balkans continue today in a different form and

on a smaller scale. For example, the re-emergence of tensions between Serbia and Kosovo in the summer of 2011 has compelled NATO, which was preparing to end its mission, to deploy temporary reinforcements between the two countries. Several and notably complex international operations took place in the area. The most important operations were: the NATO-led missions in Bosnia-Herzegovina (IFOR and SFOR missions) and in Kosovo (KFOR mission). Italy provided and continues to make a significant contribution to international operations in that region, by deploying up to 3.000 troops simultaneously into theatre. A large part came and still comes from the Army.

In this context, the 1997 humanitarian mission *Alba* in Albania is particularly significant. It was carried out under UN mandate and successfully conducted by a "coalition of the willing" organized and led by Italy, in particularly by the Italian Army. Subsequently, the Italian model was carefully analyzed and represented the benchmark for this type of operation, given the problems that were addressed and resolved, such as command and control, communications, logistics and rules of engagement. With regards to air operations, after the first experience in Bosnia and Herzegovina in 1995, there was the war against Serbia which began in 1999. In this case, a NATO-led Allied Force Operation endured 78 days, including mostly air and missile strikes against the Federal Republic of Yugoslavia. The Italian contribution to the NATO air campaign was particularly appreciated because it was not limited to providing support bases and logistics, but played a significant part in operations over Serbia and Kosovo. In fact, the number of Italian sorties was second only to America.

September 11 attacks led the United States and Allied countries to play an increasingly active role at international level, particularly through international military operations. The Italian Armed Forces took part in operations in Afghanistan, both NATO-led ISAF and US-led *Operation Enduring Freedom*. After the second war in Iraq, Italy joined the US-led stabilization efforts with the Ancient Babylon mission (*missione Antica Babilonia*) with about 2,500 soldiers deployed between 2003 and 2006. In 2006, UNIFIL 2 marked an evolution of international engagement in Lebanon. Italy increased its commitment: the Italian contingent, part of Leonte Operation, involved up to 2,500 men. Today intervention in Af-

ghanistan remains the most important and difficult for Italy, because of the characteristics of the territory, the size of the contingent (about 4,000 men) and the logistical difficulties caused by the considerable distance from Italian bases. Moreover, the mission is difficult because it was presented as a peacekeeping mission when in fact it is a peace-enforcing mission with fully-fledged combat operations and the risk of painful losses.

Finally, in 2011 Italy joined air and naval operations in Libya, as part of the NATO mission *Unified Protector*. The Italian Air Forces made more than 2,000 air sorties during the air campaign, the third largest contribution in terms of air sorties after the UK and France.

All missions have stressed the need for a better coordination of deployed forces. In particular, joint advanced Communication Command and Control (C3) capabilities are essential for gaining an overall picture of one's own forces and those of the allies and the enemy. The capabilities are required to achieve effective communication among units deployed on the ground, regardless of whether they belong to the Army, the Navy or the Air Force, and to ensure constant contact with local commands and Italian headquarters speeding up the various decision-making processes. The latter can be decisive in the most delicate situations, as experienced for example in Somalia.

Another important lesson learned was the need to improve the ability to communicate effectively with allied units engaged in multinational operations, in order to simplify and make the mission management more efficient. The problems experienced in the C3 sector by NATO in Afghanistan have required significant investments and it will take several years for this to be resolved in a way that is satisfactory. A third lesson learned from field experiences is the need to increase the protection of the troops deployed. This is be obtained not only by passive protections, but also by providing the best *Common Operational Picture* (COP), which should be shared, detailed and updated as much as possible.

The improvements which took place in these areas are remarkable and have greatly benefited the Armed forces in international operations over the past decade. The Italian Army in particular has made significant progress. It has sustained the greatest burden in the main international operations, due to the fact that these have been primarily land opera-

tions in Somalia, the Balkans, Afghanistan, Iraq and Lebanon. Undoubtedly since the start, the Italian Army has commendably, faced new and difficult tasks, and despite the transition from recruitment based on conscription to one based on volunteers and professionals. Moreover, a shortage of funds has forced many modernization programs aimed at keeping up with the upgrading pace of the most advanced Allies, to be postponed or cancelled, placing additional burden on the traditional partners of the Italian Armed Forces in international operations. However, the Army has successfully provided the core military contingents in several international missions, all characterized by synergic and closely joint/combined interventions, thousands of soldiers simultaneously deployed in different theatres often quite far away from Europe.

Such effort has significantly depleted the stock of equipment used in various and concurrent missions, more than was foreseen by the initial plans drafted. That equipment has been replaced, repaired or maintained only to a certain extent, due to the stagnation of the Italian defense budget. Although the Army has developed a significant expertise in managing a cost-effective repair and maintenance program there was the risk that the Italian Army in the future would lose interoperability with the armies of international partners. This would be very serious, detrimental, firstly to the ability to conduct an active defence and foreign policy, and consequently to Italy's international status. Today a leading role in foreign policy involves the ability to contribute to collective and international security using, where appropriate, national military capabilities. If these capabilities do not exist or do not meet the standards set by leading countries and then modeled on concrete experiences, Italy certainly cannot aspire to a leading role, as it once did during missions such as *Alba* in Albania, with the command of NATO forces in Kosovo, in Afghanistan with ISAF command or in Lebanon with UNIFIL II command.

In this context, an interoperable and well equipped military is necessary in order to play an active role in international operations, however it is also important that these capabilities are actually used, particularly in combat operations. We are no longer in the Cold War period, when military capabilities in Europe were used as a deterrent but not necessarily utilized. The military plan the best operational capability to con-

duct the full range of missions, in order to provide policy makers with all the necessary tools and the flexibility to mix them. Policy-makers provide the resources necessary to build up military capabilities able to carry out assigned tasks while protecting the forces. Political leaders also decide if, how, how much and for how long to commit the Armed Forces to new operations, always with the interests of the country in mind.

3. THE DIGITIZATION OF THE ITALIAN ARMED FORCES

Both the theoretical debate, at national and international level, and the Italian experience gained from international operations have prompted the Italian military to meet the digitization challenge.

In recent years, Italy has made several high-technology investments in the defense sector, such as the recent aircraft carrier Cavour, and participation in the Typhoon and F-35 aircraft procurement programs. Some of these were also joint projects, such as the Italian System for Classified Communications and Alerts (*Sistema Italiano per Comunicazioni Riservate ed Allarmi* - SICRAL).[6] However, these programs were limited. Until a few years ago, the Armed Forces autonomously acquired assets and capabilities, without a joint program able to fully involve all the services. Today this approach has become an obstacle to the creation of a joint netcentric capability. Moreover, as mentioned before, without a major digitization program there was the risk to lose the interoperability with the Allies' Armies and thus the ability to join international operations. "Forza NEC" program aims to achieve a joint netcentric capability for the Italian Armed Forces and to ensure their interoperability with NATO partners.

[6] The SICRAL (*Sistema Italiano per Comunicazioni Riservate ed Allarmi)* "is the Italian satellite system for military communications characterized by flexibility and versatility never reached before. The system is able to ensure interoperability between the networks of defense, public security, civil and emergency management and control of strategic infrastructure. With SICRAL the Italian Armed Forces are equipped with satellite capability and satellite communication for strategic and tactical connections on national territory and 'out of area' operations with land, sea and air platforms". Stato Maggiore della Difesa (et al.), *SICRAL,* http://www.telespazio.it/docs/Tes53_impg_3_4_09_ita_lowresolution.pdf.

Over the years, the Italian Navy and Air Force have developed greater experience in netcentric operations than the Army because they have fewer platforms which incorporate more technologies and systems able to perform different functions.[7] Take the different types of weapons on the Frigate for example, or the sensors and C4I systems on an aircraft carrier. For the Italian Army, developing netcentric capabilities means modifying tens of thousands of platforms and weapon systems because each individual soldier – and his equipment – will become part of the network. The coordination of these capabilities is an extremely complex task, which the Army could not perform simply by buying *off the shelf* platforms or NEC capability.

The Italian Army has adopted an approach which is divided into several phases. It aims to achieve by 2025 the so-called Integrated Land Force (*Forza Integrata Terrestre* - FIT), a force based on an Integrated Land Brigade (*Brigate Integrate Terrerestri* - BIT). The future brigades will be completely digitized through the entire chain of command, from the individual soldier or single platform such as a helicopter or vehicle, the so called T0 level, through all intermediate levels, such as team, platoon, company, battalion, up to brigade command post or T6 level.

The FIT represents the ultimate long term goal of the entire project: through Forza NEC, the Army should be fully digitized, by 2031. In fact, the procurement program does not only involve combat troops, but aims to "establish a modern land force, expeditionary, network capable and Effect Based Operations-oriented".[8] Considering the hybrid threats occurring in the theatre, for example with the presence of both terrorists and insurgents, the Italian Army in the future should be more mobile, sustainable, lethal, and able to adapt to different circumstances, with the best available SSA. The Army also continues to focus on the protection of forces.

The creation of the FIT for the Italian Army has meant changing the mix of heavy, medium and light components. "Forza NEC" will modify

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[7] Pietro Batacchi, *La Network Centric Warfare e l'esperienza italiana,* Roma, Centro Militare di Studi Strategici (CEMISS), 2009, http://www.difesa.it/SMD/CASD/Istituti_militari/CeMISS/Pubblicazioni/Documents/83169_NetCenWarpdf.pdf.

[8] Aa.Vv., *L'Esercito Italiano*, Torino, UTET-De Agostini, 2009, pp. 8-9.

the composition of the 11 maneuver brigades, the large operative units that provide the bulk of the Italian Army's contribution to international operations. This involves the following Brigades: ARIETE, GARIBALDI, SASSARI, AOSTA, GRANATIERI DI SARDEGNA, PINEROLO, POZZUOLO DEL FRIULI, FOLGORE TAURINENSE, JULIA, and FRIULI. Currently, this component is divided into: 5 Heavy Brigades, armored or mechanized; 2 Medium Brigades; 4 Light Brigades, including paratroopers and Alpines (*Alpini*). The Army has decided to change this structure, reducing heavy units and increasing the medium and light components in order to obtain greater tactical and strategic mobility. At the end of Forza NEC project, the Army should be made up of 2 Heavy Brigades (ARIETE and GARIBALDI), 4 Medium Brigades (PINEROLO, AOSTA, SASSARI and POZZUOLO DEL FRIULI) and 5 Light Brigades (FOLGORE, TAURINENSE, JULIA, FRIULI and GRANATIERI DI SARDEGNA).

The Netcentric approach adopted by the Italian Army follows some basic principles: achieving information superiority; Shared Situational Awareness; rapid command; accurate use of various assets. The approach is also based on three pillars: use of sensors regardless of the platforms they belong to; use of "actuators" regardless of units they belong to; facility of decision makers' interaction regardless of their position on the ground.

From a strategic and geopolitical perspective, as previously mentioned, Network Enabled Capability will be the key to ensuring interoperability of the Italian Armed Forces with those of its most important allies, and thus play a significant and visible role in international operations. At an operational level, Network Enabled Capability is the discriminating factor between success and failure in carrying out joint operations including the three Italian Armed Forces, thanks to the Common Operational Picture provided to all levels of command. At tactical level, it guarantees better communication management, in order to increase the effectiveness of the forces' actions. This also ensures a greater force protection, reducing the risk of collateral damage and friendly fire. These aspects are particularly critical in the current framework, where soldiers are continuously exposed to asymmetric threats and public opinion is becoming more and more sensitive to the death of soldiers.

A core element of the Forza NEC program is Modeling & Simulation (M&S). M&S can be defined as "the ability to easily create realistic scenarios and develop simulations of operations for the purpose of both validating requirements and training and education of troops, in a process of continuous improvement without interruption."[9]

M&S should support joint training and enable the development of doctrines as well as tactics and technical procedures. It should also allow an effective risk analysis of a program's components, through the simulation of adverse events in order to assess the effects and corrective measures. Moreover, it should facilitate the planning and integration of systems, also simulating the physical behavior of the various components. Because of the complexity and diversity of its tasks, M&S is an additional challenge within the Forza NEC program. The tendency to exploit the capabilities of advanced simulation provides benefits in each sector; therefore all Italian Armed Forces have developed a set of suitable structures for M&S.

The result of the Forza NEC program will be to digitize:

- 3 Medium Brigades, namely PINEROLO, AOSTA and SASSARI;
- 1 Joint Landing Force, formed by *Lagunari* SERENISSIMA Army Regiment and SAN MARCO Navy Regiment;
- a set of enablers, equivalent to an additional Brigade, including the Army Aviation component (AVES),[10] Reconnaissance, Intelligence, Surveillance, Target Acquisition and Electronic Warfare (RIST-EW) capabilities, the short-range air defense (SHORAD), as well as protection Chemical, Biological, Radiological and Nuclear (CBRN) and transmission components.

The 2010-2030 Army Operational Concept, (*Concetto Operativo dell'Esercito 2010-2030*) based on the Army General Planning Process directive (*Processo di pianificazione generale dell'Esercito*), addresses

[9] Raffaele Guarino (et al.), *Pragmatismo nell'implementazione delle tecnologie NEC/NCW nella componente terrestre dello strumento militare,* Roma, Capgemini-CEMISS, 2007, p. 36.

[10] Esercito Italiano*, Specialità dell'aviazione dell'Esercito,* http://www.esercito.difesa.it/Organizzazione/Armi_corpi/Aviazione%20dell%27Esercito/Pagine/default.aspx.

the transformation in a more organic way. Based on the Operational Concept, the 2013-2032 Modernization Plan (*Piano di Ammodernamento 2013-2032*) details the procurement needs, the requirements for different systems/platforms, the necessary amount of equipment to be procured, and the schedule of their acquisition, structured on three spirals. In this way, the activities and actions within the Forza NEC program have been harmonized in a more structured framework to upgrade operational and logistic equipment, concretely amplifying the scope of the program and improving its effectiveness. The Italian Army has recognized that without such adjustments Forza NEC may lead to a two-tier Army at different levels of digitization and thus modernization. This would in turn have meant the digitized Medium Brigades would have been overused, while the light and heavy brigades would have had their interoperability compromised. The new Operational Concept prevents the creation of a two-tier Army. The document realigns the modernization strategy in a more comprehensive way and aims to achieve a homogeneous force package made up of approximately 10,000 men. They take turns according to an operational cycle divided into several incremental levels of efficiency and readiness.[11] In this context, all Brigades will be equipped with a set of advanced equipment, such as the Future Soldier (*Soldato Futuro)* equipment, and advanced command, control and communication system. In addition, according to available resources, the armored vehicles should be updated and digitized. The fact that in different operational situations the availability of a light infantry or armored component is critical to build forces' packages able to face the full spectrum of potential activities, must be taken into consideration.

With regards to the joint aspect, the Army and the Navy utilize two different command and control systems. The first one uses the Army General Staff Command and Control System (*Sistema di Comando e Controllo dello Stato Maggiore dell'Esercito* - SIACCON), while the Navy has

[11] The different phases are the following: reconditioning, general and specific training, deployment's availability on national territory, specific preparation for the use in a particular theater of operation.

the Maritime Command and Control Information System (MCCIS)[12] and the Command and Control Personal Computer (C2PC),[13] respectively for the strategic and tactical levels. From a netcentric and joint perspective, the systems' interaction is crucial. Therefore, Forza NEC has developed a special gateway that enables connection and interoperability between the C2 systems. As specified in a recent document issued by the General Staff of Defence, the gateway is a device constituted by hardware and above all software that ensures both horizontal and vertical information exchange between strategic-operational and tactical level of different Armed Forces.[14] Therefore it is an essential element for the creation of the Army-Navy Landing Force.

4. FORZA NEC PROGRAM

4.1. The asset legacy issue

Forza NEC had to be harmonized with other modernization and procurement programs being developed by the Ministry of Defense before its launch, in order to avoid duplication and inefficiencies resulting in a waste of resources. In theory, there are two ways to making the Italian Army's vehicles and systems netcentric. The first involves removing all the current non netcentric equipment, and replacing it completely with new netcentric equipment. The second option is to upgrade *pro tempore* the current vehicles to new net-centric standards, while in the medium and long term the new systems equipped with net-centric capabilities gradually replace the old ones. The first solution seems the most straightforward, but practically it would be too expensive, with the bur-

[12] Jane's, *Maritime Command and Control Information System*, 20 agosto 2010, http://articles.janes.com/articles/Janes-C4I-Systems/Maritime-Command-and-Control-Information-System-MCCIS-NATO.html.

[13] Global Security, *Command and Control Personal Computer (C2PC),* 2001, http://www.globalsecurity.org/intell/library/reports/2001/compendium/c2pc.htm.

[14] Comando Logistico dell'Esercito, *Forza NEC il cammino della trasformazione,* Firenze, Istituto Geografico Militare, 2010, p. 37.

den of new training for all the military personnel due to the new nature of the systems. Therefor the second solution was chosen, by cleverly re-utilizing the "asset legacy". As a result, during the development of Forza NEC the Italian Army will use both old equipment with NEC upgrades, and new equipment already provided with net-centric capabilities. Over the years the life-cycle of various legacy assets will end and be replaced with new digitized versions. This will prevent capability gaps between old and new equipment, and a waste of working assets already known by military personnel.

Forza NEC aims to integrate other systems and programs under a single and comprehensive umbrella. These are:

- the command and control system of the Army (Sistema di Comando e Controllo dello Stato Maggiore dell'Esercito - SIACCON);
- the command, control and navigation system for the combat units' digitization (Sistema di Comando, Controllo e Navigazione - SICCONA);
- th "Future Soldier" program (Soldato Futuro);
- Blue Force Situational Awareness (BFSA), a system to identify friendly units;
- Software Defined Radio (SDR), a new type of communication equipment.

The coordination and integration of all these programs, including those already underway when Forza NEC was launched, presents a big challenge to Italian military and industry.

Forza NEC as a whole will be interfaced with the command and control system of the Italian Defence General Staff, and with the Defence Information Infrastructure (DII), namely the evolution of the telematic system for the Italian military.[15]

[15] This topic was discussed in the 157th session of the IV Commission (Defence) of the Italian Senate, on October 12, 2010, http://www.senato.it/japp/bgt/showdoc/frame.jsp?tipodoc=SommComm&leg=16&id=508056.

4.2. The financial commitment

The total cost of Forza NEC has been estimated at €22 billion over 25 years. Currently, for the biennium 2010-2011, initial funding of nearly €325 million has been provided, while for the years 2012-2016 there is a second *tranche* of €475 million, for a total of about €800 million. The cost of the first spiral, which extends over the years 2007-2018, is estimated to be around €9.5 billion.

The financial commitment has required close cooperation between the Ministry of Defence (MoD) and the Ministry of Economic Development (*Ministero dello Sviluppo Economico* - MiSE). In fact, because of the size and the impact of Forza NEC on national industry, the funds for research on future systems and equipment will be covered by MiSE budget rather than by the MoD's. The MoD's Land Armaments Directorate (*Direzione Armamenti Terrestri* - DAT) is the contracting authority for the entire program. After the Research and Development (R&D) phase, the costs of the next phases will be covered by the Ministry of Defence. The regularity and certainty of funding is essential for the success of the procurement program. Forza NEC requires constant and parallel progress in the various inter-dependent programs, because a setback of one would have an immediate negative impact on the others.

At the same time, the contract should be able to respond to any internal or external change which may occur in the coming years, such as evolutions in the operational scenario, personnel reductions, or substantial cuts to funding. The "Modernization Plan" (*Piano di Ammodernamento)* developed by SMD divides the capabilities in specific packages of capabilities. This approach is quite flexible, and allows the costs to be reduced on the basis of a capability assessment: if there is a reduction of funds, it will be possible to reduce some testing units. For example, instead of testing the new net-centric vehicles at company level, it could be possible to test a platoon-size unit. The tested unit, although smaller, still has its coherence and usefulness in operational terms. It is also clear, though, that it is not possible to fall below certain thresholds, such as just the platoon, in order to test usable assets. Some specific funds, the so-called "baskets", are planned to manage unexpected costs, such as infrastructural works, systems support, technological adjustments or other needs which could arise during the contract.

4.3. The timeframe: the program' phases

The program will cover a period from 2007 to 2031, with a spiral approach similar to that of projects of other NATO countries. Forza NEC is the single largest procurement program managed by the Italian Army, as it involves the full spectrum of land capabilities, from the dismounted soldier to the highest command levels. As a result, the acquisition of capabilities needs to be divided into several spirals. The gradual fulfillment of the different spirals will enable the Armed Forces in 2031 to have a full divisional unit with NEC capabilities. As mentioned, an immediate acquisition of all the net-centric assets would not be sustainable in terms of costs, and would also mean that equipment became quickly out-of-date due because of the rapid evolution of technology. Therefore a spiral approach has been preferred to a traditional one in order to gradually deploy the program's different vehicles and systems. The first phase, by 2018, includes the creation of the first Digitized Medium Brigade (*Brigata Media Digitalizzata*), the digitization of the amphibious Landing Force and the digitization of 50% of enablers. The first Brigade to be digitized is the PINEROLO Mechanized Brigade. The second spiral by 2026 will see the upgrade of the AOSTA Medium Brigade with NEC standards which are even more evolved than those of the PINEROLO, and the digitization of a further 25% of enablers. The third and final spiral will be completed by 2031. It will include the netcentric upgrade of the SASSARI Medium Brigade, and the digitization of the final 25% of enablers.

Forza NEC sets out very long term targets. These require a careful sequence of acquisition of capabilities, because a delay in the deadlines of a single capability could stop other parallel projects, damaging the effectiveness of the whole program. Before starting the mass acquisition of technologies', it was necessary to test the proper functioning of all the assets, establishing a specific experimentation and assessment phase for the various equipment. The Forza NEC program includes the following phases:

- The feasibility study, completed in 2007;
- The Project Definition (PD) phase, which includes the initial design of the force as well as the start of activities for the implementation of the Integration Test Bed (ITB);

- The Concept Development and Experimentation (CD&E) phase;
- The implementation phase of the first spiral, which includes: the completion of the ITB, the link between the various joint Modeling and Simulation (M&S), the creation of the first Digitized Medium Brigade (*Brigata Media Digitalizzata*), the digitization of the amphibious Landing Force, the digitization of 50% of enablers;
- The implementation phase of the second spiral, which includes the creation of the second Digitized Medium Brigade and the digitization of 25% of enablers
- The implementation phase of the third spiral, which includes the creation of the third Digitized Medium Brigade and the digitization of the 25% of enablers.

Forza NEC's feasibility study was the first theoretical step in the elaboration process of the whole program's structure. The study began in January 2007 and lasted six months. It developed a series of core elements such as:

- The drafting of the Operational Requirements of a Medium Digitized Land Force (*Forza Media Digitalizzata Terrestre*) and of the Landing Force;
- The definition of the architecture, that is the general structure of the program;
- The verification of economic feasibility, on the basis of the timetable and the available financial resources;
- The definition of the ITB as main tool to test and assess systems, vehicles and technologies;
- The definition of strategy and planning related to the future program's developments.[16]

The feasibility study was issued and approved in July 2007, opening the Project Definition phase. This first involved a Risk Reduction (RR) phase and then the real Project Definition. It begun in September 2007 and was intended to last about 18 months, then ending in March 2009. The initial PD expiry date, however, was postponed by a few months. As a

[16] AA.VV., *L'Esercito Italiano*, cit., 2009, p. 11.

result the launch of the next phase of CD&E moved from December 2009 to June 2010. The PD had four goals:

- To continue the feasibility study's analysis in order to mitigate the risks;
- The detailed design of Forza NEC and ITB architecture;
- The achievement of a Modeling and Simulation (M&S) capacity through the first ITB structure;[17]
- The planning of the following phases of the program.

Other defense procurement programs tend to move directly from Project Definition to the production of various materials and capabilities. However, due to the complexity of Forza NEC and the huge financial commitment, a new step was inserted between the PD and the subsequent production phase: the CD&E. The CD&E serves as a "capacity bridge"[18] between the two phases, and is aimed at evaluating the coherence and effectiveness of the various systems to be adopted prior to their production. In other words, it is a kind of mass risk reduction, which by a long series of tests through the ITB will provide a range of assets, like systems, technologies and equipment, already tested, monitored and controlled extensively. This will mitigate the risk of following problems with the supplies deployed.

This specific phase begun formally with contract n. 1.219 of June 9, 2010, and will last until 2013. On September 13, 2010 the framework contract for funding CD&E was signed, and consequently early execution of 20% of the contract has begun. This was regulated by article 30 of the Ministerial Decree (*Decreto Ministeriale* - D.M.) number 583 of August 15, 1995. It provides for the early implementation of the contract "in cases of urgency" and "up to a maximum of one fifth of the contract value."[19] The CD&E phase has four objectives:

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[17] Aa.Vv., *L'Esercito Italiano*, cit., 2009, p. 12.

[18] Comando Logistico dell'Esercito, *Forza NEC il cammino della trasformazione,* cit., p. 20.

[19] D.M. 5 agosto 1995, n. 583, http://www.difesa.it/Segretario-SGD-DNA/DG/COMMISERVIZI/Direttive_e_Normative/Documents/64_cond.pdf.

- The architectures' design for the digitization of the equipment and the network nodes[20] of the first spiral, including Command, Control, Communications Computers and Intelligence (C4I) capabilities;
- The ITB development and implementation. The ITB will analyze, validate and support the testing of C4I capabilities and personnel training. It will also test prototype systems of digitized vehicles, to get the appropriate feedback for eventual changes;
- The definition of the main production projects and the development and testing of prototypes;
- The procurement of the core Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance (C4ISTAR), and Command, Control and Navigation (C2N) systems. After the ITB evaluation these systems will provide the C4I backbone of Forza NEC.

The four objectives include 36 types of technical and operational projects: 7 projects refer to the first objective, 9 to the second, 8 to the third and 12 to the fourth. The 36 projects created 39 technical specifications (*Capitolati Tecnici*) related to various supplies: an integration of the different systems has already been planned.

4.4. The Integration Test Bed (ITB)

The ITB plays a central role in the CD&E. It is composed of a series of interconnected sites, which enables to support validation activities, system integration verification and testing to orientate the following developments. The ITB is the practical application of Modeling and Simulation, that is "activities aimed at accurately reproducing scenarios and physical and organizational features of units, vehicles and weapon systems",[21] in a virtual environment. M&S is therefore a necessary support for the systems' development, and the ITB is its concrete implementa-

[20] The term node refers to any single element of the line of command, starting from the lowest level, called T0, up to the brigade command post, known as T6. The level T0 could be the single soldier or a vehicle, like a tank, an armored vehicle or an helicopter.

[21] AA.VV., *L'Esercito Italiano*, cit., p. 16.

tion. The ITB can test all the various current and future equipment of Forza NEC. It is also used to train personnel.

The ITB will work during all the program's spirals to test the various capabilities. Forza NEC is a joint program; therefore the ITB is structured on a variety of different sites belonging to the various Italian Services, each one testing specific capabilities. Among the various sites the Italian Army Centre of Simulation and Evaluation (*Centro di Simulazione e Valutazione dell'Esercito* - CESIVA) is the hub of all Army, Navy and Air Force ITBs, also because Forza NEC is an Army-led joint project. The construction of CESIVA's ITB is now in progress. The other ITBs are divided in operational structures, such as the Cavalry School (*Scuola di Cavalleria* - SCUCAV) and the Infantry School (*Scuola di Fanteria* - SCUF), and in technical structures, such as the Army Information and Signals Command (*Comando Trasmissioni e Informazioni dell'Esercito* - COTIE), the Signals and Information Technologies School (*Scuola Trasmissioni e Informatica* - SCUTI), the Army Multi-purpose and Testing Centre (*Centro Polifunzionale di Sperimentazione dell'Esercito* - CEPOLISPE) and the Army Logistical Command (*Comando Logistico dell'Esercito* - COMLOG).

The ITB Navy hub will be the Navy Programming Centre (*Centro di Programmazione della Marina Militare* - MARICENPROG). It will supervise the Navy Landing Forces Command (*Comando delle Forze da Sbarco* - COMFOSBARC) and the Navy Signals and Information Technologies Centre (*Centro di telecomunicazioni e informatica della Marina Militare* - MARITELE). The ITB for the Air Force will be the Air Force M&S Centre, which will supervise the Experimental Flight Centre (*Centro Sperimentale di Volo* - CSV), the C2 Systems Innovation and Management Unit (*Reparto Gestione ed Innovazione Sistemi Comando e Controllo* - ReGISCC), the Technical-Operational Electronic Warfare Support Unit (*Reparto Supporto Tecnico Operativo Guerra Elettronica* - ReSTOG) and the Airspace Control Training Unit (*Reparto Addestramento Controllo Spazio Aereo* - RACSA). These sites will be mutually interconnected. Each one of them has a control room that masters simulation control and data exchange with other sites. The whole ITB network will therefore benefit from the constant circulation of information from each site to the others.

The ITB also encompasses some training innovation. For example,

defence industry staff providing the technologies for testing, operate side by side with military personnel. For instance, when a new vehicle is deployed, the fact that civilian and military personnel work together facilitates the learning process by the end user. Today procurement contracts also include a "training package" for some units of military personnel. After the training period with the new equipment, the trained personnel will be deployed to other units in order to spread their acquired knowledge as much as possible. This will avoid the burden and the cost of additional training cycles. Secondly, the military is planning the enhancement of e-learning via its intranet, which will save additional training costs through distance training: the military personnel will attend a series of classes on their own specialties by accessing intranet, regardless of their location.

Forza NEC training will use the traditional live approach, but it will also use the virtual approach based on real people using simulated systems, and a constructive approach with simulated people utilizing simulated systems.[22] For example, in the SCUTI facility a simulator of an Armored Medium Vehicle (*Veicolo Blindato Medio* - VBM) has recently been installed, and a SICCONA simulation system is planned for the SCUCAV. By using these devices, personnel can be trained as though they are using the real thing. Some NEC multimedia courses have already been prepared and distributed to many training institutions, such as the military Academy of Modena, the Army Non-Commissioned Officers School, the Army Application School and General Staff Course.

The next step of CD&E was to identify a suitable structure in terms of location, size and capacity, able to become the Experimental Digitization Unit (*Unità Sperimentale per la Digitalizzazione* - USD), for the Italian Army. Rather than creating a special unit from scratch, it was decided that the 31 Tank Regiment in Altamura[23] be used. The USD "has the task to verify the compliance of vehicles and digitized equipment, to test tac-

[22] Comando Logistico dell'Esercito, *Forza NEC, Il cammino della trasformazione,* cit., p. 40.

[23] *La Direzione Generale degli armamenti terrestri,* http://www.difesa.it/Segretario-SGD-DNA/SGD-DNA/DPI/Documents/57838_09DirezioneGeneraleArmamentiTerrestriGeneralDirect.pdf.

tics, techniques and procedures for their optimal use."[24] The new *Freccia* VBM and "Future Soldier" (*Soldato Futuro*) equipment package will be tested in addition to the *Dardo* and *Centauro* legacy armoured vehicles, within the same brigade, the 82th *Torino* Infantry Regiment will be the first unit to be digitized to benefit from the results of the CD&E phase.

The 82th Infantry Regiment will train its personnel with the new *Freccia* VBM. It should also test the first Digitized Barrack, a building with a specifically designed interface to interact with net-centric vehicles, weapon systems and equipment. The 2010 Army Report (*Rapporto Esercito 2010*) indicates the Army barracks *Stella* in Barletta as the prototype of the future Digitized Barracks project. In addition to the traditional functions, the Digitized Barrack aims to create a cutting-edge structure where, for instance, a vehicle back from a mission could directly download the mission's data into the barrack's database. This system is a kind of military plug and play device. Similarly to connecting a USB key in a computer, it will be sufficient to plug the vehicle to the barrack's infrastructure to ensure that the two systems interact automatically, for example exchanging information and data.

The 9th *Bari* Infantry regiment, located in Trani, will support the 82nd Regiment. The SCUCAV, an ITB site, is located in Lecce, close to the other two regiments. The geographic proximity will reduce costs and the time needed for equipment' trials. The activities in Italy are supported by other tests abroad, particularly in Afghanistan.[25] There the NATO mission is testing its own NEC structure, the Afghan Mission Network (AMN).[26] Several Italian Army companies are involved, and are experimenting in tern the new capabilities[27] in operational theater. On their return to Italy, feedback from the various units is gathered and used as a

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[24] Fortunato Di Marzio, "Forza NEC, inizia la sperimentazione"*,* in *Rivista militare,* vol. 5, 2009, pp. 25-26.

[25] For instance, on June 2010 Pinerolo Brigade sent in Afghanistan a first company equipped with VBM *Freccia*, Comando Logistico dell'Esercito, *Forza NEC, Il cammino della trasformazione,*cit., p. 13.

[26] NATO, *The Afghan Mission Network,* http://www.airn.nato.int/focus_areas/mjo/articles/mjo0310.htm

[27] The Italian units were deployed in the Shindad *Task Force Center,* in Herat province; Comando Logistico dell'Esercito*, Forza NEC, Il cammino della trasformazione,* cit., p. 33.

basis to make adjustments, in order to develop improved versions of the vehicles'. The new version of the *Freccia* VBMs, for instance, has already been deployed to Afghanistan. After many tests some of the *Lince*'s features such as the electrics system, or the vehicle's payload,[28] were also improved. For the first time defence industries' personnel were deployed together with the troops the theater, experiencing firsthand, the same daily problems faced by the military units. This in turn has helped civilians to better understand the role and use of equipment, whilst improving synergies between the military and industry.

4.5. The methodology

Forza NEC has entailed many advances not only in the technological field, but also in the project's methodologies and governance. The program's methodology is very different from those of the past, when acquisitions were made of a significant amount of equipment of the same technological level. Naturally the Forza NEC long term timeline will involve some adjustments to production during its execution, due to technological or operational developments that will occur in during its implementation. As a result, the program management follows three principles:

- The "capability approach";
- The "Transforming while operating" principle;
- The "Evolution throughout production" principle.

The "capability approach" derives from a methodology already used by NATO. This procedure considers the military capabilities to be deployed in relation to certain requirements, to identify architectures, systems, means and all the assets that could "carry out the necessary functions to provide the military with such capabilities."[29] The principle "transforming while operating" stipulates that new systems will not only increase

[28] In this case the tests in the field highlighted the need for more plugs and to carry heavier weights. As a result of this this feedback, changes to the vehicle were made.

[29] Comando Logistico dell'Esercito *Forza NEC, Il cammino della trasformazione,* cit., p. 7.

the capabilities, but also to be fully integrated with existing systems, without reducing the overall capabilities. In practical terms, for instance, the new *Freccia* that will be deployed, or the future armored vehicle *Centauro 2.0*, will be fully compatible and ready to be integrated with existing assets.

"Evolution throughout production" is one Forza NEC's most important principles. It implies that development and production phases are not designed as two separate domains. Rather, they are linked by the "evolutionary acquisition" concept, which means acquisition during the program's development. This approach is based on flexible procurement procedures and it is necessary when there are technologies with a short life-span, such as electronics or IT. In this way, during the contract it is possible to upgrade systems and equipment according to the various technological evolutions. Systems and equipment are designed as open architectures which allow them to be updated or upgraded during the project's execution. This approach aims to prevent the use, over the years, of systems and equipment with different technologies which are neither adjustable nor interoperable. In other words, the net-centric structure allows equipment to be reconfigured as new advanced solutions are developed, without affecting the equipment itself and therefore without having to remove and replace the earlier equipment with new versions.

To ensure a coordinated modernization of the various components, the above-mentioned CD&E phase was established. The CD&E is regulated by the DOTMLPFI approach, of Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities, Interoperability. This acronym expresses an idea originally developed in the US and later adopted by NATO. It implies that these elements should be analyzed together during a procurement program. Compared to the original "DOTMLPF methodology" in the US, the Italian Defence General Staff has added an "I" for interoperability, to emphasize the importance of this element. By using this methodology, the new vehicles and systems in the elaboration phase should be reviewed and analyzed in light of these parameters, to predict, at least in theory, all the possible implications brought about by Forza NEC technologies.

4.6. Governance

Forza NEC has made it necessary for the Italian military to make many adjustments due to the complexity, scale and length of the project. There was also a need to fully integrate the industrial side into the process right from the beginning of the program. These requirements led to a reorganization of the administrative offices dealing with Forza NEC.

The project governance was defined on three levels:

- The strategic level is represented by the Steering Committee chaired by the Army Logistical Commander, delegated by the Army Chief of Staff and with the participation of Departments Heads of SMD, Italian Army Staff (*Stato Maggiore Esercito* - SME), Air Force Staff (*Stato Maggiore Aeronautica* - SMA), Navy Staff (*Stato Maggiore Marina* - SMM) and SEGREDIFESA;[30]
- The operational-technical level, chaired by the Head of SME's Land Transformation Department, is divided in 5 working areas and 15 Task Forces, which gather representatives of the General Staffs, the Land Armaments Directorate and SEGREDIFESA;
- The administrative-technical level, represented by the Program Directorate established within the IV Department of SEGREDIFESA, which deals with the technical management and the relationships with industries, Armed Forces Staffs, and technical Directorates. This level is also represented by the pilot Technical Directorate represented by the Land Armaments Directorate (*Direzione Armamenti Terrestri* - DAT),[31] which specifically deals with the technical-administrative activities.

On the administrative side the Ministry of Defence has chosen to adopt a joint approach, involving all the Armed Forces in a synergic way. Forza

[30] The Secretariat General of Defence/ National Armaments Directorate (*Segretariato Generale della Difesa - Direzione Nazionale degli Armamenti* – SEGREDIFESA) was established in 1965. Currently it supervises the MoD 9 General Directorates and provides the functioning of the MoD tecnical-administrative branch, the research and supply of armaments, vehicles and equipment. http://www.difesa.it/Segretario-SGD-DNA/SGD-DNA/Pagine/default.aspx.

[31] Comando Logistico dell'Esercito, *Forza NEC il cammino della trasformazione,* cit., p. 11.

NEC governance unit reports regularly on the program's progresses directly to the Chief of Defence Staff.

The solution proposed for the MoD administrative-operational area (*Area tecnico-amministrativa)* includes:

- A general pilot Directorate, represented by the Land Armaments Directorate as the sole responsible for the whole contractual activities. The pilot Directorate guarantees the contractual and management unity of the procurement. The DAT is also "the contracting authority" with regards to the Ministry of Economic Development MiSE.
- On November 1, 2007, within SEGREDIFESA (Department IV), a special Forza NEC Program Directorate[32] was established as a body for coordination, management, control and verification of the whole program's aspects, without prejudices of the General Directorates roles. The Forza NEC Directorate is also tasked to gather eventual requests from Armed Forces Staffs, the General Directorates and industry in order to find shared solutions.

The Forza NEC Program Directorate merged the former Future Soldier, Battlespace Digitization and Combat training center Directorates. Through the Head of the IV Department, Forza NEC falls under the responsibility of the Secretary General/National Armaments Director (*Segretario Generale/Direttore Nazionale Armamenti* - SG/DNA). Its tasks include:

- Control and monitoring of projects;
- Control of the integration level;
- Requests for technical variations;
- Proposals to reshape the financial commitment;
- Coordination with other related programs.

The control tasks are crucial for the consistent evaluation of the progress of Forza NEC. To this end, some joint Project Integrated Groups have been created to monitor certain contractual aspects. In 2006, within SME, the Department for Land Transformation (*Dipartimento per la*

[32] Ministero della Difesa, *Segretariato Generale della Difesa/DNA*, http://www.difesa.it/Segretario-SGD-DNA/SGD-DNA/Pagine/Le_Procedure_di_Acquisizione.aspx.

Trasformazione Terrestre - DTT) was created to "coordinate and manage the Army modernization process with a holistic DOTMLPFI[33] approach and a transversal mandate for the organization of the Army at a senior level".

Finally, the MoD has decided to establish a single hub for the various contracts, the Land Armaments Directorate, responsible for all the procurement activities and management. This was also required in order to utilize the MiSE funds. SME is responsible for planning the operational requirements, for example identifying who is responsible for the exchange of information with the relevant units. These procedures are particularly important for ensuring that communication systems are effectively used in the field. Moreover, SME plans what to procure and when, choosing the vehicles and systems for modernization, the brigades to digitize and the timetable for such activities. All the decisions are taken under the 2010-2030 Operational Concept and the 2013-2030 Modernization Plans.

4.7. NEC Force: opportunities and challenges

Forza NEC aims to go beyond a simple integration of different technologies. It indeed aims to create a "system of systems", able to fully exploit different elements such as firepower, C4ISTAR capability, full interoperability, a more effective forces protection, systems to prevent friendly fire (known as blue-on-blue),[34] and better logistical support to face the challenges posed by future interventions. Forza NEC, however, carries several vulnerabilities for the Army, in particular in the electronic and cyber warfare fields. In fact, all the different systems, from the simple soldier to the command post, will be part of huge and constant data flow which is both bottom-up and top-down. This increases the risk that someone may intercept or disrupt the flow of communications. This

[33] Stato Maggiore dell'Esercito, *Stato Maggiore dell'Esercito - La struttura* http://www.esercito.difesa.it/Organizzazione/Organizzazione%20Centrale/Stato%20Maggiore%20Esercito/Pagine/DipartimentoImpiegodelPersonale.aspx.

[34] "Blue-on-blue" comes from the blue color used in the training maps: the blue color shows friendly units. Therefore "blue-on-blue" fire means firing on allied units.

could also happen if an opponent seizes an asset, such as a vehicle or a soldier radio. In a NEC environment each element, from the soldier to a vehicle, could be a source of vulnerability. As a result, a series of actions to guarantee the security of communications have been taken. For example, the names and frequencies turnover, data encryption, data transmission, varying radio frequencies to randomly avoid interception (a practice known as "frequency hopping"), the use of updated radio, or the provision of different communication networks, physically separated into "classified" networks and "non classified" or "no-class" networks have been planned. The analysis of operational and procedural mechanisms has resulted in a number of instructions being issued to prevent electronic interference from opponents. For example, the new routers can choose the bandwidth of communication according to the operator's directives, and the antennas can emit a signal in a single direction only in order to reduce the risk of interception.

The information distribution is not completely horizontal, but instead vertical or, more precisely, functional. While the individual soldier has a limited amount of information, the platoon commander has more, and the higher command levels have an even more complete picture. The hierarchical structure starts from the Future Soldier program, and then moves to SICCONA up to SIACCON for command post levels. This will prevent the information congestion of the peripheral units, such as soldiers, but will also prevent the distribution of sensitive and confidential data, and therefore the likelihood of interception by third parties. With this ability, in the future, the higher levels of command could even use an individual soldier as a sensor, thanks to the Future Soldier package. This will let the strategic and operational levels see what the soldier is observing on the field in real time. The individual elements, such as a soldier, a vehicle, or a helicopter will therefore have a double role. They can target opponents thanks to their armaments, such as the weapon for the individual soldier, a machine gun or cannon for the vehicles. At the same time, they are sensors for the higher command level. With the constant flow of information even the lower level units could have a clearer overview. This in turn should allow better communication of orders as well as greater security for the units.

4.8. Some examples of equipment

Among the equipment already used or under development by the Italian Army are the following vehicles and aircrafts:

Centauro: the "heavily armored car Centauro" is an eight-wheeled combat vehicle with a 105/52 cannon. *Centauro* is one of the most important innovations in the Italian military, and by the early 90s was the backbone of the Army Cavalry units. It has also been exported to Spain and Oman. It requires a four people crew and can carry from 2 to 4 soldiers more in the rear area. It weighs 26 tons and in addition to the 105/52 cannon the armament includes two 7.62 machine guns. Its maximum speed is 100 km/h.[35]

Helicopters: the three main helicopters involved include: the A129 *Mangusta* helicopter "for reconnaissance and escort" (*Elicottero da Esplorazione e Scorta* - EES), armed with the anti-tank SPIKE missile system (the deployment is underway), 70 and 81 mm rockets and a 20 mm cannon;[36] the NH90[37] and the CH-47[38] for transport purposes.

Dardo: The *Dardo* is a tracked armored Infantry Fighting Vehicle (IFV), which carries three crew members plus a team of six people. It weighs about 24 tons and the armament is a 25 mm cannon as well as a coaxial 7.62 machine gun. Its maximum speed is 70 km/h.[39]

Freccia: The eight-wheeled vehicle *Freccia* "is the main vehicle of the new NEC Land Brigade, and it is the first digitized vehicle of the Italian Ar-

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[35]Esercito Italiano, *Blindo armata pesante "Centauro",* http://www.esercito.difesa.it/Equipaggiamenti/armi_materiali_mezzi/Mezzi/Ruotati/Blindati/Pagine/BlindopesantearmatCentauro.aspx.

[36] Esercito Italiano, *A 129 "Mangusta",* http://www.esercito.difesa.it/Equipaggiamenti/armi_materiali_mezzi/Aeromobili/Elicotteri/da%20Esplorazione%20e%20Scorta/Pagine/A129Mangusta.aspx.

[37] Esercito Italiano, *NH 90,* http://www.esercito.difesa.it/Equipaggiamenti/armi_materiali_mezzi/Aeromobili/Elicotteri/da%20Trasporto/Pagine/NH90.aspx.

[38] Esercito Italiano, *CH 47 c,* http://www.esercito.difesa.it/Equipaggiamenti/armi_materiali_mezzi/Aeromobili/Elicotteri/da%20Trasporto/Pagine/CH47C.aspx.

[39]Esercito Italiano, *VCC Dardo,* http://www.esercito.difesa.it/Equipaggiamenti/armi_materiali_mezzi/Mezzi/Cingolati/Trasporto%20e%20Combattimento/Pagine/VCCDardo.aspx.

my."[40] Belonging to the same family of *Centauro*, *Freccia* can carry 11 equipped soldiers, of which three as crew. The vehicle is equipped against new threats such as the Improvised Explosive Device (IED)[41] and it will be available also in many forms such as "Command post", "Mortar" and "Anti-tank". The vehicle weights 28 tons and it is armed with a 25 mm cannon and a 7.62 machine gun. Its maximum speed is 105 km/h.

UAV and UGV: the Army intends to adopt one of the most recent military technologies such as the Unmanned Aerial Vehicle (UAV) for the air component and the Unmanned Ground Vehicle (UGV).[42] This equipment, thanks to the absence of a pilot can sustain a wide range of actions without the limits of human being. Some examples are its ability to fly for many hours, or to control or attack very dangerous areas without risking the soldiers' life.

The UAVs[43] can be used in many different contexts, both military and civil. For military purposes, UAV could attack, for example with missiles, be used in reconnaissance, intelligence or surveillance roles. Currently, the Army is acquiring some Tactical UAV systems for medium-range reconnaissance, intelligence and surveillance purposes, and has acquired some micro UAV systems for a short range (0-10 km) use. The UGVs[44] can be used, for example, to find out a mined area.

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[40] Esercito Italiano, *VBM 8x8 "Freccia",* http://www.esercito.difesa.it/Equipaggiamenti/armi_materiali_mezzi/Mezzi/Ruotati/Blindati/Pagine/VBMFreccia.aspx.

[41] "Gli ordigni esplosivi improvvisati, più comunemente conosciuti come IED (*Improvised Esplosive Device*), sono ordigni realizzati in maniera artigianale tramite l'impiego di esplosivi recuperati da parti di ordigni convenzionali (proiettili e mine) ed esplosivi artigianali fatti in casa", in Ministero della Difesa, *IED - Improvised Explosive Device,* http://www.difesa.it/Content/Pagine/IED.aspx.

[42] Eugenio Po, "L'EI e il programma Forza NEC"*,* in *Rivista Italiana Difesa*, n. 10, 2009.

[43] For a juridical analysis, Rocco Lobianco "Unmanned aerial vehicle" in Rocco Lobianco, *Compendio di diritto aeronautico,* Milano, Giuffrè, 2009*,* pp. 110-111.

[44] "*It is not only unmanned aerial vehicles (UAVs) that are changing the nature of warfare by becoming increasingly sophisticated and able to take over more of the roles of manned flight. Also coming are unmanned ground vehicles (UGVs). Like UAVs, the ground versions will first be employed on triple "Ds"; that is dirty, dangerous and dull work. Robots that help to detect and defuse mines are already doing service, although these are operated by remote control*" The Economist, *Now follow me*, July 21, 2010, http://www.economist.com/blogs/babbage/2010/07/unmanned_ground_vehicles.

VLTM Lince: the Light Tactical Multirole Vehicle (*Veicolo Tattico Leggero Multiruolo* - VTLM) *Lince* is a four-wheeled drive vehicle already successfully deployed in Afghanistan. Around 1150 units have already been provided to the Army. The *Lince* has a high-security standard due to the special shape of the passenger cell. It can carry four people plus the pilot, it weighs 6.5 tons and has a top speed of 130 km/h.

VTMM: the Multirole Medium Tactical Vehicle (*Veicolo Tattico Medio Multiruolo* - VTMM) has been jointly developed by IVECO and Kraus-Maffei, as a multi-role vehicle for non-combat but rather logistical, electronic warfare, engineering, command post or ambulance tasks.[45]

5. FORZA NEC'S INDUSTRIAL COMMITMENT

5.1. The defense industry and the net-centric challenge: backbone and ITB

For many years the national defense industry has been faced the challenge of digitization, today one of the most ambitious goals for the military. The industry's ability to produce different types of high-quality platforms, such as vehicles, tanks, ships or aircraft, is a strong indication of dynamism, but in the current context most of these systems are ineffective without a net-centric capability. The need to produce interconnected systems and to integrate them in a coherent way is a challenge both for the General Staffs and for the industry. The latter, particularly, compete in this new technological field. The defense market is becoming more international, European and transatlantic, and even global.[46]

[45] Roberto Cibrario Assereto, *Audizione presso la Commissione Difesa del Senato della Repubblica,* 9 giugno 2011, http://www.senato.it/documenti/repository/commissioni/comm04/documenti_acquisiti/audizione%20dr.%20Cibrario%209giu2011%20-%202.pdf.

[46] "The deconstruction of the previous balance of power and the gradual reconstruction around new equilibrium has had an obvious impact on the international defense market", Dottori Germano, Marrone Alessandro, "Il mercato della difesa tra geopolitica e globalizzazione", in Catalano Claudio (a cura di), *BARICENTRI: lo shift globale degli equilibri politici, economici e tecnologici?,* Roma, Finmeccanica Occasional Paper, 2010.

Therefore the industrial system also needs to open up to foreign competition, at the same time being able to penetrate markets that in the past were closed to certain companies. The competition challenges have caused the birth of new partnerships between companies, forcing industry and research to increasingly improve themselves and their policies. Today such improvements are necessary to compete with a number of players, whilst facing shrinking defense budgets throughout European.

Inevitably the NATO NEC concept is will influence defence procurement and thus the related market in the coming years. The basic ideas of this concept have imposed a series of new requirements, to which industry has had to adapt. Modularity, interoperability, flexibility, and industrial-military cooperation are some of the new key words that are shaping the evolution of defence market.

The Italian military as a whole is deeply involved in the net-centric debate. The military-industry dialogue on the related procurement programs should consider some key elements:

- The increasingly joint and combined nature of future operations;
- The foresight of future areas of operation;
- Possible geopolitical changes;
- The differences between the Services;
- Some "pre-NEC" ongoing projects and the asset legacy issues;
- The inherited traditional approach with its limited public-private interaction;
- The need to make dozens of systems and equipment from different suppliers interact;
- Strict budget constraints due to current economic conditions.

The need for a holistic NEC approach has led to a series of reflections by both the military and industry. They had to consider a pre-NEC scenario where there had already been some asset acquisitions oriented towards battlespace digitization. While these previous acquisitions lacked of coordination, Forza NEC aims for a different approach to a standard procurement program, simply based on orders and sales. The military has needed a further step to analyze and assess equipment before the final acquisition of net-centric capabilities and technologies, at the CD&E phase and the ITB.

The first objective of the CD&E phase concerns the architectural design and the C4I[47] backbone development. The backbone is the main telecommunication infrastructure which enables the information flow among the various command and control (C2) systems. The transmission capacity and data sharing is a *conditio sine qua non* for the whole Forza NEC program: without a robust network for information flow, any net-centric capability simply cannot exist. Therefore industry immediately focused on the network design, to ensure fast and secure communication between all of the operational forces. This kind of C4I backbone, able to operate in a joint and combined environment, could allow the military to deploy a limited command structure into theatre, while the headquarters at home could manage the necessary activities through network infrastructures such as radios and satellites. The creation of the backbone implied the adoption of the same type of radios, routers, application services for C2 functions at all levels (i.e. squads, platoons, companies and so on).

The second industrial goal of the CD&E phase is the ITB development. The ITB networked sites use a single set of simulation tools, which ensures interoperability between the sites and other similar networks. The Basic Synthetic Environment (*Ambiente Sintetico di Base* - ASB) is the core base software which acts in every site as a virtual base to integrate the various simulation tools. There will also be a series of digitized equipment simulators such as UAV, UGV, Reconnaissance, Surveillance, Target Acquisition (RSTA) systems and vehicle platforms. They will be fully integrated with the ASB and with other ITB's C2 and C4 systems. Moreover, there will be a reproduction of Forza NEC C2 and C4 systems, which will host the various systems' real software, being the produced by Forza NEC or already existing in the Armed Force. Finally there will be a mini ITB site mounted in a shelter, deployable everywhere in Italy to assess real exercises. Its structure will be similar to a command post, but the shelter ITB will have a different function.[48]

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[47] *Command, Control, Communications, Computers and Intelligence.*

[48] Shelters are metal architectural structures suitable to house equipment that allow brigade or regiment C4 functions. Usually a brigade command post has nine elements, while a regiment has three. The command post shelters have different communication

From an industrial perspective, the ITB performs a series of different but complementary functions:

- C2 software integration and validation;
- C2 software maintenance during its life cycle;
- Technology check;
- Testing;
- System integration and validation.

The CESIVA hub will host the Army ITB Control Room Battle Lab Enabler (CRoBLE). It will have the ability to plan checks, execution of procedures, the need for human and technological resources, and the supervision of the execution. The other ITB sites will host their own control room which centralizes the simulation control and data exchange with other sites; thereby each site will enjoy its own flexibility. ITB's role is to create a distributed structure of testing and verification to operate on the systems as though in the real environment, with the support of simulation elements.

These simulation elements consist of:

- The Basic Synthetic Environment (ASB), a set of tools and cross-cutting and general-purpose software dedicated to simulation, control and analysis;
- The Digitized Systems Simulators (*Sistemi di Simulatori Digitalizzati),* specialist components dedicated to a single system or digitized element simulation.

Among the various ASB components there is a specific program for Data Recording and Analysis (*Registrazione e Analisi dei Dati*). It allows an operator to create different types of numerical analysis of the collected data, to support the performance estimation activities of the systems, such as time measurement and data accuracy.

Among the Army ITB sites, the SCUCAV or the SCUTI have facilities such as rifle ranges or training areas to conduct specific activities of ac-

systems, including encrypted systems for data secure transmission. The shelters are not deployable autonomously but require the help of another means, usually a truck or a plane such as the C130.

ceptance, verification, operational validation, and testing. All these activities will be fully connected to the other ITB sites. On these sites it will be possible to test and develop new training methods in line with net-centric technologies and procedures. Industry is also involved in training activities with a first *tranche* of specialist training for military personnel. System technical assistance can include a training and collaboration activity. A transformation such as Forza NEC might require a detailed analysis to determine the training requirements and subsequent activities.

To sum up, the CD&E phase, which is still in progress, is a turning point for Modeling & Simulation activities. It also leads to increased collaboration between the military and industry, underlined by the deployment of industrial personnel in operational theaters. The positive feedback coming from these experiences will have an impact on the development and evolution of vehicles, capabilities and equipment.

5.2. The organization of the industrial side

The industrial activities of supply, testing, simulation and verification of systems and technologies may appear easy. For instance it could be sufficient to test a vehicle in the field and with the simulators to obtain feedback. But this simplistic analysis clashes with the reality. The vast majority of current military equipment is rarely produced by a single company. Today a single company cannot manufacture all the elements from guns to missiles, from vehicles to radios, from sensors to control systems, but rather several companies contribute to produce the same platform. A variety of assets are needed to equip a divisional level unit, including logistics, electronic warfare and various support units, in addition to the traditional combat functions. As a result, several suppliers are required. If these suppliers were operating without mutual connections, this could compromise the utility of the net-centric architectural design. Then there is a second problem: the plurality of suppliers requires a series of different contracts with the Ministry of Defence (MoD), which may create more difficulties for end-users and multiplies the number of administrative actions required by each individual contract.

Forza NEC has offered two innovative solutions to these problems, by creating the system integrator and prime contractor roles within the

procurement program. Regarding the systems' integration, the point is that Forza NEC is a complex and joint project based on the sharing of information and C2. Otherwise, gaps among the nodes, from a soldier to the brigade command, might seriously compromise the whole net-centric architecture.

Industry therefore has to have an alternative choice:

- Provide a set of elements to the customer without any integration. Consequently, the customer should integrate different equipment on its own, for instance soldiers, radios, communication systems, or C4ISTAR;
- Directly provide an integrated product.

For example, in the first case different companies would provide different items, such as a tank, a radio and a C2 system. The Armed Force which receives the items should therefore integrate them, by mounting radio and C2 equipment on the tank. In theory this process might seem simple, but the variety of equipment, their different age and technological levels, and the technical problems that may arise should be taken into consideration. As a result, such a task requires a large amount of personnel and specialist know-how which today the Armed Forces does not have. Therefore this first solution is unviable.

However, in the second option industry directly integrates individual pieces of equipment, whatever they are, providing the customer with a complete package, such as a fully equipped tank with radio and C2 system. In this second case the integration activity and burden falls entirely to industry and not the Armed Forces. The customer remains responsible for planning what to procure, the products' requirements, the amount of equipment and the purchase timeframe. The supplier has the task of integrating all the necessary hardware and software, regardless of which company produces what. This implies a strong cooperation between companies to ensure the various components' full interactivity, or at least to reduce technical problems as much as possible. The complexity of the integration process has led the MoD to choose only one industrial counterpart with a role of systems integrator that has to integrate the various systems and equipment and deliver the complete product. Selex Sistemi Integrati (Selex SI), a Finmeccanica company,

with a solid national and international experience in this field, was chosen for this role.

The purpose of the system integrator is to:

- Create the system of systems, or System of Systems Engineering (SOSE);
- Integrate the C2 capability;
- Integrate the systems through the Modeling & Simulation techniques also in the verification and validation phases.

The second problem to be addressed was the number of contract parties. According to the Italian law, this problem could be addressed by using a Temporary Group of Companies (*Raggruppamento Temporaneo di Imprese* - RTI), a kind of joint venture. However Forza NEC decided to go with a prime contractor, a practice already used in the US. As mentioned, the defence industry includes a series of different suppliers, specialized in various components such as helicopters, sensors, UAVs, artillery and so on. This meant that a coordinator in a *primus inter pares* position, and the companies' MoD interface needed to be identified. The role of prime contractor was also assigned to Selex Sistemi Integrati, which is both prime contractor and systems integrator.

This approach is positive in many ways. First, is more efficient for the MoD to interact only with the prime contractor than to deal with RTI. Second, the customer does not need to oversee different simultaneous industrial activities because the prime contractor gathers the management of all initiatives, representing itself and the other companies in front of the MoD. Forza NEC has therefore replaced the RTI model which let integration up to the customer with a theoretically more efficient approach where the integration begins on industrial side from the design and development and continues during the product's production. Secondly, the prime contractor allows more unity and stability of the industrial team. This structure can provide the customer with a complete architectural vision of the elements that form the program, and a better coordination of the production team. Finally, in order to fund Forza NEC R&D activities, MiSE required not only a single MoD contracting station but also a single private interface.

By utilizing the private agreement" (*Trattativa Privata)* legal instrument, a single contract was signed between the MoD DAT and Selex SI as

representative of all the companies involved as subcontractors. It included provisions on the prime contractor and the system integrator roles, as well as on the respect of individual companies. According to the contract, Selex SI does not replace the role of individual companies, which remain Design Authorities for their specific projects, but integrate the different systems already produced by the various partners in a coherent and complete way. To sum up, the framework agreement envisages:

- Selex SI as prime contractor and system integrator;
- The MiSE funding, according to law 421/1996;
- The other companies responsible for individual projects, as subcontractors of Selex SI
- A division into parcels which are the supplies to be provided according to each of the specifications included in the contract.

The subcontractors, while dealing autonomously with their systems, have a constant link with Selex SI, in order to begin considering the integration requirements and production phases. Forza NEC includes the most important Italian security and defense companies, as listed below:

Company name	**Area of expertise**
SELEX SISTEMI INTEGRATI (including the former ELSAG DATAMAT)	*Prime Contractor* Architecture, system administration, C2, C2 logistical systems
MBDA ITALIA	Anti-Air Artillery
SELEX GALILEO	C2 and navigation systems, sensors, UAV
SELEX ELSAG (merger of ELSAG DATAMAT and SELEX COMMUNICATIONS)	Communication and security systems
OTO MELARA	Vehicles and C2 and navigation digitization systems, UGV
AGUSTAWESTLAND	Aircraft integration
ELETTRONICA	Electronic warfare systems
IVECO	Vehicles and C2 and navigation digitization systems
ENGINEERING INGEGNERIA INFORMATICA	Data fusion systems
IVECO-OTO MELARA Consortium	Vehicles and C2 and navigation digitization systems
RTI "Soldato Futuro" (SELEX COMMUNICATIONS now SELEX ELSAG, FABBRICA D'ARMI PIETRO BERETTA, SELEX GALILEO, SISTEMI COMPOSITI, AEROSEKUR)	"Soldato futuro" package

The activities carried out by Forza NEC open up new opportunities for the defense industry. In theory the industrial structure adopted by Forza NEC strengthens the cooperation between national companies, combining specialist expertise, promoting ideas and experiences exchange, rationalizing the number of contracts and eventually facilitating the integration of legacy elements and systems.

5.3. Forza NEC: from the project to the single capabilities

Once the operational requirements and guidelines were received, industry had to translate the concepts into real equipment and elements, called "physical objects", or tools,[49] to be delivered to the customer. This process began with the Army's asset legacy renewal, to provide the customer with the core Forza NEC features and then move to net-centric exploitation for new capacities. Therefore the industry has worked on asset legacy reutilization within Forza NEC, on the spirals' planning, and on the reflection about capabilities to enhance.

One of the goals of the Project Definition phase (PD) was to assess the capability gap of several legacy systems, and then upgrade the systems for their digitization. For example, *Centauro, Dardo Ariete* and other analog vehicles are being digitized with a SICCONA upgrade. In the light of further improvements to introduce on the *Freccia* vehicles, Forza NEC plans to adapt SICCONA to *Freccia* standard, for example introducing a broadband radio. The new equipment to be delivered during the spirals will be fully compatible with the existing NEC elements due to their net-centric design. The asset legacy has been used as a starting point to avoid the waste of existing resources, systems and equipment.

The foot soldier, which plays a crucial role in current operational theaters, is in the spotlight because to fully integrate a soldier in a C4I architecture he has to be equipped with an extra load, in addition to his weapons and standard equipment. Due to its importance, the Future Soldier project, launched in 2003, has been integrated into Forza NEC

[49] These "physical" tools are different from the ITB tools, as they are not software but physical elements delivered to the MoD (such as a tank or a vehicle).

and it will provide the foot soldier basic equipment. Albeit on a smaller scale, the soldiers will be provided with net-centric equipment such as individual computers and radios, currently under consideration by industry particularly for energy consumption. For instance current batteries, which are now contained in special watertight and resistant cases, will, in the future be set up according to the missions being carried out, and will have a different time duration of between 24 and 72 hours.

Beyond the asset legacy integration, at the core of the Forza NEC architecture, is the Situational Awareness (SA) capability. According to the system integrator's definition, SA is "the awareness of an operational situation among the forces."[50] This is the real divide between analog and net-centric systems and implies a big effort for systems and sensors to provide the Common Operational Picture (COP)[51] drawing information by all the tactical and strategic levels. The tactical SA, updated in real time or in near real-time, will be implemented by sensors' deployment in the theater and collection and reporting systems.

The SA envisaged by Forza NEC will allow:

- The data fusion from different sensors to provide a COP as precise as possible, offering to the command level an information synthesis more comprehensive than the mere sum of sensors information;
- A better operation management for commanders thanks to COP comprehensiveness;

[50] Selex Sistemi Integrati, *Situation Awareness,* http://www.selex-si.com/SelexSI/IT/Business/Systems_of_systems/Homeland_defence/situation_awareness/index.sdo.

[51] According to the Department of Defense, *Dictionary of military and associated terms,* Washington DC, Department of Defense, 2011, p. 69, "a single identical display of relevant information shared by more than one command. A common operational picture facilitates collaborative planning and assists all echelons to achieve situational awareness". The *US Army FM-3-0 Manual* instead, defines the COP as "a single display of relevant information within a commander's area of interest tailored to the user's requirements and based on common data and information shared by more than one command. The availability of a common operational picture facilitates mission command. The common operational picture lets subordinates see the overall operation and their contributions to it as the operation progresses", Department of the Army, *FM 3-0 Operations,* Department of the Army, 2008, page 5-80, http://downloads.army.mil/fm3-0/FM3-0.pdf.

- A rapid capacity of detecting, tracking and target classification for the lower levels;
- Improved tactical information sharing for the T0 tactical level, such as a vehicle or a soldier;
- A better engagement capability to identify the target; this has some positive although indirect effects on the troops security, as they can react to adversaries in a short time;
- a logistics able to fulfill its function in a right time due to shared information on the various vehicles;
- prevent "friendly fire" through the Blue Force Situational Awareness; this system identifies friendly or allied units and enemy ones, thus reducing the possibility of fire between national or allied units.

The threat of friendly fire during operations led to research on Combat Identification, i.e. the recognition of friends and enemies in the operational environment, particularly when multinational contingent are deployed together. The NEC capabilities address these challenges by identifying friendly, enemy and unknown units in a short time. A better awareness of the different forces in the field is linked to the SA and contributes to forces protection. Currently NATO has two procurement programs to identify allied units and thus prevent friendly fire, the New Generation Identification Friend or Foe (NGIFF)[52] for air identification and the Battlefield Target Identification Device (BTID)[53] for land identification.

Forza NEC has planned to equip the vehicles with BTID systems to:

- Identify Italian land vehicles with the same devices;
- Identify land vehicles of allied Armed Forces operating within multinational coalitions;
- Interface and exchange data with different C2 systems.

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[52] Jane's, *New-Generation Identification Friend-or-Foe,* 9 November 2001, http://articles.janes.com/articles/Janes-Radar-and-Electronic-Warfare-Systems/New-Generation-Identification-Friend-or-Foe-NGIFF-system-International.html.

[53] Global Security, *Battlefield Target Identification Device,* http://www.globalsecurity.org/military/systems/ground/btid.htm.

In addition, Forza NEC's timeline and the spiral system allows for subsequent evolution, based on future technological developments. The gradual acquisition of equipment and systems over the years will facilitate the companies in the workload organization, harmonizing it with production and processing times. The *transforming while operating* principle implies a net-centric capability of the new equipment to be delivered, i.e. the successor vehicles of *Freccia* which therefore will be fully integrate with the other systems and equipment. In the long term this approach will eliminate the asset legacy issue, as all the future vehicles will have NEC standards. According to the second principle, *evolution throughout production*, hardware and software systems will be designed as open architecture to allow easy reconfiguration when necessary.

Further capabilities will be developed, for example improving urban communications or localization and evacuation of wounded soldiers. For this purpose the Armed Forces are going to acquire some net-centric Tactical Medium Multirole Vehicle (*Veicolo Tattico Medio Multiruolo* - VTMM) with ambulance equipment. Combat service support is essential to support the operational activities, and will be fully integrated within Forza NEC. The same net-centric system able to identify the targets will help to identify friendly forces that are in trouble or in need of assistance.

Finally, the foot soldiers equipment also has room for improvement. Technology can increase the capacities of different nodes, but in today's military operations many essential functions, such as civil-military cooperation and territorial control through physical presence, rely mainly on the soldiers. Italian Armed Forces have paid lots of attention to this field, and consider the Future Soldier program a great innovation for the individual soldier.

With regards to the miniaturization of technologies, Radio, communications equipment and sensors have to be brought by a soldier already carrying a weapon, ammunitions, water, personal protection such as body armor, and other gear. Load and energy are crucial problems for the foot soldier equipment: therefore weight, functionality and power consumption require further industrial efforts. The industry should provide personal net-centric systems that must be user-friendly, fast to use, light and at the same time reliable even in critical situations. Finally, Future Soldier package will have some physiological sensors that could monitor the soldier's health.

5.4. Technologies and Systems

The following elements are among the technologies and systems involved in Forza NEC:

SIACCON: the Automated Command and Control System (*Sistema Automatizzato di Comando e CONtrollo*) was introduced in the early 90s. It is structured on an Information Analysis and Selection Centre (*Centro Analisi e Selezione delle Informazioni* - CASI), a Fusion Center (*Centro di Fusione* - CF) which holds the updated database, and a Decision Center (*Centro Decisionale* - CD) in which concise data are presented to decision makers. The SIACCON is designed to automate the strategic command posts' procedures in the operational theater. This C2 system allows a Battle Management Support for many Army functions, from battalion level up to corps level. The higher command levels have a greater range of functions. The evolution of the first SIACCON, the SIACCON 2, is currently under development, and it is based on the modern Service Oriented Architecture (SOA) technology. It has two different working levels: one for the common basic services and another for specialist services. The latter are specific for each command post cell or for the lower hierarchical levels, such as companies, platoons, squads and individual soldiers.[54]

SICCONA: the Integrated Command, Control and Navigation System (*Sistema Integrato di Comando, COntrollo e NAvigazione*) provide "the net-centric interconnection of land combat vehicles". The system can provide map, navigation, and Situational Awareness information, and enables messages and logistical data exchange. SICCONA is going to provide some interconnections with Future Soldier package. SICCONA testing began in 2006 within the 31th Tank Regiment, and involves a range of vehicles such as *Ariete, Dardo, Centauro* and *Freccia*.[55]

BFSA: the Blue Force Situational Awareness is an ongoing program undertaken by the MoD and developed by the industry for tracking and

[54] Jane's, *SIACCON,* 10 May 2011, http://articles.janes.com/articles/Janes-Military-Communications/SIACCON-Automated-Command-and-Control-System-Italy.html.

[55] Jane's*, SICCONA,*12 November 2010, http://articles.janes.com/articles/Janes-C4I-Systems/SICCONA-Italy.html.

identification of friendly forces at tactical level, aimed to Combat Support and Combat Service Support equipment.

Future Soldier: The Future Soldier package represents an example of a legacy program that was harmonized within Forza NEC and the Army's evolution. The Future Soldier will have improved traditional military gear, for example a lighter rifle, a modular backpack, a better load disposal and a new battledress. Future Soldier package will provide other digital assets such as minicomputers and advanced radio that allow the foot soldier to operate in a net-centric environment integrated with SIACCON and SICCONA.

The "Future Soldier" package aims to improve the soldier capabilities in five areas:

- Engagement effectiveness: it will lighten the weapon, improve target acquisition and fire control, and provide a thermal camera and laser pointers;
- Survival: a ballistic or NBC protection, and soldier health sensors will be added to standard equipment;
- C2 systems: it will integrate C2 systems with the upper levels, by providing a computer, GPS and an individual radio, to improve communications and information management;
- Autonomy: it will provide the soldier with a power supply of at least 24 hours;
- Mobility: it will be increased thanks to material ergonomics, weight reduction and load optimization /modularity.

Currently the Future Soldier package has four shapes:

- *Basic*, which provides a soldier with the essential gear, that means lower lethality equipment: rifle, helmet, flak jacket and radio or.
- *Rifleman*, which provides to the soldier with all the lethal capabilities, including weapon, sights, C4I capabilities including radio and computer, as well as night mobility equipment.
- *Grenadier*, which also equips the soldier with a grenade launcher, for a better and more comprehensive fire.
- *Team Commander*, which provides to the soldier with more operational management capabilities, also to enable the acquisition of targets and C2 functions.

3.
The French case study

This case study proposes an overview of the conceptual background and the various information and communication programs implementing the network-centric or network-enabled operations in France.

1 THE FRENCH NET-CENTRIC CONCEPT

In the US, while the digitization project Force XXI in the Army was launched in 1994, the NCW concept matured among the information technologies community (primarily in the Joint Staff, the NDU and the Navy) during the mid-90s only to emerge in 1998 in the form of NCW, providing afterward, during Donald Rumsfeld's tenure, a structuring idea of the transformation. In France too, the concept effort lagged behind the programmatic initiatives by the services to implement these technologies.

The French concept was for a while named "*opérations infovalorisées*" (information-enabled or value increased by information). This term is continued to be used but the concept has now shifted to a more classical "*opérations en réseaux*" (networked operations).

The Centre interarmées de concepts, doctrines et d'expérimentations (CICDE, joint center for concepts, doctrines and experiments) gave in 2006 the following definition: "'Opérations en réseaux' qualify the operations for which the control of the information and the optimal interrelations of all the players and systems constitutes critical elements of the operational efficiency in particular by the control of the effects."[1] Ac-

[1] Centre interarmées de concepts, doctrines et expérimentations, Concept exploratoire des opérations en réseaux, PIA 06-101, n. 94/DEF/CICDE/NP du 05 mars 2007, p. 4.

cording to the concept, networked operations have four aims:

- To adjust the distance and the speed of operations to generate the advantage over the adversary;
- To reinforce the ability of joint, multinational and interagency stakeholders to cooperate;
- To enhance the relevancy of operational functions in the reaching of desired effects and controlling their own activities;
- To reduce the frictions and opaqueness of operations.

According to the concept, these aims have notable implications for each of the six fundamental functions:

- For the situational understanding, networked operations ease the information dissemination toward analysis and decision-making centers; allow exploiting expertise via the reachback thus allowing the reduction forward-deployed staff. They allow the timely understanding and the leverage of each tactical element for the operational-level decision-making. The challenge remains here to desaturate information;
- In support of the force generation and projection: OR ease the inter- and intra-theater mobility, allow the synchronization of the projection operations, facilitate the build-up of tailored combined and joint packages;
- In support of the command function: the OR accelerate the decision-making process, imposing the speed of the action on the enemy to quickly involve various stakeholders through collaborative means, and at all levels of command to develop a shared understanding of the decision;
- In support of the application of the effects: OR optimize the use of weapon systems, enable the synchronization of the operations, the adaptation of modular and flexible force packages to the threat and the evolution of the situation. Finally, they allow to calibrate the sufficient effects according the principle of the economy of force and the need to limit the risk of collateral damage;
- In support of the force protection: OR offer a larger margin of freedom in the organization of operational functions by reducing the need to collocate them, thus reducing their vulnerability. They con-

tribute to a better anticipation of threats, including versatile asymmetrical ones and allow a protection based on mobility rather than on hardening. Combined with the use of unmanned assets, OR allows to reduce the exposure of assets;

- In support of force regeneration: OR allow for punctual logistics and a better knowledge of unit status while reducing the workload to develop it. They finally support the joint and multinational pooling of capabilities.

Among specific concepts related to OR, it is important to mention the SA2R (*surveillance, acquisition, reconnaissance et renseignement*) the French version of ISTAR. SA2R, as expressed by CICDE[2] and used by services, envisions not only the networked multi-sensor intelligence collection but also more broadly the ability to access to the non-military all source intelligence in theatre. The author, who participated to the preliminary work on this concept, considers nevertheless that SA2R confirms the existing notion amongst the intelligence community (all-source intelligence and collection coordination). The real issue lies rather in the reorganization of the intelligence exploitation function, in order to better organize the responsiveness of the expertise of intelligence analysts for users confronted with increasing and diversifying flows of information.

In substance, while most officers acknowledge the increasing importance of information technologies, many, notably in the Army, tend to criticize the US concept for two reasons. The first is the "centricity" of the network. This critique is related to the wider perception among the French of the US military over reliance on technology, an enduring element of US culture, as explained by many scholars including Colin Gray. The second one is about the scope and the ambition of US transformation, maintained by the UK notion of "revolution in military affairs", the heart of which would be the NCW. In 2003, the French developed an approach to transformation, encompassing *the opérations en réseaux*, the effects-based approach and the concept development and experi-

[2] Centre interarmées de concepts, doctrines et expérimentations, *PIA-06.102 - Concept exploratoire SA2R,* n°153 DEF/CICDE/NP du 5 mai 2008.

ment approach. But, as explained in the *Plan Prospectif à 30 ans* (the main S&T roadmap) of the DGA (*Délégation générale pour l'armement*, the MOD procurement agency),

> The French transformation is neither the translation of a specific strategy based on the power and technological superiority, nor its acceptance as a new dogma, nor the questioning of methods of action that would have lost their relevance: it is essentially a global process of progress, focusing on operational efficiency, able to adapt the military to the variations of environment by making the best use of available resources, and a pragmatic and flexible approach.[3]

The French claim to be closer of the UK "Network-Enabled" concept, seen as describing more pragmatically that information technologies are a supporting tool not an end in itself. Rapidly, the term of "*infovalorisation*" did emerge in the French HQs as a way to describe the added-value of information without putting in question the enduring key tenets of operations.

In fact, this difference always seemed to us to be purely superficial in the case of networked operations: As summarized above, the French concept completely adheres to the Adm Cebrowski's NCW basic tenets: information superiority, shared awareness, self-synchronization of elements, the need for interoperability and so forth. As the author realized it, when the French staff decided to develop, around the mid of the last decade, a Common operating picture at the joint level, it experienced the same difficulties to define discriminating information requirements which would customize the COP. On the other hand, the so-called "control of effects" is shared by all military decision-making including the US one, whichever way they operate. The question is more about the relevancy of effects, the way to measure them and the difference in the degree of the use of force between US forces and European ones.

Another more important difference, also illustrated in the "pragmatic" approach and the notion of "*juste suffisance*" (just enough means or

[3] Délégation générale pour l'armement, *PP30, Chapitre D2 Partenaires, Transformation et opérations en réseaux*, 2007, p. 5.

effects) is related to the constraint of resources which permanently plagues our military far more than US. This constraint leads to an incremental and limited programmatic implementation of the networked operations.

2.THE JOINT LEVEL PROGRAMS

2.1. The joint communication systems: Syracuse SATCOM and future software radio

A backbone of the French NCO is the SYRACUSE (*SYstème de RAdioCommunication Utilisant un SatellitE*) satellite communications system.[4] French forces currently use the third generation of this system. The program started in 1980. This first generation consisted of a payload on three Telecom I satellites, launched between 1984 and 1987 and operated by both Defense Minister and the French civilian telecommunication company, *France Télécom*. These systems were phased out in 1994. The second generation program began in 1987. Again, it relied on dedicated payloads, this time on 4 Télécom II launched between 1991 and 1996.

The third generation, launched in 1999, is currently composed of two dedicated satellites, SYRACUSE 3A and 3B, launched in 2005 and 2006. While SYRACUSE 2 payloads were exclusively SHF, Syracuse III spacecraft combines SHF and EHF emitters, may precisely calibrate the apportionment of its capabilities to the specific needs of each user, and is protected against electromagnetic pulses. The ground segment includes 367 stations. Most of them are to be delivered in 201:[5]

- 323 ground stations: half of them are man-portable. Other are deployed on armored vehicles or deployable at the various tactical and operational-level HQs;

[4] Ministère de la défense, *Dossier d'information, Lancement du satellite Syracuse 3B*, Kourou, août 2006, p.19, http://www.ixarm.com/IMG/pdf/dossiersyracuse.pdf.

[5] Xavier Pintat et Daniel Reiner, *Projet de loi de finances pour 2011: Défense - Equipement des forces*, 22 novembre 2010, http://www.senat.fr/rap/a10-112-5/a10-112-511.html.

- 44 naval stations, equipping the aircraft carrier, the two *Batiment de projection et de commandement*, all surface combatants and submarines.

These stations allow a maximum of 2 Mbits/sec for protected liaisons, 5 Mbits/sec for non-protected ones, and up to 16 liaisons in parallel for ground stations and 6 liaisons for naval ones.

The budget for a third SYRACUSE satellite has been shifted to the SICRAL II program in cooperation with Italy. The development started in 2010 with an expected launch in 2013. As Syracuse, SICRAL system is intended to provide forces with satellite protected communications. Finally, under the NATO SATCOM V program, SYRACUSE III, as well as Italian SICRAL I system and UK SKYNET, rent capabilities for NATO operations, notably about 45% of SYRACUSE III SHF capabilities.

The OR is also equipped with software radio technology. According to the MOD, "it can offer, on a single and versatile platform, a wide range of broadband communications services, replacing equipment specific to each function."[6] Key joint and multinational radio-software program under development include:

- The joint program CONTACT (*Communications Numérisées Tactiques et de Théâtre*) which must be interoperable with NATO. It should eventually replace most existing radio and tactical data link systems (PR4G, Link-16 and CARTHAGE, etc.). On December 2010, a study contract has been awarded to Thalès to develop the system;
- The European secure software defined radio (ESSOR) program launched in 2008 in partnership with Finland, Italy, Poland, Spain and Sweden. According to the EDA, "*The strategic aim of the ESSOR Program is to provide the basis for development and production of Software Defined Radio (SDR) products in Europe in order to have the equipment operational in Europe in the timeframe up to 2015*". The program, managed by the *Organisation Conjointe de Coopération en matière d'Armement* (OCCAR), will study the software architec-

[6] Bruno Daffix, DGA/COM, "La DGA lance les études du futur poste radio tactique interarmées", 26/01/2011, http://www.defense.gouv.fr/content/view/full/103015.

ture, starting from the US Joint Tactical Radio System as a basis, and the development of a high data rate waveform.[7]

2.2. The joint information systems for strategic and operational levels

The current information system for joint C^2 levels is SICA, *système d'information et de commandement des armées*. The initial SICA G0 program has been launched in 1995, but the system was really mature from the G1 version, fully operational around 2000-2001. It equipped at that time more than 2000 stations on 10 metropolitan and 15 overseas sites, notably at the strategic level, the defense staff and its *centre de planification et de conduite des opérations* (CPCO, planning and operations center), and at the operational level, the *état-major interarmées de force et d'entraînement* (EMIA-FE) at Creil Air Force base, which provides the core element of the deployable joint force headquarters. The applications, whose the number grew up significantly over the decade, include all the tools necessary for strategic and operational-level planning, operations or intelligence staffs including operations plan development, databases, messaging, COP, collection plan, etc. The SICA has been developed and maintained, under the management authority of DGA, by a *Groupement d'Intérêt Economique*, gathering EADS Defense and security, ATOS Origin, and Steria firms.[8]

The MOD decided to further upgrade and adapt the CIS to the change of organization at the strategic level, what is named *Pôle Stratégique Paris* (PSP). The CIS of the PSP encompasses now the Directorate for Military Intelligence and the Operational Headquarters (OHQ) at Mt Valérien. It is interfaced with NATO and other multinational C^2 and information exchange networks. A first increment, based on a new SICA version, has been developed in 2007-2009 timeframe. A second increment,

[7] EDA, "ESSOR", http://www.eda.europa.eu/Otheractivities/SDR/ESSOR.

[8] MOD Factsheet, *Le programme Sica (système d'information et de commandement des armées)*, 2005, avalable on http://osdir.com/ml/culture.war.guerrelec/2005-11/msg00028.html.

started at the end of 2010, fastens the joint IS deployed on theatre of operations, to the interoperable framework provided Army SICF.[9] The end state is to create a single armed forces CIS in 2016 (see the final section of this case study).

3. THE DIGITIZATION OF THE FRENCH ARMY

The digitization project in the French army is the *Numérisation de l'espace de bataille* (NEB, digitization of the battlespace), launched in 1999 and incrementally implemented during the last decade and well underway. In 2005, this project has been supported by tools developed with the *Bulle opérationnelle aéroterrestre* (BOA, airland operational bubble) demonstration launched in 2005. The digitization is now part of the joint information system program on one hand, and SCORPION comprehensive program to develop the future capabilities of the battlegroup.

As defined by the Army headquarters in 1999,

> The digitization of the battlespace is intended to give any responsible of an action, the informational superiority, that is, the ability to acquire process and use information relevant to its mission. It must have a transparent and all useful information on friends as any opponent in their environment, at the right time, regardless of where it is located, regardless of the source and so securely (integrity and security information) that it can take the first decisions that will give him the advantage.[10]

[9] MM. Xavier Pintat Et Daniel Reiner, Sénateurs, *Avis présenté au nom de la commission des affaires étrangères, de la défense et des forces armées (1) sur le projet de loi de finances pour 2011, adopté par l'assemblée nationale, Tome V Défense - équipement des forces*, 18 novembre 2010.

[10] Délégation générale pour l'armement, *Liste des capacités technologiques*, 2008, CT14, p. 15, www.ixarm.com/IMG/doc/Capacites_technologiques-_detail.doc.

3.1. The digitization of the battlespace (Numérisation de l'Espace de Bataille, NEB)

The NEB is firstly permitted by the signal capabilities of the Army. The backbone of the communication system of the French ground forces in operations is the *Réseau intégré des transmissions automatiques* (RITA, Integrated network of automatic transmission), providing communication capabilities at the corps level. RITA was conceived in the 1960's and developed in the 1970's by Thomson. When the RITA became operational from 1983 within the French and Belgian armies, it was the most advanced ground communication system of the world. The US Army picked up the switching technology of RITA to equip its signal battalions. RITA is a flexible and modular mesh network of nodal centers interlinked with radio relay stations (FHM stations in the first generation) through modular UHF beams, the stations providing radio linkage to subscribers (HQs as well as units). RITA was digitized from the onset, and totally automated.[11]

3.2. Communication systems

Of course, RITA has been progressively upgraded to take in account the progress in communication technology. The current system is RITA 2G HD (second generation, broadband), experimented in 2005.[12] It incorporated IP technology as well as satellite communication.

Today, a typical RITA 2G area network includes:

- The liaison through fiber optic linkages, CHF radio stations ("*Chaîne hertzienne des forces*") and SATCOM. CHF radio stations allow secured SHF liaisons with a data rate ranging from 2 megabit/sec at the maximum range of 50 km up to 34 megabit/sec at the range of 36 km;[13]

[11] Amicale des anciens du 40ème régiment de transmission, *L'arme des transmissions*, non daté, p.29, http://le40rt.anciendu40.fr/historique.pdf.

[12] Centre de la doctrine et de l'emploi des forces, "Retour d'expérience", *Héraclès* n. 9, 2005, pp. 6-8.

[13] Armée de Terre, *Arme des transmissions, dossier matériels*, juillet 2005, p. 29.

- The nodes (either CART, *centre d'accès radio et de transit*, or CTRT, *centre radio de télé-exploitation et de transit*) providing the mesh of the network and the access to the CP and mobile users;
- The stations connecting the command posts: the CMAI (*centre multi-service d'accès et d'interface*) stations for HQ allowing connectivity with other networks and maybe more importantly, ASTRIDE (*Accès par Satellite et par Transmission hertzienne au Réseau de zone et de l'Intranet De l'Espace de bataille*) station. With 40 stations delivered in 2006, the ASTRIDE phase 1 allow connectivity between RITA and SYRACUSE. With 129 stations scheduled, the phase 2 will expand this connectivity to the battlegroup level, not only with SATCOM but also with other allied and civilian networks.[14]

As a complement to RITA:

- For longer range communication, French Army operational and tactical high level command posts, some intelligence, artillery and engineer units as well as special operations units of the three services use the new HF MELCHIOR (*moyen d'élongation pour les communications en hautes fréquences interarmées et OTAN en réseau*) stations. A total of 1100 stations have been ordered to Thalès Communication SA: 675 ones delivered in 2010, 475 hardened ones by 2012, but delays are expected. The station, either man-portable or embarked on vehicle, allows secured IP, voice, data, messaging communications up to 5000 km, the access to SATCOM and GSM networks.
- For short range ground communications (from 2 km for individual dismounted soldier to 30 km when used by vehicle) at the brigade or battlegroup level, French forces rely mainly on PR4G (*poste radio quatrième génération*) VHF system. From 2005 to 2010, they have been complemented with a new evolution, the PR4G-VS4-IP, highly secured, anti-jam and IP system, allowing voice and data exchange with a quadrupled data rate compared to the previous version. Thalès Communication SA developed the system and delivered more

[14] *Les SICs pour tous*, Ecole des transmissions, armée de Terre, non daté http://www.etrs.terre.defense.gouv.fr/sicpourtous/SIC_OPERATION/le_reseau_de_zone_rita.html.

than 7000 IP radios used by the full range of vehicles, aircrafts and dismounted units. PR4G-VS4-IP represents the main communication tool allowing the connection of NEB tactical IS.[15] A total of 33 000 PR4G and PR4G-VS4-IP are used by the French forces.

3.3. The chain of information systems

- *The système d'information et de commandement des forces (SICF)*

The SICF constitutes the digitized battle management tool of headquarters from brigade up to land component command. The program started in 1995 with an initial capability in 1999. It equips Corps-level Lille-Based *Commandement des forces d'action terrestres* (CFAT) and the Eurocorps, the EMFs (force headquarters), and all the Army combat ad functional brigades. It allows the development and the sharing of the tactical situation, supported by graphic tool, the exchange of orders and reports through messaging or formatted tools, the collaborative work within the staff. It includes specific functional tools for intelligence, logistics, 3D coordination, fires coordination and so forth. The SICF ensures interface with other service and allied systems, using for this purpose NATO standards such as AdatP-3 for messaging, APP6-A symbols, and ATCCIS database.

- *The système d'information régimentaire (SIR).*

Manufactured by EADS DCS, SIR equips Brigade and below levels, including notably the battlegroup, the basic combined arms reinforced-battalion used for deployment. It allows the exchanges of orders and reports with SICF through messaging and pre-formatted templates, supports the development of the shared tactical situation, through the ground recognize picture, on which the positioning of units is automatically updated and, again, several applications for intel, logistics, etc. First SIRs has been delivered in 2002 and extensively experimented. The system is officially in service since 2007. The regimental command post de-

[15] François Cornut-Gentille, Député, *Avis présenté au nom de la commission de la défense nationale et des forces armées, sur le projet de loi de finances pour 2011 (n° 2824), tome VII, défense, équipement des forces - dissuasion*, 14 octobre 2010, pp. 243-245.

ploys four VAB forward armored vehicles or shelters, each equipped with two stations and each company commander owns a light SIR kit on its VAB.[16] EADS delivered from 2002 to the end of 2010, 721 SIR-equipped new or upgraded vehicles and shelters and 118 dismounted SIRs. The fielding rhythm starts with 2 regiments per year from 2002 to 2006 to 5 regiments per year, 2007 onward. A new version is currently fielded, from 2009, on the new *véhicule blindé de combat d'infanterie* (VBCI, infantry fighting vehicle) which replaces the VAB. Ultimately in 2016, 110 VBCI-SIR and 97 VHM (high mobility vehicles) should have been provided.[17]

The first exercise of implementation of a digitized armored GTIA with Leclerc main battle tanks (MBT) took place at Mourmelon in November 2003. The SIR has also been experimented in the *Régiment de marche du Tchad* then fielded in the 2ème *Régiment étranger d'infanterie,* the first digitized infantry regiment of the Army, which tested the SIR in the second digitized GTIA exercise in November 2004.[18]

- The système d'information terminal (SIT).

SIT is a family of information systems, extending the NEB down to the squad level (the 10 men-*groupe* in the French unit, headed by a sergeant). The system is deployed since 2008. The DGA ordered first to Nexter 1200 SIT ICONE embarked on the MBT Leclerc and SIT V1, to equip notably 400 infantry fighting vehicles.[19] Nevertheless, the most numerous systems will SITEL (for ELementary) for other vehicles, and SIT COMDE (*combattant débarqué*, dismounted combatant) for FELIN (see below), each manufactured by Sagem. The contract has been

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[16] LtCol Eric de Saint-Salvy,, « Les PC numérisés de l'infanterie », *Fantassins*, n. 15, pp. 24-25.

[17] MM. Xavier Pintat Et Daniel Reiner, Sénateurs, *Avis présenté au nom de la commission des affaires étrangères, de la défense et des forces armées (1) sur le projet de loi de finances pour 2011, adopté par l'assemblée nationale, Tome V Défense - équipement des forces*, 18 novembre 2010, p. 62.

[18] LtCol Eric de Saint-Salvy, *op cit*.

[19] "Commande de 800 Systèmes d'Information Terminaux SIT V1 pour l'Armée française", 19 février 2009, http://www.nexter-group.fr/index.php?option=com_content&view=article&catid=54%3Acommuniques&id=149%3Acommande-de-800-systemes-dinformation-terminaux-sit-v1-pour-larmee-francaise&Itemid=97&lang=fr.

awarded in 2003 with a first prototype in 2005 and a first delivery in 2007. About 4500 SITEL will be delivered by 2012.

- Army aviation digitization

SIT will be also deployed on army helicopters in the framework of the digitization of the army aviation (NUMALAT, *numérisation de l'aviation légère de l'armée de Terre*). The CP of the *groupement aéromobile* (GAM, airmobile battlegroup, the equivalent of GTIA for Army aviation) is connected to upper echelon (brigade) through SIR, on which missions are planned. SIT have been integrated from the onset on the new Tigre attack and NH-90 utility helicopters (named EUROGRID) and are being retrofitted on older types (SITALAT on Gazelles and Cougar aircrafts). Missions are prepared by the crews on specific stations which feed the SIT. Another key component of the NUMALAT is the HM PC kit (utility helicopter command post) allowing to command the GAM in flight. 15 kits were delivered in 2010. Extensive experiments of NUMALAT have been underway since 2009 by the *3ème régiment d'hélicoptères de combat*. SIR and mission preparation module seem to be matured and well employed. It was scheduled to complete the build-up of NUMALAT in 2013 but several problems remain to be fixed with SITALAT.[20]

- Functional information systems

Conversely to other units, artillery regiments use vertical functional systems to coordinate fires:

- ATLAS (*Automatisation des Tirs et des Liaisons de l'Artillerie Sol/sol*) is the information system coordinating field artillery fires (MLRS, canons). At the regimental command post level, it allows to plan the fires, to integrate the target information and to direct fire orders to the batteries. The computation of fire solutions is ensured at the battery level (at a speed of 8 rounds in 2,30 min). The regimental network is composed of 92 terminals;[21]

[20] Captain Xavier Quintin, "Expérimentation tactique (EXTA) de la numérisation de l'ALAT au 3e RHC: bilan intermédiaire"*, Revue d'information de l'ALAT*, n. 21, janvier 2011, p. XXVI.

[21] "Le système ATLAS Canon", site du 1er régiment d'artillerie de marine, 2008, http://1rama.free.fr/materiel_ATLAS.php.

- MARTHA (*Maillage des Radars Tactiques contre les Hélicoptères et les Aéronefs à voilure fixe*) for air defense. This system entered into service in 2005 with 45 stations to coordinate short range air defense (MANPADS and Hawk Surface to air missiles) operations. A second step includes 14 new high level centers and 34 command post vehicles, in order to manage the new mid-range surface-air missile (SAMP/T, sol-air moyenne portée). MARTHA use both PR4G and Link-16 TDL. In 2006, the defense staff decided to merge MARTHA into the Air Force SCCOA stage 4 (see below).[22]

With regards to the intelligence function, the multi-sensors brigade and its reconnaissance regiment CPs used GRANITE NG (*Gestion du Renseignement et Analyse des Informations Transmises par les Equipes*) a dedicated information system allowing the processing and production of intelligence but its functions have been transferred into SICF-SIR system. Each reconnaissance unit, for example the *Escadron d'éclairage et d'investigation* (EEI) continues to feed SIR through the MAESTRO (*Module Adapté aux Échanges Sécurisés, aux Transmissions et au Raccordement des Opérationnels*) system.[23]

- *FELIN (fantassin à équipements et liaisons intégrées, Infantryman with integrated equipment and liaisons).*

The FELIN soldier system is the last piece of the digitization. Designed and partially manufactured by Sagem, it is the first "land warrior-like" system to enter into service in wide scale. As explained earlier, the platoon commander and group leaders are connected with the hierarchy through their SITCOMDE, which features many capabilities: The classical exchanges of orders/reports and management of the tactical situation through the mapping tool, but also the digital request for a fire support, etc. All the soldiers of the platoon are connected via the *Réseau d'information FELIN*, a data and voice UHF radio network, which can also be configured to handle sub-networks, for example at the squad level. Each soldier is equipped with a GPS-radio (the voice exchange being

[22] LtCol Loic Boué, "Mise en application de la coordination 3D", *Doctrine tactique*, n. 14, janvier 2008, pp. 32-35.

[23] Armée de Terre, *Arme des transmissions, dossier matériels*, juillet 2005, p. 35.

made through a very silent osteo-microphone) and a small terminal (*interface homme-machine*) used to get maps or, for the combat half of the group, to transmit video taken through the two sights used on their FAMAS assault rifle or Minimi gun.[24]

During 2007-2008 year, the FELIN have been extensively tested in several environment: the *Régiment de Marche du Tchad*, in Djibouti in desert environment; the *8ème régiment parachutiste d'infanterie de marine* in urban area; the *13ème bataillon de chasseurs alpins* (BCA, mountain troop battalion) in mountain and cold environment as well as in jungle in Guyane. In April 2008, the DGA awarded to Sagem a contract of €143 million for the delivery of 5045 systems from mid-2009 to the end of 2010, in order to equip 5 infantry regiments. In October 2010, the *1er régiment d'infanterie* (RI) has been the first regiment to obtain its 875 collections of equipment for its 6 companies and supporting units. 3 companies will been projected as the backbone of the first FELIN-equipped GTIA deployed in Afghanistan at the end of 2011.[25] Are following, in 2011, the 13ème BCA, the *16ème bataillon de chasseurs*, and 92ème RI and the 35ème RI, both mechanized with VBCI.[26] The initial objective of the LPM 2009-2014 was the delivery in 2014 of 22 300 systems to equip the 20 infantry regiments of the Army, but the amount has been scaled down in 2010 to 17 884 systems, the remaining of which have been postponed to the 2015-2020 period.[27]

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[24] Rupert Pengelley, "Moving towards a digitised future: France steals a march with FELIN", *Jane's International Defense Review*, June 2008, pp 64-70.

[25] "Le 1er Régiment d'infanterie est la première unité de l'armée française à avoir perçu le système FELIN", http://www.ri1.terre.defense.gouv.fr/EnjeuxDefense/Specificites/felin.html.

[26] Général d'armée Elrick Irastorza, chef d'état-major de l'armée de terre in M. Jean-Louis Bernard, *Avis présenté au nom de la commission de la défense nationale et des forces armées, sur le projet de loi de finances pour 2011 (n° 2824) tome IV défense préparation et emploi des forces forces terrestres*, 14 octobre 2010, p. 43.

[27] MM. François Trucy, Jean-Pierre Masseret et Charles Guené, *Projet de loi de finances pour 2011: Défense*, Rapport général n. 111 (2010-2011), fait au nom de la commission des finances, déposé le 18 novembre 2010, http://www.senat.fr/rap/l10-111-38/l10-111-38.html.

3.4. The BOA demonstration

The BOA (*bulle opérationnelle aéroterrestre*) demonstrator was launched in 2004. Building on NEB programs, its aim is to experiment all the facets of a digitized force envisioned as a system-of-systems. DGA notified this program to a group composed of Thalès Communications, GIAT industries and Sagem DS in 2005. The contract features an amount of €130 million and duration of 7 years. It is focused on

- The development and maintenance of a common tactical picture;
- The coordination of direct and indirect fire and target designation;
- The reinforcement of force protection;
- The joint and combined interoperability.

The most important component of the BOA (counting for EUR 90 M) is the TACTIC (*Technologies et Architecture du Combat Aéroterrestre aéro-terrestre Info-valorisé au Contact*). TACTIC is a small-size experimental unit (12 armored vehicles, 30 soldiers, 3 UAVs and unattended sensors) to test all these networking-related issues, notably the insertion and management of unmanned assets in the battle network.

Another key product of the BOA is the LTO (*Laboratoire Technico-Opérationnel*) a battlelab provided by the contractors to the DGA to support the experiment of operational concepts, TTPs and technologies of the system-of-systems. Operational since 2006, the LTO is now a key asset of the DGA, oriented by the defence staff and operated by its *Centre d'analyse technico-opérationnel de Défense*, at Arcueil. It gathers, on specific projects, operational users and industry to simulate and experiment technical solutions, draw up implications in terms of doctrine, organization, material and so forth. LTO worked now on many joint and service-related issues, either off-the-shelf solutions for rapid needs, or supporting multi-years programs submitted by CICDE or defense staff capabilities development division. These projects included the Air force SCCOA, the Navy CEMP (see below), time-sensitive targeting, the effect-based approach to operations, or the SA2R concept, focused on multi-sensors collection.[28]

[28] Délégation générale pour l'armement, Introduction au laboratoire technico-

The BOA program also included a specific experimentation in collaboration with Germany. Launched in 2009, the Architecture Real-Time Integration System Test bench focused on several aspects of distributed operations:

- Distributed control of ground unmanned vehicles;
- Distributed indirect fire control;
- Combined training based on simulation;
- Persistent communication with dismounted platoon.[29]

3.5. The challenge of interoperability and the failure of the Opération d'ensemble SIC Terre

In the last decade the Army deployed or developed no less than 14 communication and information systems, manufactured separately by competing firms. The Army experienced (and continues to experience) therefore a limited interoperability not only with other systems at the joint and multinational level but also between the NEB systems at the combined level, between the branches of the Army. Among many examples of these limitations, SIR and ATLAS are not directly interoperable with negative consequence for the combined arms action. As Major-general (ret.) Klein explained it

> Currently, the gunner cannot obtain the operation order from the GTIA he supports, and conversely, he cannot transmit its "artillery" layer in the GTIA CP. In addition, it is impossible to superimpose a fire plan and a plan of obstacles, which is the basis of combined arms action.[30]

opérationnel, présentation, 22/02/2007, http://www.see.asso.fr/sds2007/docs/Tutoriel-8-3-Laboratoire-Technico-Operationnel-X-Lecinq.pdf.

[29] Laurent Barraco, "La bulle opérationnelle aéroterrestre", *Technologue et* Armements, n. 2, juillet-septembre 2006, pp. 36-41.

[30] GDI (2S) Michel Klein, Philippe Gros, GCA (2S) Michel Asencio, *Comment maintenir la perception de la réalité dans les postes de commandement des opérations infovalorisées?,* rapport d'étude, Fondation pour la recherche stratégique, 28 janvier 2008, p. 18.

Therefore, as soon as 2002, DGA decided of one *Opération d'ensemble (OE) SIC Terre* (Land CIS comprehensive operation) whose the objective was to build-up a single technical architecture, a single technical socle toward which all land CIS has to converge. According to Col Henry, "*Key to technical interoperability of our SIOC, the OE SIC Terre is a precondition for the digitization of the battlespace*."[31]

In January 2005, the DGA awarded to a consortium gathering Thalès (70%) and EADS-Défense et sécurité (30%) a contract of €230 million over 7 years to run this OE SIC Terre. The migration of these systems toward the targeted architecture was intended to be incremental.[32] A first milestone was reached in 2007 with an initial operational capability covering 60-70% of the information exchange requirement.[33] But the operation was a failure and DGA cancelled it in 2009 after increasing delays and technical shortfalls. As the National Assembly reported it, the industrial architecture is designated as the primary cause of this failure:

> The association, without leader, of two competing entities is not sufficient to extinguish the competitive rivalry; the two companies do not share their technological knowledge. The co-contracting has been reduced to a financial sharing and not a sharing of trades.[34]

For example, according to a French officer in charge of the NEB in one staff, and discussing about the limited interoperability between SIR and MAESTRO, "*Thales does not issue its DLL in which the mapping is explained and vice versa for EADS*."[35]

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[31] Colonel Heny, «Interopérabilité: de l'OE SIC TERRE à la NEB», *Heraclès* n. 32, avril-mai 2009, p. 13.

[32] Colonel Heny, op cit.

[33] Ministère de la défense, *note détaillé sur le programme SIC Terre*, in François Cornut-Gentille, Député, *Avis présenté au nom de la commission de la défense nationale et des forces armées, sur le projet de loi de finances pour 2010 (n° 1946), tome VII, défense, équipement des forces – dissuasion*, 14 octobre 2009, p. 90.

[34] François Cornut-Gentille, Député, *Avis présenté au nom de la commission de la défense nationale et des forces armées, sur le projet de loi de finances pour 2010 (n° 1946), tome VII, défense, équipement des forces – dissuasion*, 14 octobre 2009, p. 89.

[35] "Numérisation de l'Espace de Bataille Des technologies, mais surtout des Hommes!", *blog Armées.com*, Posté le 10/08/2010 à 11:14 http://www.armees.com/

Another area of interoperability issue is with joint and multinational systems. It is notably a concern for army aviation at the crossroad of land and air operations. Helicopters should be able to exchange both air operations control data through the Link-16 tactical data link and command and reporting data with SIR. Currently, SITALAT and EUROGRID can, with unexpected limitation for the former, exchange with SIR through various ground PR4G radio communication modes. Such exchanges are being greatly expanded with HM PC. But as demonstrated by the current engagement of GAM off the Libya coast in Operation Unified Protector, French helicopters (and British Apaches as well) do not communicate through Link-16. The requirement has long been identified by army aviation, which, since 2008, has experimented a Link-16-equipped Cougar and they expect to field this Link-16 on their command helicopters in the coming years.[36]

Despite these issues, the MOD keep the objective to complete the initial capability for the technical socle in 2012, and then to develop a "capability level-1" of CIS in 2013, under the framework of both the SIA program (for Brigade and above level, see the last section of this study) and SCORPION (for battlegroup and below level).[37]

3.6. The pace of digitization and the dedicated budget at a glance

To date, several brigades have been "NEB-certified" including:

- The *6ème brigade légère blindé*, in the October 2008 CPX, which trained 1200 men of the brigade, with 600 vehicles (whose 250 ones were digitized);[38]
- The 3ème brigade mécanisée in 2008;

forums/topic/91351-numerisation-de-lespace-de-bataille/.

[36] Captain Benoit Dumail, "État des lieux de la numérisation de l'ALAT (NUMALAT)", *Revue d'information de l'ALAT*, n°20, janvier 2010, pp. 26-30.

[37] Ministère de la défense, *note détaillée sur le programme SIC Terre*, in François Cornut-Gentille, op. cit.

[38] "Le 1er REG à la pointe des nouvelles technologies", 22-10-2008, http://1reg.legion-etrangere.com/modules/info_seul.php?id=63&page=1.

- The 2ème brigade blindé in 2009;
- The 1ère brigade mécanisée in 2011.

These command post exercises aim to certify the procedures and skills of the staff with the chain of command SICF-SIR-SIT. The certification does not mean that the brigade units are fully equipped and trained, especially as the importance of operational deployments in Afghanistan, Lebanon, Ivory Coast and elsewhere significantly hinder the pace and the scope of this training for most brigades and their regiments.[39] The *Loi de programmation militaire 2009-2014* objective is to digitize entirely 5 brigades in 2014 and all Army brigades in 2020.[40] From a budget standpoint, the Army dedicated from 2003 to 2008, an average of €190 million (2008) to its digitization program encompassing CIS summarized above. Under the current LPM, voted in 2009, this amount is maintained.

3.7. SCORPION: A French FCS-equivalent

SCORPION (*Synergie du COntact Renforcé par la Polyvalence et l'InfovalorisatiON*, which could be translated by "synergy of contact operations enhanced by versatility and Information") is today the main integrating program for the development of the future capabilities of the Army. It may be seen, to some extent, as a French equivalent to the US Army FCS/BCT Modernization program.

SCORPION is focused at the level of the GTIA. A typical 800-1000 men-strong GTIA includes a command element, the core battalion (either a light or mechanized infantry or armored cavalry one) or 2-3 of its companies, reinforced by one combined armored cavalry /mechanized troop (for infantry predominant battlegroup, such as in Afghanistan),

[39] Colonel Olivier de Cévin, "L'entraînement du PC numérisé de niveau 3 sur fond d'OPEX régulières", Héraclès, décembre 2009, pp 18-19.

[40] Avis n. 548 (2008-2009) de MM. François Trucy, Jean-Pierre Masseret et Charles Guené, fait au nom de la commission des finances, déposé le 8 juillet 2009, *Projet de loi relatif à la programmation militaire pour les années 2009 à 2014 et portant diverses dispositions concernant la défense*, http://www.senat.fr/rap/a08-548/a08-548_mono.html.

one combined artillery battery, one or several engineer platoons, and supported by signal, logistics and medical detachments. It is usually fragmented in company-sized sub-GTIA, organized depending on the mission and commanded by a captain.

SCORPION integrates within one single project management team all previously launched programs related to this GTIA level, and encompasses new ones. It is a very long program, currently articulated in two steps. The first phase extends until 2020. The second one runs in theory over the 2030 decade. In the first phase, regarding vehicles, it includes mainly:

- In the short term, the continuation of the fielding of FELIN soldier systems and the VBCI, already in service in two regiments;
- In the second part of the decade, the upgrade of the 254 Leclerc MBT, the replacement of the current VAB by 977 *véhicules blindés multi-rôles* (VBMR, multirole armored vehicle) in various versions, and the replacement of AMX-10 RC and Sagaie light wheeled tanks by 72 new *engins blindés de reconnaissance et de combat* (EBRC, armored reconnaissance and combat vehicle). Unmanned tactical air and ground systems are also developed. These new platforms should equip 18 GTIAs in the 2016-2020 timeframe.

A key element of SCORPION is of course the digitization. It leverages directly the lessons gathered through the BOA demonstration. A first intermediate objective in 2014, named NUMTACT (for *numérisation tactique*), is to enhance the sharing of tactical situation and all aspect of battle management through the replacement of SIR-SIT-MAESTRO systems by the SI/CS v0 (*système d'information et de combat SCORPION*) based on one single technical socle, as envisioned in the former OE SIC Terre. A second step aims a real step forward in the "*infovalorisation*" by the fielding of SI/CS v1. It will allow collaborative functions such as the management of direct and indirect fires (with the integration of ATLAS functions) and should take benefit of innovations in "vétronique" (integration of IS into the new vehicles), GALILEO navigation and positioning. The CONTACT future software radio system will provide the

communication linchpin for the system, dramatically enhancing joint and multinational interoperability.[41]

3.8. Lessons learned, doctrinal implications and cultural assimilation of the digitization

Concurrently with the development and the fielding of such equipment, the Army develops several doctrinal documents. The general principles of the courses of action described in the doctrine of the digitized brigade-level force are the following:

- Concentration effects and not the forces,
- Increase the speed of the operation,
- Simultaneous actions rather than successive ones,
- Freedom of action of the combined-arms commander,
- Indirect approach to destroy the coherence of the enemy, not its mass,
- Greater maneuvering capabilities.[42]

The doctrine recommends a more distributed and reactive maneuver for offensive as well as for defensive posture. For offensive action for example,

> Units equipped with the means to collect tactical intelligence, limit the freedom of action of the opponent and promote, through the air/land synergy, the application of effects on contact and in depth. As part of the actions of circumstance, the tactical reserve infiltrates between the various components of the opponent to a designated objective or against which it applies or support the application of effects.[43]

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[41] État-major des armées / état-major de l'armée de Terre, *Scorpion, objectifs opérationnels et capacitaires*, présentation aux industriels, avril 2009, http://www.ixarm.com/IMG/pdf/Presentation-SCORPION--14-04-2009--Vfinale-c.pdf.

[42] Centre de doctrine d'emploi des forces, *Principes d'emploi de la FOT numérisée de niveau 3*, n. 000785/DEF/CDEF/DEO, 8 juillet 2004, p. 9.

[43] Ibidem, p. 10.

Beyond tactics, the doctrine also deals with the implementation of digitization. To this end, two processes gain particular attention.

- The first, during the planning, is the generation of the digitized force, the feeding of the CIS with all required data regarding the force, the enemy, the environment: the establishment of the order of battle (ORBAT), the basic data of each elements of this ORBAT, basic intelligence and terrain products, the technical data for communication systems (i.e. messaging addresses) and so forth.
- The second, during operations, is the management of the recognized tactical picture, notably the procedures and responsibilities to exchange and validate operational, intelligence and logistics data.[44]

While digitization is not yet complete, years of test and initial implementation allow interesting conclusions to be drawn up.[45]

Firstly, most tenets of NCW seem to be confirmed by French officers. A first real test of the SIR has been the exercise executed by the GTIA deployed in the FINUL in Lebanon in July 2009 with obviously good results. A captain testified about the added-value of the system:

> The SIR is interesting because it allows an overview of the deployment of my sections and patrols in progress. In addition, the transmission of orders and reports by the SIR, under the form of an interactive map and pre-formatted messages, can increase their speed and reliability and avoid cluttering the radio network.[46]

The digitization reportedly:

- Visibly reduces the time gap between the evolution of real situation and the perception of this situation by the commander and the risk of orders becoming out of date;

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[44] LtCol Pierre Clochard, "L'accompagnement doctrinal de la numérisation de l'espace de bataille", *Doctrine tactique*, n. 20, octobre 2010, pp. 8-9.

[45] GDI (2S) Michel Klein, Philippe Gros, GCA (2S) Michel Asencio, *op cit*.

[46] Etat-major des armées, «09/07/09 Sud-liban: exercice de déploiement du déploiement au Sud-Liban», http://www.defense.gouv.fr/operations/liban/actualites/09-07-09-liban-exercice-de-deploiement-au-sud-liban.

- Reinforces the responsiveness of the force, notably by enhancing the initiative at each echelon;
- Reduces the risk of friendly fires;
- According to earlier users, at the end, allow far better collaboration within the staff;
- Allows to better characterize the constraints and opportunities of the environment, which were previously apprehended intuitively.

It seems nevertheless that such systems are not easy to assimilate. Many problems are hopefully temporary, related to the build-up of the digitization:

- One officer described SIR as a "tool very long to set up and subjected to numerous malfunctions internally";[47]
- The break in the battle management modes between digitized command post and the command of non-digitized dismounted units, what is a very common situation in counterinsurgency and stabilization operations. It should be progressively be fixed as the SIT is fielding in unit;
- The time dedicated to find solutions to operate the network which reduces the time available for tactical decision-making;
- It seems that, as the US Army Battle Command System[48], SICF and SIR software are not well suited to depict and manage knowledge regarding irregular adversary and stabilization operations.

Even if these problems are fixed, some enduring challenges remains.

- These systems require any way a lot of training to gain and maintain skills, regularly hampered by the numerous updates of the systems.
- A typical constraint of such system is the writing of orders and reports through very strictly formatted template, what user tend to bypass by the use of Outlook messaging system.

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[47] "Numérisation de l'Espace de Bataille Des technologies, mais surtout des Hommes!", *blog Armées.com*, Posté le 10/08/2010 à 11:14 http://www.armees.com/forums/topic/91351-numerisation-de-lespace-de-bataille/.

[48] Daniel Gonzales, *Networked Forces in Stability Operations, 101st Airborne Division, 3/2 and 1/25 Stryker Brigades in Northern Iraq*, MG 593, Rand Corporation, 2007, p. xxxi.

- The appropriation of SIR by the regiment CP takes one or two years, necessary to manage the risk of information overload and the focalization on the computer. At that time, explained Colonel Dupuy de la Grand Rive, commander of the *1er Régiment de spahis*, "*Free from technology, leaders can return to the military decision-making and run the battle. The user is no longer hypnotized by the screen, absorbed in the management of information, it is ready to fight*."[49] Nevertheless, the colonel considers the isolation of the user as a permanent risk to be trained against.
- Other officers consider the gap between the virtual world of the computer-created picture and the real world as an enduring risk.
- Many officers fear also the micro-management, permitted by the digitization, even more coming from the strategic level than coming from direct upper echelon, especially as, like their US counterparts again, most of them do not consider that digitization justifies the flattening of the various levels of command, conversely to what envisioned proponent of the NCW. Nevertheless, the digitization allows organizing the operational functions with more flexibility.

As a matter of fact, while SCORPION and FELIN key milestones are well discussed, the digitization per se is no longer a key issue of the debate surrounding the Army. A first cause is the assimilation of systems which are not viewed as revolutionizing the warfare even though their added-value in terms of operational efficiency seems to be widely accepted. The second and more pressing reason is of course the engagement in Afghanistan, putting concerns such as the operational preparation of GTIA to be deployed, urgent material needs to better protect the force against IEDs and other insurgent courses of actions, the counter-rebellion and counterinsurgency doctrine and tactics at the top of the agenda.

[49] Captain Thomas Dijol, "Liberté d'action", *Terre Information Magazine*, n. 215, juin 2010, p. 37.

4. THE FRENCH AIR FORCE

4.1. The SCCOA

The *système de commandements et de conduite des opérations aériennes* (SCCOA, Air Operations Command and Control system) constitutes the main C^2 system of the *Armée de l'air.*[50]

SCCOA integrates several components. It encompasses the fixed elements operating the air defense over France, which were formerly known as STRIDA (*Système de Traitement et de Représentation des Informations de Défense Aérienne*). It includes currently:

- About one hundred high and medium altitude and approach radars;
- Five Detection and control centers (CDC), which fuse information to detect, classify aircrafts and control the air defense missions. Each CDC is able to handle more than 2000 tracks and 1000 flight plans;[51]
- The *Centre national des opérations aériennes* (CNOA, Air operations national center) on Lyon-Mont Verdun 942 Air Base which also hosts the French Joint Force Air Component Command headquarters;[52]
- The GRAVES system for space surveillance.

SCCOA includes also deployable component for theater air operations. This deployable component (C3M, *centre de coordination et de contrôle mobile du SCCOA*), developed during the 2000 decade, has been designed to fulfill the requirements of the NATO air component when led by French. It has been therefore certified for NRF 5 in 2005, NRF 12 in 2009 and, recently, for NRF 17 in 2011. It integrates:

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[50] For a general overview, DGA, *Le système de commandements et de conduite des opérations aériennes, mise à jour le 14 juin 2011*, http://www.defense.gouv.fr/dga/equipement/information-communication-espace/le-systeme-de-commandement-et-de-conduite-des-operations-aeriennes-sccoa.

[51] SCCOA (Systeme de Commandement et de Conduite des Operations Aeriennes) (France), Command information systems - Air, Jane's C4I Systems, May 16, 2011, http://articles.janes.com/articles/Janes-C4I-Systems/SCCOA-Systeme-de-Commandement-et-de-Conduite-des-Operations-Aeriennes-France.html.

[52] Ministère de la défense, BA 942, Centre national des opérations aériennes, http://www.ba942.air.defense.gouv.fr/index.php?option=com_content&view=article&id=223&catid=7.

- A JFAC HQ and its deployable CAOC allowing to control up to 1000 sorties/day;
- An air coordination center to integrate air support to land and maritime operations;
- An expeditionary air base to control local airfield;
- A deployable CDC;
- The Joint module of Army MARTHA system allowing to coordinate 3D and notably surface-air systems;
- Other assets such as deployable weather stations or theater surface-air communications center.

The SCCOA is an evolutionary system, launched in 1993. Current modernization activities correspond to the third step of the program started in 2001. These modernizations include upgrades of CDC and radars, the handover of air operations control center from Taverny 921 air base to Lyon-Mont Verdun air base, and more importantly, a limited integration with NATO ACCS and the development of the deployable component. The SCCOA 3rd step has been engineered by MOSS SAS, a dedicated subsidiary company formed by Thalès and EADS, which includes 80 people.

The fourth step, which began in 2010, is intended to upgrade the radar coverage of French territory by the replacement of older radars, to complete the full integration with ACCS to allow a seamless air control of NATO countries airspace and the same integration for air operations. The five CDC will be replaced by three NATO ACCS ARS (Air control center, RAP production center, Sensor fusion post), include the Lyon-Mont Verdun base, which will also host a Combined Air Operations Center with NATO standards. These developments will allow it to create one single radar-based air recognition picture. SCCOA step 4 also includes the enhancement to the mobile component and will also fully absorb the management of the once-Army MARTHA 3D coordination system.

The SCCOA program has been funded with

- 171 million Euros in 2009,
- 48 million Euros in 2010, and
- 69 million Euros in the 2011 budget.

4.2. The tactical level: Link-16 datalink and CAS-related networking

At the tactical level, two important developments allowed recently French Air Force to enter in a more networked environment. The first one is the introduction of the Link-16. The first trial of the Rafale with link-16 took place in 1999. Now the system is fully integrated onto the Rafale. French Air Force is currently equipping, from 2009 to 2014, its 33 Mirage 2000-5 (dedicated to air defense) and 77 Mirage 2000D (dedicated to interdiction) with MIDS terminal.[53] Link-16 equips as well all French C^2 platforms: aircrafts such as AWACS, Navy Hawkeye and, from 2015 Maritime Patrol Atlantic-2, ground-based centers such as CDC, ARC and CAOC, and most important naval platforms including the aircraft carrier, the two *Batiments de Projection et de Commandement* (BPC, Command and Projection Ship) Tonnerre-class and Cassard and Horizon-class air defense frigates.[54]

Link-16 constituted "a true revolution", according to the LtCol Maihol, head of Rafale team in the *Centre des expérimentations aériennes militaires* (CEAM) at Mont-de-Marsan air base in 2008. Compared with former operations based on radio exchange, the added-value of Link-16 is reportedly threefold:

- It accelerates considerably the information exchange between AWACS and the patrol's combat aircraft;
- The pilot situational awareness is not 'mental' anymore and relies on a comprehensive visualization of all mission-related elements, including targets or tracks beyond the scope of the embarked sensors;
- It allows a dramatic shift in the interoperability with other NATO assets.

Nevertheless, during the implementation of the Link-16, some challenges did emerge. A first one has been the filtering of information. A pilot explained that "*the more you are remote of combat zone, the more you*

[53] Sirpa Air, "Livraison du premier Mirage 2000 doté de la liaison 16", 12/10/2010, http://www.defense.gouv.fr/air/breves-migration/livraison-du-premier-mirage-2000-dote-de-la-liaison-16.

[54] "Liaison 16", Wikipedia, http://fr.wikipedia.org/wiki/Liaison_16#cite_ref-121.

display Link-16 information. As you are coming closer to the zone, you need to filter the mass of data to keep the most relevant ones". This issue has been resolved with new F-3 Rafale standard, in service since 2009.[55]

During current Libya war, French Rafales used the full capabilities of Link-16, including the automated target designation to the *Armement Air Sol Modulaire* (AASM), a new air-surface precision-guided weapon, in the French arsenal since 2008:

> To illustrate the Rafale's networking capabilities, one pilot described how the aircraft can receive target coordinates from an AWACS or another aircraft via Link 16. To accept the assignment, the pilot pushes a button, and the coordinates are automatically programmed into the AASM guided bombs, with no further action by the pilot who, once in range (up to 30 nautical miles), again pushes a single button to launch all three – or all six – AASMs to their individual targets. 'We can fire the AASM against targets abeam or behind us, and can hit up to six in a single pass' the pilot continues.[56]

While the Link-16 is currently widely disseminated, the program remains plagued by an important shortfall. As the LtCol Foussard explained to the 2008 *Livre Blanc* (the French defense review) panel:

> In Afghanistan, when you are with a Mirage 2000 D, by night, with somebody who roars on the radio that he needs a bomb and that you do not have fuel anymore, you have to refuel and to find with your only night-vision googles, a tanker which is without any lights and does not speak. […] This problem is partially bound to the sensors of our planes; these are not equipped with Link 16 yet.[57]

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[55] Guillaume Steuer, "Liaison 16 sur Rafale: retours d'expérience", *Air & Cosmos*, n. 2114, 29 février 2008, pp. 20-23.

[56] Giovanni de Briganti, "Rafale in Combat: 'War for Dummies'", *Defense-aerospace.com*, posted May 31, 2011, http://www.defense-aerospace.com/articles-view/feature/5/125860/rafale-in-combat%3A-%E2%80%9Cwar-for-dummies%E2% 80%9D.html.

[57] Audition du Lieutenant-Colonel Bruno Foussard, *Livre blanc sur la défense et la*

The French pilot intended to illustrate the slow downgrading of French material, but his example also illustrates the need to equip all aircraft involved in the operations, including the tanker, with Link-16. This does not seem to be included in the current program.

Due to current engagement in Afghanistan, French Air power, like most of its counterparts, recently made tremendous progress in the area of Close Air Support-related networking, the so-called digital CAS. Indeed, in the COIN theatres, more than 85% of the airstrikes are CAS missions coordinated through TACP/JTACs. Nevertheless, it should be noted that after the initial air strikes in support of Operation Enduring Freedom in the year following the 11/9, the French commitment has been very limited in Afghanistan in terms of air operations. It resumed significantly from 2007. This situation created some discrepancies with allied air forces since French air force did experience the compelling needs to develop material and procedures adapted to the counterinsurgency context with delay.

To find an immediate solution to this urgent requirement, the *commandos parachustistes de l'air 10* (CPA 10, special air commandos trained in TACP functions) and the CEAM developed in 2007 on their own experience a COTS solution for digital CAS: the SCARABEE (*Système de Communication Aéroterrestre, de Restitution, d'Acquisition et de Bibliothèque Embarquée Évolutif*). With this system, the pilot and the ground JTAC share the same referenced picture. The latter "dresses" the image with his indications and returns it to the pilot. The referenced image solves the problem of coordinates, which is useful notably in urban CAS.[58]

But the SCARABEE was plagued with two limitations: it was a unique and "handworked" French system, which competed with the US ROVER (Remotely Operated Video Enhanced Receiver), developed incrementally since 2002 and widely curculated as the main standard for digital

sécurité nationale, tome 2, Les débats, 2008, p. 27, http://www.livreblancdefenseet *securite.gouv.fr/IMG/pdf/livre_blanc_tome2_lesdebats.pdf.*

[58] Commandant Rémy Martin, « De l'entomologie dans la transmission de données », *Penser les ailes françaises,* Centre des études stratégiques aérospatiales, n°18, pp. 140-144.

CAS.[59] The SCARABEE was presented as complementary to ROVER, a very sophisticated system allowing the JTAC to select the best weapon and to perform direct collateral damage estimate but whose video exchange requires more radio discussion and exploit only the airborne pod. The ROVER 5 evolved well to reduce this inconvenience. Nevertheless, from a practical and operational perspective, the situation was a showstopper for the French system. Indeed, French Rafales, M 2000Ds or Super Etendards, have, as their counterparts of the coalition, been indifferently supporting the ISAF or OEF ground contingents on several occasions, while engaged on "troop in contact", replaced by other aircrafts which were equipped with ROVER.[60] The French Air Force decided therefore to equip its detachment with the latter which is operational on Mirage 2000D since March 2010.[61]

5. THE FRENCH NAVY

The main CIS program which allows the digitization of the French Navy is the SIC 21 (*Système d'Information et de Communication du 21e siècle*). After experimentation, SIC 21 entered into initial service in 2007. SIC 21 is funded with €19 million in the 2011 budget, and is currently equipping 45 land-based and 54 embarked sites. Manufactured by Thalès, SIC 21 uses service oriented architecture. It hosts the same core of classical applications as Army SICF, ranging from messaging to VTC, chat, and of course applications oriented to plan and conduct naval operations (situational awareness, intelligence, planning tools) and interfaces with other external applications. For example, SIC-21 use LuciadMap geographic information tool suite to generate the shared air and

[59] Olivier Zajec, « Le 'paradigme ROVER': paradoxes de la standardisation en coalition, *DSI*, n°57, mars 2010, http://www.dsi-presse.com/?p=1861.

[60] Jean Guisnel, « L'armée de l'air attend avec impatience le système Rover », *Le Point.fr*, 05/08/2009, http://www.lepoint.fr/archives/article.php/367003.

[61] SIRPA Air, « Le Rover sur les Mirage 2000D en Afghanistan », 12/10/2010, http://www.defense.gouv.fr/air/breves-migration/le-rover-sur-les-mirage-2000d-en-afghanistan/%28language%29/fre-FR#SearchText=rover#xtcr=1.

maritime recognized picture, to make terrain analysis supporting mission planning.[62]

Regarding the communication layer, SIC 21 federate two networks:

- The network ashore linking Navy HQs and other facilities, and
- The RIFAN (*Réseau Intranet des Forces Aéro-Navales*), which provides an IP network for deployed naval forces. RIFAN provides "*email voice over IP, chat, FTP file-exchange, video-conferencing and co-operative mapping to provide ships a common operational picture for shared situational awareness*."[63] A first contract was awarded to Thalès in 2004 for €60 million to equip 67 naval platforms. EADS Defence & Security, DCNS and Rohde & Schwarz have been awarded two contracts in 2008 and 2010 (for a total of €290 million), for the conception, development, fielding and maintenance of RIFAN 2,. RIFAN 2 will equip 116 vessels and 64 aircraft (Atlantique 2 maritime patrol aircraft, E 2-C Hawkeye et NH90 helicopters).[64]

At the platform level, one key CIS node of the naval networked operations remains the SENIT (*Système d'exploitation navale des informations tactiques*). SENIT integrates and manages all the weapon system of the vessel, links with tactical data network such as Link-16 for air operations and NATO Link-22 for naval operations. Navy have employed nine generations of SENIT, the last one SENIT-9 being used on the BPC.[65]

The 2009 DGA plan for research and technology identified six main stakes for naval warfare, among which "*The fight over the surface by looking for synergies in the naval force* (tenue de situation multi-plate-forme *and* capacité d'engagement multi-plate-forme)."[66]

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[62] *SIC 21: The French Navy's new generation C2 system for Network Centric Warfare built by Thales*, Luciad, http://www.luciad.com/files/assets/downloads/case_study_dga_sic21.pdf.

[63] Tim Fish, "French Navy to extend intranet system", *Jane's Navy International,* 13 Jan 2009.

[64] « RIFAN 2 - Un nouvel intranet pour les forces aéronavales », *Mer et marines*, 01/09/2009, http://www.meretmarine.com/article.cfm?id=109195.

[65] « SENIT: Système d'exploitation navale des informations tactiques », *netmarine.net*, http://www.netmarine.net/armes/senit/index.htm.

[66] Délégation générale pour l'armement, *Plan stratégique de recherche & technologie de défense et de sécurité*, 2009, p. 57.

The *capacité d'engagement multi-plate-forme* (CEMP) represents a very challenging program at the heart of expected capabilities of NCW. It is the French equivalent for US Navy's Cooperative Engagement Capability. The requirement has been expressed in 2001 for a more reactive engagement capability against various kinds of threats including asymmetric ones. But one of the key areas of importance for such a program is clearly missile defense.

A first part of this CEMP, the *tenue de situation multi-plate-forme* (TSMP, multi-platform situational awareness) was initiated by the DGA in 2004 and awarded to DCNS. Three architectures were experimented in 20 scenarios: the development of the tactical situation centralized in one platform, distributed among platforms of the network and hybrid with each platform performing its own situation while one federates and manages the network. The last solution was selected in 2008, for follow-on development.[67] According to Hervé Fargetton from DGA, who assessed the system,

> The capability offered by DCNS involves, along with conventional Tactical Data Links (TDL), High Data Rate network (HDR) to improve tracks reactivity and continuity. Force units are sharing elementary detections and the DCNS capability is based on distributed multi-platform data fusion running on each force unit. Specific technical exchanges on HDR ensure synchronization of the different tactical pictures.[68]

TSMP are to be completed in 2011. This capability should be implemented in the SETIS combat management system of the new *Frégate Européenne Multi-Missions* (FREMM, multi-missions frigate) class[69] the first two units of which are to be delivered in 2012 and 2014, on a total of 11 ships.

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[67] *Richard Scott, "Sensing in clutter: improving littoral situational awareness",* Jane's Navy International*, 23 April 2009.*

[68] Hervé Fargetton, Evaluation of The DCNS Multi Platform Situational Awareness Capability, MAST 2011 Conference Session, Operations & Capabilities (Surface) NNEC, Monday 27th June 2011, http://www.mastconfex.com/sessions.asp?s=2B.

[69] « FREMM: 11 frégates multi-missions pour la flotte française », 27/10/2008, http://www.meretmarine.com/article.cfm?id=108646.

Finally the DGA included also among its priorities

> The fight against submarines and the emergence of the concept of cooperative engagement for the undersea space [...] the cooperation between air (maritime patrol), surface and undersea platforms, by the development of multistatic detection.[70]

The upgrade of the acoustic detection system of the maritime patrol aircraft Atlantic 2, which are to begin in 2011 with a first capacity expected in 2014, will include such capability by allowing the delivered sonobuoys to work as a network.[71]

Nevertheless, the full implementation of such cooperative engagement capabilities will probably not be fulfilled until the end of the decade and depend heavily on the shrinking defense budget more than on the technology.

6. THE JOINT CONVERGENCE TO SIA: AN AMBITIOUS TARGET

The defense staff, notably the divisions of joint programs and capabilities coherence developed a new approach towards the middle of the decade to reach the end state of joint interoperability. The whole project is now called the *système d'information des armées* (SIA, armed forces information system).

This approach is the creation of joint *socles techniques communs* (common technical bases, STC) upon which various services corresponding to various functional and operational requirements can develop and exchange data. As stated by the joint objective document:

> The referential models, now fragmented, are intended to lead to the formation of a set of common referential called "socle" for or-

[70] Délégation générale pour l'armement, *Plan stratégique de recherche & technologie de défense et de sécurité*, 2009, p. 57.

[71] Vincent Groizeleau, Patrouille maritime: Le programme de rénovation des Atlantique 2, 03/02/2010, http://www.meretmarine.com/article.cfm?id=112321.

> chestrating the convergence of IS (architectural framework, standards and applicable standards, reference models data, …). This socle should, on publication of this document, be compatible with those defined and implemented by our major allies, to ensure the sustainability of our national investment.[72]

The approach is incremental:

- A first step is the convergence towards one common joint set of "socles" with interoperable land, air, sea applications;
- At longer term, the optimization of the socle and the "urbanization", that is the coherent migration of joint functional applications covering all the need.

There are two "socles":

- The first (STC-E) deals with the data exchange (wide area and radio communication networks, hardware, protocols, etc.);
- The second (STC-IA) create the common set of applications for all users (software architecture, messaging, directorate, etc.).

These STC are deployed since September 2010 on three bases per week and should be therefore completed by the end of 2011. This STC will be upgraded as service oriented architecture (SOA) in the 2011-2013 timeframe. This transformation is implemented by the *Direction Interarmées des Réseaux d'Infrastructure et des Systèmes d'Information*, created in 2003, which operates all defense CIS.

The French minister of defense, Hervé Morin, decided in 2010 the launch of conception studies of this SIA. According to the MOD,

> Operationally, the SIA will allow armed forces to have, by 2016, a unique command and control system, with a global networking, a secure and jointly shared picture of the operational situation and greater interoperability, both internally and with our allies.

The Mod takes the following approach:

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[72] État-major des armées, *PIA 06-320, Objectif directeur des systèmes d'information opérationnels et de communication*, N° 429/DEF/EMA/DCE/OCO du 24 juillet 2007.

- A first step has been, for operations, to take the SICF as the basic joint and land high levels of command information system from FHQ to brigade level;
- This system is beginning in 2011 to migrate onto the STC-IA ("*SI haut*");
- After the evolution of the "socles" toward a SOA, SCCOA and SIC-21 are intended to migrate onto the STC-IA in around 2016, forming the first step of the SIA.

It remains to be seen if this ambitious project will reach the objective within the scheduled 5 years, which should not be taken for granted. On one hand, the approach is limited to the high levels of command. On the other hand, it is challenging because it encompasses the complexity of joint arena with competing service interoperability needs with other land, air or sea allied partners, and may be hindered by the same problems of information sharing between industries experienced before. Some are also questioning the interoperability between this high level information system and SC/IS for lower tactical echelons.

4.
The British case study

1. The digitization debate

In 2009, soldiers of the British Army began using a new 'smart binoculars' system known as the Joint-Target Acquisition System Mk II (J-TAS Mk II). This equipment was ordered from Thales UK as an *Urgent Operational Requirement* (UOR) in December 2007 and combines daylight and thermal sights with a laser rangefinder and a built-in GPS receiver. By all accounts from the field, it is an excellent piece of equipment that helps troops recognize targets. Seeing as the system 'knows' its own location (through the GPS equipment), and the distance and bearing to a target (using the laser), it can very accurately work out that target's location. It features an array of connection sockets across the back of the device that would enable J-TAS to be directly connected to a soldier's radio to digitally pass that location data and, theoretically, the video feed from the sight directly to strike aircraft or artillery for engagement. However, the British Army doesn't use that facility; instead it relies on a soldier's ability to read off the data presented on the J-TAS screen and then transmit that as a verbal grid reference over a secure voice radio. This is partially down to the British Army operating procedures and rules of engagement, but in some ways this discontinuity between possessing the capability to network systems and a reluctance or inability to fully exploit it forms a metaphor for the UK's whole approach to digitization.

Although the UK has identified a firm commitment to the transformational potential of a truly digitized and networked joint defence force

since the mid-1990s, it has only slowly been adopted into practice and there are still substantial 'stove piped' systems with only rudimentary connections to other national and allied assets on the battlefield. Despite all of the services undergoing an undeniable revolution in digitization of individual pieces of equipment and capabilities over the last decade, the parlous situation of a truly networked capability is as true for the Royal Air Force (RAF) and Royal Navy (RN) as it is for the Army. Budgetary issues, programmatic setbacks and operational realities have all conspired to derail the overarching networked vision that would have all of the services acting seamlessly together, let alone networking in with their international allies.

This digital vision is largely a range of individual service-specific programs for each of the forces. However in the early 2000's, the UK – like many of its European neighbours – adopted a UK-wide network-enabled capability (NEC) approach, rather than the US concept of network-centric warfare (NCW). Despite being very similar, the decision not to place a network at the very centre of operations is a crucial distinction. Opting for the NEC route essentially means choosing to use the advantages that networked sensors and weapon systems afford to enable existing forces act more quickly, proactively and effectively rather than placing the centre of gravity on the network itself.

This policy was seen as particularly important to retain the primacy of responsibility for operations on the forces themselves and ensure that they could remain effective in the event of communications failures or the loss of access to a network. Against a background of today's environment of the increasing threat of cyber-attacks and a level of reliance on networking capabilities that was absolutely unimaginable back in the mid-1990s when the Internet and computing revolution was only just surfacing, that policy seems very prescient.

However, that policy may also be one of the main factors that has hamstrung and hindered the UK's ability to develop and deploy a universally coherent, digitized, networked force. This is because by not placing the network at the centre of operations, it is by definition a secondary enabler and can lead to further stove piping. After all, under an NEC concept is it necessary to network a Tornado GR.4 with all other assets as a node on the battlefield? Or is it sufficient to just provide a voice

connection to a *Joint Terminal Attack Controller* (JTAC) on the ground, and another to an airspace coordinator and a separate datalink to its weapon? As we will see in the RAF requirements section later, that level of connectivity has proven to be insufficient for a congested, multinational battlespace like Afghanistan, so perhaps a more NCW approach would have been more successful.

On the other hand, the NCW is clearly not without its problems. For example, though the US Army's Land Warrior leading edge army digitization project, which relies heavily on communications and assured connectivity, proved successful in Iraq. However, the dismounts' reliance on the connectivity offered through the communications bearers carried by their Stryker vehicles was a demonstrable weakness in Afghanistan as the destruction of a vehicle left the soldiers disconnected and vulnerable. Within the UK, the use of NEC as a concept appears to have fallen out of favour. Networking aspirations were set out in the UK's 1997 Strategic Defence Review and remained a core section of the Ministry of Defence publications, such as the 2005 Future Capabilities report. However, by the time the *Strategic Defence and Security Review* (SDSR) was launched in October 2010, there was only a single mention in the section on Naval Forces. This set out that "maritime intelligence, surveillance, target acquisition and reconnaissance (ISTAR) capabilities based on network enabled warships, submarines and aircraft".

This is presumably because digitization and networking have become such central elements of the modern defence environment that their importance can be taken for granted. Another passage in the report sets out that the SDSR "will deliver a major restructuring of the Armed Forces in order to generate future military capabilities that will be high-quality, in training and equipment, with the logistics, communications and other enablers necessary for the tasks we plan to undertake."

In a UK context, digitization covers five main areas: secure voice radio; data transmission; joint force integration; common operating picture generation and shared mapping; replacing obsolete 'mandraulic' systems with computerized, automated systems. Of the UK services, the British Army has probably attracted the greatest criticism – not all warranted - for its slow pace of digitization, with critics largely focusing on the glacial transition to the Bowman communications system as a par-

ticular sticking point. Defence analyst Dr. Jim Storr wrote in the October Royal United Services Institute (RUSI) Defence Systems journal that

> in 1995 and 1996 a few highly visionary, well-placed and capable people developed a vision of battlefield digitization as a theatre-wide, highly integrated, broad and deep capability that would revolutionize the British Army. Huge amounts of money were linked to the program: in 1997 this amounted to about £4Bn in the long-term castings. It would largely be in service by 2005-8. It has failed.

It is true that the program has slipped and is only now beginning to really show benefits on the battlefield, but asserting that "digitization has failed" is probably overstating the argument.

Dr. Storr also points out that one of the curious elements of the push towards digitization is the relative lack of empirical data that NEC actually provides greater capabilities on the ground.

> The evidence for the effectiveness of battlefield digitization, [he said], has always been slim or non-existent… The most positive piece of [Operational Analysis] OA suggested tactical benefits due to improved situational awareness [SA]. However, subsequent field trials have shown that the kind of data rates required to give that level of situational awareness are not going to be delivered by Bowman. So there is no real evidence that digitization improves operational effectiveness.

In fact, although increasing connectivity is clearly vital for connecting 'sensor-to-shooter' more closely, and joint fires requires connectivity as a basic essential, the path to digitization is littered with good ideas that work in exercise but don't necessarily prove popular in theatre. For example, the UK deployed the Thales UK-developed ELSA (Enhanced Low-Level Situational Awareness) package into Afghanistan in 2008 explicitly aiming to enhance soldier SA. The deployment followed successful trials by the Warminster-based Infantry Trials and Development Unit, which suggested that increased awareness improved navigation accuracy and efficiency.

ELSA consists of a MILTRAK display – derived from a Nokia mobile telephone – with an integral GPS package connected to a data-capable UHF or VHF radio, in the UK's case using a Selex EZ PRR (Personal Role Radio). In essence, this affords platoon commanders with regularly updated position data on their soldiers, overlaid onto maps, aerial photographs or a simple oriented pointer. Despite the success in UK-based testing, it has proven less popular in operational service. For example, on his return from Afghanistan in 2009, Major Richard Cantrill commanding officer of Lima Company, 42 Commando, Royal Marines, told *Jane's International Defence Review* that despite his marines all being able to "see the possibility of its functionality" during operational work up training, they opted not to use it in Afghanistan. Primarily, he said that it was not sufficiently reliable or easy enough to use to justify its additional weight, distraction and battery requirements.

Giving that the average weight of British infanteers in Afghanistan ranged from 55 kg to 75 kg at the time, the decision is understandable. However, there is still a general preference to rely on traditional soldiering skills and personal relationships. Other soldiers have returned from theatre and anecdotally expressed the importance of the morale of soldiers being reassured that their immediate command structure has a direct knowledge of their location and status which only comes with a physical connection and sharing a few words while on patrol or – particularly – while taking cover in a firefight, rather than just presenting an intangible dot on a computer screen.

Major Cantrill's experience concurs: "The only way to gain assured tactical situational awareness is by speaking to commanders that you trust. The shortcomings of these systems only make them 'useful' and there is no room for systems that are just 'useful'".

Brigadier Gordon Messenger, commanding officer of 3 Commando Brigade also supports this view, he believes "we're still miles away technologically and culturally from having a system that is light enough, timely enough and accurate enough to provide a proper solution."

This reliance on traditional skills and a degree of healthy scepticism regarding technology seems to be a common theme running through UK land forces. Speaking in April 2011, Brigadier Mike Hickson, Director *Royal Logistics Corps* (RLC), stated. You've got to recognize that there's

a cyber-threat out there," Brig Hickson agreed, "so you've got to have a fallback mechanism to protect any of your kit that might be affected. That's obviously easier to say than do, but as long as you recognize in advance that something is at risk, you do what you can to mitigate it. During training we switch off all the [information systems] tools," he said.

> I think you'd be very foolish to go into an operational theatre with individuals who have never done the job on paper. Losing the digital tools is a retrograde step and it slows everything down, but if you can't do it off the back of a cigarette packet, it's all going to collapse if you later lose them. I will guarantee you that at some point you'll lose connectivity. Bandwidth is much better than it was and our demands for it are much lower so some of the traditional problems are disappearing now, but even so the systems can collapse. You've got to be able to do the job in the dark, with your fingers.

That's not to say that the UK's land forces are resistant to change, they clearly embrace systems where there is an obvious use. For example, their adoption of ROVER (Remote Optical Video Enhanced Receiver) terminals which enables them to see full motion video and imagery transmitted from allied aircraft was both rapid and widespread. Furthermore, as personnel numbers drop off, specifically the UK Ministry of Defence's 2010 SDSR plans to slice 7,000 soldiers from the Army's establishment by 2015 and slim the RM down by 15% to just 1,800 marines. The force multiplying capabilities offered by networked systems are likely to become yet more important. Base protection, for example, is increasingly being automated with remote cameras and unattended ground sensors networked to a lean-manned command post enabling soldiers to patrol more and freeing them up from sentry work. Though, there is obviously a balance to strike there ensuring that there are sufficient off-duty soldiers available to react to any incursion.

This pattern follows the experience of the RN to an extent, because the Navy has consistently introduced automation over the last few decades as it embraced the concept of lean manning and internal networking technology evolved. This process principally saw the increased

adoption of monitoring systems networked to a central point on the ship, but also improved automation of ship systems and processes that enabled crew numbers to be reduced. As for the wider adoption of digitization and networking, the inherently expeditionary nature of the RN ensured that it has also been a keen adopter of networking technologies. It's Cold War posture within NATO and the UK's global interests have clearly afforded the Navy long experience of thinking of its vessels as sensor and weapons nodes in a larger fleet network, both national and international.

This has necessitated the adoption of advanced terrestrial communications systems, satellite and datalinks to connect with everything from Somali fishing vessels with just a cell phone aboard, right up to coalition fleets of aircraft carriers, submarines, aircraft and unmanned systems.

At an individual equipment level the RN has completely recapitalized its legacy weapon and sensor systems over the last 20 years – using commercial-off-the-shelf equipment where possible – and the combat information centres of even the oldest remaining frigates are unrecognizable from the cramped spaces packed with CRT screens and large processing cabinets 10 to 15 years ago. The newer vessels, such as the Albion-class LPD (Landing Platform Dock) amphibious ships have taken it to even greater extremes, with large ergonomically designed spaces for command teams complete with video walls, wireless networks, remote hot-desking workstations and hugely powerful communications and battle management suites. This extends into the accommodation suites, which are well appointed with connectivity for laptops and media access.

Similarly, the RAF quickly realised the benefits of communicating with other national and coalition assets, particularly for the air-to-air battle and, more recently the service's burgeoning role in close air support (CAS) has highlighted some shortcomings in its connectivity. The latter has mostly been addressed at a functional level, but there is still a lot to be addressed before it can declare itself fully digitized.

However, all three services have apparently stepped back from some areas of networking. In the early part of the last decade, the Ministry of Defence (MoD) articulated an aspiration to 'confederate' simulator sys-

tems to enable forces to exercise jointly. This was to have seen RAF Tornado and Typhoon pilots flying simulator missions over main battle tank (MBT) crews in their own vehicle simulators and RN vessels initially plugged in alongside. Then, later over satellite communications links, with all operating in a common synthetic environment. A mission could even have drawn in Combined Arms Tactical Trainer scenarios, bridge and gunnery simulators.

The basic principles of this have been tested and proven, even networking UK simulators with US and Australian systems, but the practice was rarely used as each service has focused on its individual training needs at an individual, group and relevant joint level without having to go to the effort of coordinating a mass exercise. Reportedly, in May 2011 there were multiple Tornado simulators on the RAF Loss-iemouth base, however, they are rarely linked together, as they are used more for individual crew certification and training than group flying.

All of that notwithstanding, two major themes have underpinned the UK's process of digitization over the last decade: the incessant development of computer processing power and networking technologies; and the fact that UK forces have been deployed in two major multinational operations in Iraq and Afghanistan for nearly ten years. The latter in particular has spurred digitization because the polyglot, multinational nature of the deployments has required the UK to chase connectivity with coalition partners, particularly – but not exclusively – the USA. The complexity of the asymmetric, relatively low technology threat has also required the UK to build on its own asymmetric capabilities by using technology to multiply its forces and bludgeon the Iraqi and Afghan insurgents wherever possible.

This coalition approach has encouraged the UK to move away from national-only communications in Afghanistan and the forces in theatre have been using a Secret-classified wide-area network called *OverTask* as the main command and control system since around 2008. This was acquired under the Defence Information Infrastructure umbrella, which will be discussed in more detail, later on.

During the WBR's Battlespace Information 2008 conference in Brussels, Commodore Eric Fraser, Chief J6 at the UK's Permanent Joint Head-

quarters stated that when *OverTask* came in, it marked a turning point for British forces, as they were "beginning to see network-enabled capability in action". He added that

> a year ago, we had difficulty speaking to our Danish colleagues, for example, operating in Helmand Province. They weren't on JOCS [Joint Operational Command System - the UK's communications net] and we weren't on the NATO system. Now we can talk to whoever we need to.

It might be fragmented and a long time coming, but the UK has most of the pieces in place to really embrace the NEC. The dawn is coming.

2. THE BRITISH ARMY

The British Army has a fractured relationship with digitization, particularly at the soldier level, although the MoD revealed plans to re-inject some coherence into the program again in June 2011.

Like most 'western' countries the UK embarked on a soldier digitization project in the mid-1990s, looking to capitalize on the newly in-vogue NEC/NCW and the computing connectivity revolution that was under way at the time. The UK's project was christened FIST (Future Infantry Soldier Technology) in 1995 and that name still persists, despite the program being effectively hijacked and derailed by operations and the UK's policy of rushing UORs through to the field. Although the urgent response to requirements has been admirable, it complicated and virtually derailed any real attempts to maintain FIST as a coherent program for most of the last decade.

For example, FIST was originally envisaged as a holistic package of complementary acquisitions, but has subsequently been broken down into a series of themed areas, which have in turn been usurped in some instances by the acquisition of UOR equipment, particularly in the area of weapon sights and the huge proliferation of thermal sights across British troops.

The problem with the UOR process is largely that the pace it needs to move at dictates that the MoD buys equipment off the shelf, which clear-

ly requires the Ministry to select the best fit available for the capability rather than develop bespoke equipment. That need not be a bad thing in itself, it is certainly cheaper. However, the problem is that what one manufacturer has on its shelf may not necessarily be entirely compatible with another manufacturer's system, or indeed complement the Army's specific requirements.

By way of example, the German Infanterist der Zukunft (IdZ) program has taken a holistic approach to power management, with a single bespoke battery pack shaped to fit the load-bearing equipment and body armor, and provide power to the soldier's navigation and battle command computer, radio and weapon sights. In contrast, British soldiers in Afghanistan have to carry a wide range of batteries to power all of their off-the-shelf ancillaries, greatly increasing their weight burden and contributing to the fact that British soldiers have the dubious distinction of carrying the heaviest average loads of any force in-theatre.

On top of this, the UORs have pre-empted some of the capabilities that were intended to be fielded under FIST and sucked funding away from the core FIST developments and acquisitions, leaving the program in some disarray. The Surveillance and Target Acquisition (STA) Increment 1 element of FIST, for example, was overtaken by the Synergistic Individual STA (SISTA) package ordered under a UOR in late 2007.

Other elements of the Army's supposed bright new digitized future have been abandoned altogether. A good example of this is the classic 1990s element of any soldier digitization project that promised the ability for soldiers to aim their weapons around corners or fire from under cover using what amounts to a video camera attached to the weapon sight.

France's *Fantassin à Equipements et Liaisons Intégrés* (FELIN) future soldier project offers a similar capability, but John Foley, technical director at FIST's prime contractor Thales UK, said that during trials of a remote-targeting system for FIST Increment 1a, the soldiers did not like using it and it has been shelved indefinitely. As an alternative,, the Increment 1a package that was sent to Afghanistan in 2009 was a distinctly low-technology Lightweight Infantry Periscope; essentially a pocket-sized mirror.

Meanwhile, the FIST C4I (Command Control Communications Computers and Intelligence) package has also been reshaped and re-scoped

several times. However, the basis of the individual soldier's connectivity still centers mostly on the Bowman suite developed to replace the Clansman radio and bring in a raft of new connectivity benefits. The latter include secure voice over software-defined radios (SDR), data sharing, free-text and own station position-reporting (OSPR – essentially a blue-force tracking and navigation tool).

According to David Lynam, a former director of *Equipment Capability Command and Control Information Infrastructure* (CCII) in the MoD, "Bowman was very much more than just a radio program. It is true to say that the majority of the £4Bn quoted for Land Digitization was for Bowman, but also that the smallest proportion of that money went on the actual radios."

One of the key underlying development principles of Bowman is that improved capabilities are developed incrementally and regularly rolled out as software and hardware updates. The software enhancements are principally known Bowman Combat Infrastructure and Platform (BCIP) updates. The latest standard in service in-theatre, BCIP 5.4.2, was deployed into Afghanistan in April 2011 and the final BCIP 5.5 de-risking program was submitted to the MoD for assessment at the end of 2010, enabling development work to begin in early 2011 ahead of roll-out in 2013.

BCIP 5 builds on the fairly basic BCIP 4F version that has been in service since 2004, migrating the whole system to the Windows XP operating system and introducing a tactical internet – with Bowman Chat and White boarding, as evaluated on Exercise 'Flying Rhino' in the Czech Republic in early 2010 – and a tactical network-network gateway (TNG). BCIP 5 actually debuted operationally in 5.2.1 form that was installed on several RN vessels running anti-piracy patrols.

According to General Dynamics UK, its Edge test bed used to test Bowman enhancements has been used to investigate new ways of enhancing the system's bandwidth, and the results could be pulled through into Bowman by late 2012.

The new TNG is viewed as particularly important for operations in Afghanistan as the British Army's operational realignment in-theatre in 2010 brought them under the US-led Regional Command (South West), which uses the FBCB2 JBC-P (Joint Battle Command - Platform) battle

management system at the lower tactical levels, not hitherto compatible with Bowman.

For its part, Bowman Chat is also proving useful. On Exercise 'Flying Rhino' it was trialed in an enhanced form to connect with the chat facilities of the Overtask (J-Chat),the Joint Automated Deep Operations Coordination System (JADOCS) information networks currently used by British task force and the Battlegroup headquarters in Afghanistan. This may be rolled into BCIP 5.5.

'Flying Rhino' also served as an experiment testbed trialing a divisional wide-area network (WAN) with a 2 MB/s terrestrial link between separated headquarters locations in the Czech Republic (where the exercise was held), supplemented by two further 2 MB/s Project Reacher Skynet V satellite ground terminals linking to Germany, the UK and Afghanistan. Access for the latter was provided by the EADS Cormorant theatre-wide area communications network, which was originally fielded as a theatre-level asset in 2004 before being supplanted by a Radwin 2000 infrastructure as a temporary fix until Falcon. Confusingly, it has no relation to the Harris Falcon soldier radios; the architecture can be delivered in theatre later in 2011. The rest of the army is not expected to get access until 2013, which is why Cormorant was used in Flying Rhino and continues to be used by the army out of theatre.

Although Bowman has attracted the most attention as the biggest single project, BAE Systems Insyte's Falcon actually forms the real backbone of British Army digitization. This is because it is the replacement for Ptarmigan, Euromux, RTTS and DLAN, and it provides the theatre data highway between Corps and Brigade.

According to BAE Systems, the Falcon will provide a capacity backbone that binds Bowman, Cormorant and Skynet V together in theatre, with an open architecture that should remain 'future proofed' by nature of its open architecture.

Like Bowman and FIST, Falcon is being acquired in a series of increments. *Increment A* was originally set to equip the Allied Rapid Reaction Corps in 2009, but that has slipped a few years. *Increment B* provides connectivity for Division formations and below, while *Increment C* extends this to deployed RAF bases. The final, aspirational *Increment D* should draw in remote, mobile users ashore and maritime platforms.

Nevertheless, on the exercise Cormorant proved that telephony connections could be made between combat radio users in the field and division/brigade staff cells, connecting the BCIP 5.4.2 LAN subsystem to Cormorant through the TNG.

In hardware upgrade terms, Bowman made it into the field for technical and operational trials with the VHF Portable Transceiver (VPT) in 2004 and immediately ran into issues with its battery and form factor. Despite several revamps – including one last year which added power meter to the battery, however it was placed in an area that means it has to be removed to check how much power is left. The overarching conclusion is that it is essentially the same radio. Most of the soldiers' complaints referred to usability rather than its capabilities and a new design has been developed by ITT under Project Viper and trialed by the Army in late 2010 and early 2011.

Simultaneously, other members of the ITT-supplied Bowman VHF radio family, based on the SINCGARS-derived ADR+ PRC355 manpack transceiver, have also been upgraded as part of the unfolding BCIP 5 update program.

Away from the dismounted sections of Bowman, it proved deeply problematic installing systems into the Army's vehicles. Lynam stated that under original plans drawn up in the late 1990s, "it required, over four years to have over one third of the Army out of the order of battle at any one time". This would have been logistically complex by itself, but those plans were made on assumption that there would be no major deployments to complicate matters further. Unfortunately, as history proved, the UK was imminently to embark on two major sustained operations in Iraq and Afghanistan, making the 'Bowmanisation' effort even more of a logistical, planning and operational headache.

These deployments proved troublesome for the sheer access to the vehicles being fitted with the new systems, but also because the nature of the improvised explosive device (IED) threat in-theatre required the urgent installation of jamming systems onto vehicles. These jammers obviously needed to be deconflicted in antenna location, frequency and bandwidth with the new communications systems, which was a substantial task in itself. However, this was still further complicated until relatively recently by the fact that the Army was simultaneously intro-

ducing a hugely disparate range of new vehicles into service for Afghanistan in the shape of MAN ERF trucks, mine-protected Wolfhounds, Jackals, Ridgbacks, Coyotes and most recently the Ocelot.

All of these new vehicles had unique interference requirements and design authorities, so for several years the *Government Furnished Equipment* (GFE) communications systems and jammers were fitted in an ad hoc way. This resulted in confusion over exactly who had responsibility for the design authority, leading to what one industry source said was "engineers just drilling holes for antennas and sticking radios where they thought it was best, messing up the wiring looms and causing big interference issues."

General Dynamics UK eventually successfully argued that some of the criticism Bowman had attracted from operational forces could be easily addressed with a reinstallation and deconfliction program. This led to the company dispatching staff into Afghanistan to remedy the situation, with widespread approval from the Army and MoD.

In an effort to avoid this in the future, the UK embarked on a comprehensive *Generic Vehicle Architecture* (GVA) project to standardize interfaces and develop an open 'middleware' data distribution service into which any future systems could be plugged and managed. The first iteration, GVA Version 1, was published in August 2010 and the first GVA-equipped vehicle is expected to be rolled into service with the new Force Protection Foxhound in late 2011.

In a similar manner to the issues caused by vehicle installations, the rollout of constantly evolving Bowman upgrades and more capable software was also hugely complicated by the operational workup training requirements of the forces heading out to theatre. Workup training can take in the order of 12-18 months, the Battle Groups heading out to theatre inevitably don't deploy with the most up-to-date software, instead preferring to deploy with a system they trained with and are accustomed to. For example, although the first iteration of BCIP 5 was officially accepted in January 2008 it didn't make it into Afghanistan for two years to allow further enhancement and additional training time for the initial brigades without impacting ongoing operational deployments.

In addition, the pace of development and acquisition of systems meant for several years that modern systems were deployed out to the-

atre, faster than a training pool could be built up in the UK, so some units would be more limited in their operator capability than the Bowman equipment that they used. For example, despite the Bowman standard deployed in Afghanistan being capable of secure data transmission in 2008, when the Black Watch, 3rd Battalion, The Royal Regiment of Scotland was doing its work up training ahead of deployment to Afghanistan in 2009, the Battle Group decided to keep things simple and just train on voice.

Major Olly Kingbury, staff officer for the 19 Light Brigade certification team that assessed *The Black Watch* during Exercise Grand Prix in Kenya said that "this battle group took the decision not to train with Bowman's data functions at the beginning of the year and will stay with BCIP 4F. We'll train up with data as a brigade in 2010 after the Afghan deployment, but already we can start to see the benefits. The Battalion's discovered that INTSUM [intelligence summaries] reports are a bit of a pain, because instead of just transmitting them, they have to "send a runner or sit on the radio for 15 minutes reading them out."

Beyond the minutiae of soldier connectivity, the British Army has the lead on another key British digitization program in the shape of the *Royal Artillery's Land Environment Air Picture Provision* (LEAPP) program. An industry consortium led by Lockheed Martin UK and known as *Team Athena* won the competition to work up the program in 2008, which aims to increase land forces' awareness of the operational air picture in near-real time. This will aid with airspace deconfliction for outgoing artillery, friendly aircraft and command of ground-based air defence assets.

The LEAPP air picture will be generated with *Saab Microwave Systems Giraffe Agile Multi-Beam radar* and combined with Link 16 data from all connected radars in theatre. It will be disseminated using the Falcon trunk network. The Falcon interface was proven in mid-2009 and LEAPP is now expected to enter service in roughly the same timeframe as Falcon.

The MoD's Joint Sensor and Engagement Networks integrated project team also investigated a future evolution of LEAPP towards a *Networked Enabled Airspace Defence and Surveillance* (NEADS) project that would draw together the RAF's *Future Local Area Air Defence Sys-*

tem (FLAADS) and the Army's Thales High Velocity Missile System, amongst other systems. Little more has been seen of NEADS in public, but additional funding was allocated to the program in 2009. For its part, the *Army Air Corps'* (AAC) approach to digitization is driven through its AH.1 Apache Longbow attack helicopters. It still has quite a large number of AH.9A Lynxes, but they are little more than battlefield taxis these days and will be replaced in 2014 by the Battlefield Reconnaissance Helicopter version of AgustaWestland's Wildcat.

At the moment, the UK has no plans to take its Apaches through the US Army style Block III upgrade program that will enable the crews to take full Level 4 control of UAVs. Though, it does have an aspiration to incorporate a full-motion video transmission system. This latter would enable the crew to share imagery from the crews' Lockheed Martin M-TADS/PNVS (Modernized Target Acquisition Designation Sight/Pilot Night Vision Sensor) with other aircraft and troops on the ground for positive target identification and so forth.

This may in due course take the form of an installation of Lockheed Martin's VUIT-2 system that the US Army has had in service since 2008, however, this will result in a complication for the British helicopters. This is because their upgraded Rolls-Royce Turbomeca RTM322 engines enable the AH.1s to fly with their mast-mounted APG-78 Longbow radar, whereas the Americans have to remove it in the hot and high Afghan airspace. As a result, the AH.1 does not have the available real estate on the airframe that the US helicopters use.

In the interim, the Apache force is working on achieving greater situational awareness with battlefield command centres through the General Dynamics *Apache Bowman Connectivity* (ABC) program. Although, that does not appear to be a high priority, as the AAC is focused on keeping up the tempo of operations in Afghanistan and, as of June, off the coast of Libya.At a more local level, the UK Apaches have been making great use of the Symetrics V3.02 Improved Data Modem (IDM) to transfer data between AAC, Dutch and US Apaches in-theatre. In an attempt to get FIST-type capabilities back on track in a sustainable program for the future army, Major General Carew Wilks, Director of the Programmers and Technology Group within the MoD's Defence Equipment and Support (DE&S) organization, told the June 2011 *Soldier Technology*

Conference in London that the MoD was taking control of the program back from industry.

He said that in effect, the MoD was to become the architect of the *Dismounted Combat Capability* (DCC). This would be based on a new open architecture 'plug-and-play' backbone, with the acquisition of each incremental piece of equipment competed internationally. That would open the program up to foreign industry, but Maj Gen Wilks said that the UK will require assurances that it can modify, repair and enhance the systems locally within the country throughout their lifespan. This will be achieved through a Generic Soldier Architecture (GSA). The Army is also experimenting heavily with a range of digitization technologies to enhance *Forward Operating Base* (FOB) and *Tactical Base* (TB) force protection in a series of FOB Exercises (FOBEX). The latest of which took place in February 2011 looking to plot out how FOBs can be integrated into the UK's future digitization roadmap, such as it is.

In essence, the result of that FOBEX boiled down to the need for a common architecture that would ease the rapid integration of new cameras, communications bearers and remote systems under an initiative known as *Generic Base Architecture* (GBA). Together GVA, GBA and GSA will form a Land Open Systems Architecture (LOSA), which should be fielded as a formal Defence Standard (Def Stan) in January 2012. Substantial progress has already been made towards this and the UK hopes that the new formal standards – GVA is Def Stan 23-09 and GBA is draft Def Stan 23-13 – will be adopted or at least endorsed NATO-wide to improve interoperability.

The revised DCC ensemble is to be acquired in a series of 'Epochs'. The first is running until 2015 and includes new Commander's Lightweight Radios (CLR) using the data-capable Harris RF-7800S SPR and Casualty Locating Beacons (CLB). The latter is a simplified version of the ELSA capability expected to be acquired in two batches. CLB 1 is based on a GPS-enabled version of the Selex PRC343 EZPRR and is due to enter service with two brigades in October 2011. CLB 2 is still being defined, but according to Colonel Bill Pointing, DE&S' *Dismounted Soldier Systems* team leader, the MoD is currently weighing up three options: i) Buy additional CLB 1s; ii) Acquire an evolved version or iii) End the project after CLB 1.

Epoch 1 also includes a new tactical SA tool known as TacSA that is based on the squad-level US Tactical Ground Reporting (TIGR) system. TacSA is expected to be built on and rolled into a platoon-level *Dismounted Situational Awareness* (DSA) package that is expected in Epoch 2, which is set to run from 2016-2020. DSA will be delivered in concert with a new combined voice and data radio. Between now and then, some of the UOR communications equipment (including Harris' PRC-117 satcoms, the EZPRR, PRC-117 and PRC-152-based air-ground radios and the CLR) is expected to be made 'core' and supported beyond the assumed end of hostile operations in Afghanistan, or at least when the UK expects to withdraw from the country in 2015.

3. THE ROYAL NAVY

The RN is a keen believer in the benefits of networking and digitization, having long been a member of both the Link 11 and 16 communities.

The RN's intrinsic forward-deployed and coalition-based posture is a mixed blessing in that it has fostered an enthusiasm for and wide experience of networking with other assets. However, the international naval domain is complicated by different navies using a wide range of disparate networks and waveforms. These include the CLEW (Conventional Link 11 Waveform), SLEW (Single-tone Link 11 Waveform), Link 16 and Link 22 standards, as well as the increasingly well-adopted CDL (Common Datalink) used by reconnaissance aircraft and WDL (Weapon Datalink) for engagement systems, each of which requires its own message-handling and management systems. On top of this, strike aircraft and attack helicopters are more commonly using *Variable Message Format* (VMF) data messaging these days for both targeting and command-and-control interfaces, which is efficient and well-suited to their narrow bandwidth legacy radio systems. This is because it does not require a separate data-bearer, but enforces yet another communications mode onto naval assets.

As such, the RN is in the process of adopting a network-of-networks approach as a stepping-stone towards the UK's planned wider *Global Information Infrastructure* (GII - see Joint Capabilities section below for

more on this). All of the Type 23 frigates and the three amphibious assault ships – HMS Ocean, HMS Albion and HMS Bulwark – for example can all access Link 16 through Rockwell Collins' AN/URC-138(V)1(C) LVT (Low Volume Terminal). This is essentially a 'receive' system, but also provides the host platform with a PPLI (precise participant location and identification) capability and enables free text messaging.

Meanwhile, Link 16 has been rolled out to other elements of the rest of the fleet under the Navy's *Joint Tactical Information Distribution System* (JTIDS) project, with systems fitted to the now defunct Invincible-class aircraft carriers and mostly retired Type 42 destroyers. The importance of the latter installation is that they have been integrated with *Action Data Automation Weapons System* (ADAWS) under Increment 2 of the rollout, enabling them to contribute to the recognized air and maritime picture with NATO allies, particularly the US. Increment 2 also provides *Satellite Tactical Datalinks* (STDL) offering Link 16 connectivity over the UK's Skynet IV/V satellite constellation and enhancements to the Data Sciences (now IBM), and the developed Data Link Processing System which enables it to handle STDL, as well as Links 11 and 16. JTIDS Increment 3 pushes STDL to the Type 23s, but they will remain limited to Link 11 levels of granularity by their legacy DNA combat management systems, which require a translation interface that can transform the Link 16 J-series messaging into the Link 11 format that DNA requires.

STDL effectively enables the picture-compilers to draw on every radar feed and share the wider picture with each of the outfitted platforms. Therefore, though the Type 23's Type 996 radar is only relatively short-ranged it can be used as a gap-filler within a wider fleet context. This is particularly important for littoral operations, as its loss resulted in a dramatic consequence in the Argentinian air force's operations against the RN in the Falklands/Malvinas conflict in 1982. STDL is limited; however, the *Super High Frequency* (SHF) nature of the Skynet satellites is not interoperable with other navies, the US Navy, for example, mostly uses UHF satellites. Nevertheless, satcoms provides links into the RNCSS (Royal Navy Command Support System) and its successor, the UK-wide JC2SP (Joint Command and Control Support Programmed).

The new Type 45 destroyers and the Queen Elizabeth-class aircraft carriers are expected to get additional command and control capabilities under JTIDS increment 4, but in the meantime the destroyers are managing Link 11 and 16 access. As well as connectivity at sea, these links will provide the interface with the UK's LEAPP airspace C2 system.

The Navy plans to transition to Link 22 in due course, and in April 2011 the MoD contracted BAE Systems to explore its integration aboard the Type 45s and new carriers in an 18-month technology study. This will aim to demonstrate the maturity and capability of Link 22, including interfacing it with other Link 22-enabled platforms. Link 22 should offer an enhanced common tactical picture for all assets in due course, with outfits being rolled out across the surface fleet, submarines and interfaces to air assets and LEAPP.

The RN has also been deeply involved in the US-led *Cooperative Engagement Capability* (CEC) project in development with Raytheon. CEC transforms all of the suitably outfitted vessels into sensor platforms and fire units which are able to exploit the full ranges of their weapon systems. This often outstrips the performance of the launch ship's organic sensors.

The RN has completed a three-part formal CEC Assessment Phase and it was supposed to be brought into service in 2008, but the funding stream to actually get it into service remains uncertain at the moment. This is because the MoD is going through the painful contractions in budgets caused by the SDSR and plotting out bigger issues such as how to protect platforms and acquisition projects from the 'austerity measures' the Government has put in place to address the global financial crisis. The Navy's nuclear attack submarines, meanwhile, have been afforded a key place within the UK networked battlespace, this befits their role as key intelligence, surveillance, target acquisition and reconnaissance (ISTAR) assets. They were some of the first UK vessels to be fitted with Link 11, getting a tactical datalink receive-only terminal in the 1990s.

That has undergone a series of upgrades since then and today the six Trafalgar-class SSNs uses an Inmarsat satcoms-based system known as ESIXS (Enhanced SSN Information Exchange System). The submarine force will eventually transition to the NEST (Naval EHF/SHF SATCOM

Terminal) standard in development for the replacement Astute class. However, the last time that NEST surfaced in public view was in June 2009 when it was heavily criticized by the UK National Audit Office for being 19 months behind schedule, so that may still be some time away. Submarines have fairly obviously always been limited in their connectivity by the nature of the environment in which they operate, needing to surface or hoist ultra-high frequency (UHF) or SHF communications masts to contact allied assets or reachback to national centres. The space-hungry extremely low frequency systems developed for through-water Cold War submarine communications have fallen out of favor and been ditched in favor of satellite communications. However, these still mostly require the submarine to approach the surface.

The RN's solution to this problem is the *Recoverable Tethered Optical Fibre* (RTOF) developed by QinetiQ and the MoD over the last decade, but now being produced by Ultra Electronics Ocean Systems and Weir, Strachan & Henshaw for the RN's Astute class and the US Navy. The system is based around a small (450 mm or 250 mm diameter) stealthy buoy released from the rear of a submarine on a fibre optic tether to rise up to the sea surface where it can sweep for hostile radar transmissions and establish high-speed data transmissions over satellite links. The developers claim there is no plume or splash while the buoy is on the surface, enabling the boat to remain covert at depth. Trials involve outfitting the buoy with a UHF satcoms payload, GPS receiver, radar warning receiver, VHF line-of-sight radio and bathymetric sensors to help calibrate the submarine's sensors through thermocline layers and salinity gradients across the water column. In future RTOF may be fitted with SHF and EHF systems, or electro-optical payloads and laser warners to increase the boat's situational awareness.

The Fleet Air Arm has been simplified and shrunken considerably over the last few years with the retirement of the FA.2 Sea Harrier and the reduction of the remaining fleet to HMA.8 and HAS.3 Lynx variants, HM.1 Merlins and Airborne Surveillance and Control (ASAC.7) Sea Kings. The latter are well networked, fitted with the Link 16 connectivity and picture-sharing capability that is crucial to its role. By comparison, the Lynxes and Merlins are rather disadvantaged like many of the British Army's recent digitization upgrades. However, this is being ad-

dressed incrementally through planned programmers and through UORs. The Merlin fleet, for example, was fitted with Link 11 data connectivity in line with acquisition plans, but the experience of having Royal Marines and RN sailors arrested and detained by Iranian forces in 2007 directly prompted the RN to procure Wescam MX15 electro-optical camera fits and video downlinks. The cameras and transmitters were trialed in 2009 and quickly adopted for service. They enable an orbiting Merlin to fly above a boarded ship, transmitting full-motion video back to its launch ship and also to the boarding party if they have a ROVER terminal, which the Navy believes could have averted the Iranian embarrassment. The latter unfolded when an Iranian patrol vessel surprised the boarding party who were unsighted on its approach.

This offers an accessory to the Xeres maritime interdiction system developed by Drumgrange and deployed with RN boarding parties. Xeres was originally developed to guide boarding parties in rigid inflatable boats (RIB) to their objective using a datafeed from the launch ship's radar, but it quickly evolved into a more networked situational awareness tool. It uses a version of Ultra Electronics SML Technologies' ship identification transponder as a dedicated UHF datalink to keep the mothership informed of up to 15 simultaneous boarding parties' locations using Ultra's Safe Navigator electronic chart system. This picture is also transmitted to the RIBs over the UHF datalink, while their crews use Harris' Falcon II very high frequency (VHF) frequency-hopping radios for secure voice communications. Once aboard the ship, the boarding party's own Xeres kit comprises stills and video cameras, a document scanner, explosives and chemical detectors and a rugged laptop. All of this can be linked together to share additional video with the mothership via the Falcon II radio's built-in modem.

The RN's Lynx fleet is to be replaced with AgustaWestland's new Wildcat, which will be more connected to the fleet from the start, but will initially be a minor player rather than a key networking node. Work is ongoing on the aircraft and a competition is still seeking the Tactical Data Link - Independent Message Set that will link the helicopter into operations. The Navy has yet to settle on a format for that link and it may end up with a gateway interface able to deal with multiple formats. The final digitization development area that the UK is considering for the RN

is ballistic missile defence (BMD). Although the UK has no articulated BMD requirement, it showed a potential step towards BMD capability in late 2010 when the joint US/UK BAE Systems-built Advanced Radar Technology Integrated Systems Testbed (ARTIST) successfully tracked objects in space for the first time. ARTIST builds on the Multifunction Electronically Scanned Adaptive Radar (MESAR) projects and Sampson multifunction radar at the heart of the Type 45s' warfare system.

BAE Systems has postulated an upgrade path that would confer a BMD capability to the new destroyers, though the UK has no current commitment. If it did take up that option, the Type 45s would at least initially most likely be used in a 'tripwire' forward-based scanning role with no organic engagement capability because MBDA's own Aster missile (called Sea Viper in UK service) BMD upgrade path is unfunded and would need many years of development work. As such, the RN would need to accelerate its involvement with CEC and develop datalink connectivity with NATO's nascent Active Layered Theatre Ballistic Missile Defence (ALTBMD).

4. THE ROYAL AIR FORCE

The RAF has a mixed relationship with digitization, on one hand the youngest UK service is a keen adopter of new technology, steeped in the cutting edge networking and communications necessities required by the environment in which its aircraft operate. The air force's whole ethos is tuned towards platforms travelling at hundreds of miles per hour, tackling opposing aircraft and weapons travelling at similar speed. Hence, nowhere else is it more important to be able to act and react quickly to get within the opposition's decision loop. Factor in high-speed missiles and you're into the realm of thousands of miles an hour, with closing speeds of just seconds.

However, on the other hand, the RAF has to somehow balance these stressing requirements with the foibles and challenges of operating ageing, and legacy platforms. The RAF's GR.4 Tornado force is a particularly interesting case in point because the roots of the aircraft stretch back to the 1960s. Although the aircraft's avionics and systems have been regu-

larly updated and enhanced, the process has left the service with an aircraft using a heady mix of outmoded, unergonomic systems alongside absolutely brand new, first rate modern packages. This upgrade process has ensured that in some ways, the GR.4 is the most capable of all of the Tornados still in service in Germany, Italy and Saudi Arabia. It has the most advanced reconnaissance pods with Rafael's Litening III and Goodrich's RAPTOR. Furthermore, it has the widest range of weapons with Brimstone, Storm Shadow, Enhanced Paveway II, III and IV; and the most advanced defensive aids suite. Nonetheless in one crucial area, it lags a long way behind Italian and German Tornados because unlike them, it currently has no Link 16 datalink access.

This is a historical curiosity because the GR.9 Harrier force that the UK retired prematurely in December 2010 could access Link 16, as could the GR.4's air-to-air fighter sibling, the F.3. Its oversight in the GR.4 force is a huge hindrance to its operations over Afghanistan and Libya. British pilots returning from Afghanistan in early 2011 affirmed that not having Link 11 was like being blind: "if you don't have a datalink, you are pretty much left without any SA on what is going on around you – reliant on the radio calls from AWACS". This is particularly challenging in tremendously busy environments like Afghan airspace, which is shared with fast jets from a large number of foreign air forces, helicopters, unmanned aircraft, non-military aircraft, artillery shells and guided rockets. At a stroke, access to the Link would enable the GR.4 aircrews to see all of the other assets around them at a glance and also to be seen and avoided. Furthermore, It would improve connections with ground forces that could instantly transmit standard nine-line CAS messages in near-real time with no translation issues for non-English speakers. This would have obvious benefits for the polyglot JTAC community in-theatre.

The RAF is acting to remedy this situation with a datalink retrofit through BAE Systems' *Tactical Information Exchange Capability* (TIEC), which is being carried out through the Air force's Tornado Capability Upgrade Strategy (Pilot) project, more commonly known as CUSP. A Tornado fitted with TIEC made its maiden flight in December 2010 and successfully connected up with an air picture generated by an RAF E-3D, but it is not expected to filter into the operational fleet until 2012. In

parallel with TIEC, the Tornado force is also working on the *Secure Communications on Tornado* (SCoT) package developed under Ultra Electronics as prime contractor, partnered with Rohde & Schwarz. In essence, SCoT is a package of software-controlled radios enabling secure frequencies and waveforms to be stored locally and accessed through a simple touch-button interface.

Aircrews assert that this will greatly reduce the current communications workload that requires them to manually select different radio nets and frequencies to talk to other air assets, JTACs and battlespace managers. Work was contracted to Ultra in 2005, but only began testing in the middle of 2010. In the interim, the GR.4a Tornados have been upgraded with a CAGNET multi-band transceiver based on a Rohde & Schwarz MR6000L software radio, which uses the Have Quick II waveform for air-ground communications with JTACs. SCoT uses the same transceiver as the CAGNET fit, but has additional waveforms including SATURN. Together with TIEC, SCoT comprises an essential upgrade for the Tornado force. Flight Lieutenant Chris Baber, an RAF navigator with over 20 years on Tornados said that

> if you're working with multiple JTACs in a stack of aircraft and you've been cleared to release weapons, there might still be aircraft below you so you have to clear it all out, which takes time. Sometimes if the guys on the ground are really screaming for it then you might just have to take a calculated risk, but all of that goes away if you're on the Link because you can see the lateral spacing and separation.

However, it should be noted that the Link will not cure all of the Tornado's connectivity issues.

The RAPTOR pod attracts great praise for the incredibly high resolution imagery that it produces, however the imagery is currently not downlinked directly to ground forces or the imagery analysis teams. The aircraft would have to return to base and have its data 'brick' physically removed from the pod, imagery extracted, stored and processed, which can take 12 to 24 hours. This is largely due to the resolution of the imagery and lack of available bandwidth; hence there is no immediate so-

lution in progress. On the other hand, The Litening III pod has no such limitations, fitted with a ROVER link to share video with forces on the ground in real time.

The F.3 Tornado's replacement, the Eurofighter brings its own raft of challenges and opportunities, not least evolving the aircraft as a genuinely multirole platform, but connectivity and digitization are not really big issues. Out of the box, the aircraft is fitted with Link 16 terminals offering a sufficient level of network capability and the F-35s that will eventually follow Typhoon into service. Replacing the Tornados should represent yet another step forward, with Link 16 and other much-vaunted communications and sensor capabilities.

The same is largely true of the other supporting electronic mission aircraft, such as the Link 16-equipped E-3D Sentry and *R.1 Sentinel Airborne Standoff Radar* (ASTOR) platform. Sentinel has an electronic mission suite comprising embedded, real-time signal and image-processing computers, a Logica Joint Tactical Information Distribution System Link 16 package. Furthermore, it has a similar Cubic and Ultra-developed narrowband datalink system to the system used aboard the E-8 Joint *Surveillance Target Attack Radar System* (Joint STARS) aircraft; wideband datalinks and SHF satcom terminals, as well as a host of V/UHF-band voice radios.

In short, all of this makes the aircraft a key node in any network it takes part in, especially due to its ability to generate an electronic operational picture and disseminate it to other allied aircraft. However, the SDSR stated plans to "withdraw the Sentinel airborne ground surveillance aircraft once it is no longer required to support operations in Afghanistan." The decision to retire the aircraft prematurely, ostensibly as a cost-saving measure, took defence analysts and serving personnel by surprise because the aircraft are relatively new and only deployed for the first time in 2008, attracting praise for their capabilities ever since.

They are also a vital part of the RAF's 'find' target-acquisition capability and are currently in heavy demand over both Afghanistan and Libya. In fact, the five aircraft are being switched between the two taskings on a daily basis, according to a May briefing from Air Chief Marshal Sir Stephen Dalton, Chief of the UK Air Staff.

Beyond that, the aircraft have a central role in finding enemy air de-

fences. The RAF has an unusual *Suppression of Enemy Air Defences* (SEAD) capability based on the GR.4-carried MBDA Air-Launched Anti-Radiation Missile (ALARM) and other geo-referenced weapons, such as Storm Shadow. The posture is unusual because unlike the Italian and German Tornados, the GR.4 has no organic opposition radar geo-location capability. Hence, the aircraft has a very limited reactive capability, relying on planned SEAD missions or off board targeting assistance from other assets, such as ASTOR to find the targets for them and transfer data via Link 16. As such, the Sentinels are playing such a crucial role that it is considered unlikely that the MoD will be able to complete its promise to axe the force in the next few years. This is in spite of with the ongoing acquisition of RC-135 Rivet Joint electronic intelligence/signals intelligence (ELINT/SIGINT) that are supposed to do a similar job and also take over from the RAF's Nimrod R.1 aircraft which are supposed to be retired in June 2011.

The RAF's cargo fleet is also being used heavily and the service is investigating a more comprehensive add-on Link 16 capability for its C-130J transport fleet, involving the installation of an AN/USQ-140(V)1(C) MIDS Rockwell Collins AN/URC-138(V)1(C) LVT and its integration with the aircraft's mission system.

The RAF Regiment is planning to recapitalize its Air Defences over the next few years, replacing its legacy Rapier missile launchers with the FLAADS currently in development with MBDA. The concept requires a full common operating picture to be established and envisages a network of remote fire units linked together over a secure MBDA-developed datalink for the engagement portion of the system.

This new datalink would enable the fire units – based on cross-country trucks fitted with *Common Anti-air Modular Missile* (CAMM) vertical launch cells – to be essentially passive with no organic radar of their own, instead taking cueing and targeting data from any relevant source on or over the battlefield. This will increase their own survivability and hopefully take enemy aircraft by surprise.

MBDA FLAADS spokesman Dr. Philip Miller told Jane's that the company has an open architecture sensor interface that can accept even low-quality data from legacy radars, because the launch unit just needs the data to orient the missile to the threat as CAMM has a fully active ra-

dar seeker able to find and attack targets up to 20 km away. CAMM is also fitted with a two-way, dual-band datalink, enabling the fire unit to share more accurate data as midcourse guidance updates when possible. MBDA and the MoD undertook firing trials with FLAADS in 2010, which are understood to have been successful. However, neither party is currently willing to offer more details, preferring to keep them as 'news' for the September 2011 DSEi trade fair in London.

5. JOINT CAPABILITIES

The *Joint Helicopter Force* (JHF) has not been forgotten in this digitization process. Trials in late 2009 and 2010 demonstrated the potential of Rockwell's Rosetta gateway and General Dynamics UK's NetLink multilink processor (a development of TIEC) to correlate input from a host of local and strategic satellite-based blue-force tracking systems. Inputs included Link 16, VMF, Bowman, QinetiQ's Helicopter/Ground Asset Tracking Systems (HeATS/GrATS) blue-force tracking systems, as well as the NATO Friendly Force Identification system and the US Army's Force XXI Battle Command Brigade and Below (FBCB2) battle management platform.

In essence, this project ran under the Joint Data Networks Backbone (JDNB), which forms the UK's overarching plan to integrate all of the disparate datalink standards, including an Integrated Broadcast Service (IBS) as well as all of the standard TDL. Accordingly, JDNB was envisaged to take a spiral or incremental development program rather than trying to pull such a wide field of systems, protocols and waveforms together in a single phase. This approach is known as Network Project Backbone and the first 'spiral' stage involved fielding new gateways and data forwarders to start breaking down barriers between the existing links.

JDNB itself is part of the UK's GII project set up to support "the specific, near real-time needs of C2 [command-and-control] and situational awareness for maritime, land and air platforms" according to the MoD's statement of intent. In its preliminary form, the MoD expects GII to be based on NATO Tactical Data Link standards, but the Ministry plans to

eventually migrate it to a set of J-series (Link 16) type and VMF standards. These messages will in turn be disseminated across the JDNB in a coherent format and style. GII would eventually encompass all of the UK's communications bearers, including the Skynet V satellites, HF networks, DII (Defence Information Infrastructure) and CII (Coalition Information Infrastructure), as well as the JDNB into a single, easily managed network.

When originally postulated, all of this was originally expected to pass through Initial Gate development in 2008 and then full Main Gate acceptance in 2010, but it was slipped out of the 2007 planning round as money was diverted elsewhere. It is currently unclear exactly when GII might be expected into service, despite industry having developed several systems (such as NetLinks and Rosetta) that would appear to do what the MoD is intending to do. In September 2008, for example, the NetLinks gateway message 'normalizer' installed at RAF Waddington was used to translate HeATS platform tracking data to VMF and transmit it to an orbiting E-3D Sentry suitably fitted with a corresponding NetLink gateway. The Sentry took the data and converted it into the BCIP5 format before displaying it on a standard Barco-supplied screen using the Common Battlefield Application Toolset. Subsequently, it exchanged the Bowman positional and free text messaging between the Sentry and a separate ground station using a Bowman UHF High Capacity Data Radio (HCDR).

In effect, this affirmed the principle that assets with a Link 11 outfit – or a wide range of other traditionally incompatible systems – could securely access portions of a Link 16 network and in return have Link 16 data presented in a Link 11 format.

6. INDUSTRY COOPERATION

As seen above, the defence industry plays an absolutely vital role in every aspect of the UK's push towards digitization. The MoD also has an avowed intention to buy 'best-of-breed' rather than buy British, although there is a natural inclination to support domestic industry where possible and retain sovereign capabilities for sensitive areas, such as

communications. As such, there is every possibility for international co-operation at a theoretical level. However, in practice the UK doesn't seem to be effective at doing so. The MoD could have saved a lot of heartache and investment by buying a Bowman-like capability off the shelf, for example, but the bespoke Army-wide service that will eventually be taken into service was deemed to be worth the risk of going alone.

Similarly, the issues raised by the disintegrated FIST package could be addressed by the MoD sourcing elements of the French FELIN future soldier package – which is arguably the most mature in the world – for a relatively low investment. That is unlikely to happen because the capabilities don't directly match the British Army aspirations or CONOPS, although the two countries signed an unprecedented defence procurement cooperation agreement last year. Therefore, anything could happen if the economy worsens and budgets are still further constricted. That is also not to say that the UK will not buy elements of any of its NEC programmers from abroad, clearly it already does, with particular emphasis on US procurements to try and maintain a degree of interoperability with its most powerful ally.

In addition, the UK already plans to buy aircraft (US F-35), vehicles (Spain's ASCOD) and radars (Sweden's Giraffe and Arthur) amongst other systems from international consortia and foreign companies. French R&D funding helped with development of the UK's new aircraft carriers too. This is only set to grow in future.

The defence world is in flux at the moment, with uncertain research and development funding, coalition operations and the challenge of interoperability, shrinking procurement budgets and off-the-shelf purchases all complicating the issue. One thing is certain though, no country and no company can afford the luxury anymore of 'reinventing the wheel' and developing entirely bespoke elements of a system every time it articulates a new requirement.

The future has to be collaborative.

Conclusion

Information Technology has introduced radical and visible changes to the Western economy and society. The military sector must take into account this permanent revolution: it must adapt, change, exploit its opportunities and handle its risks, as IT contributes to restructuring the context in which the military operates. Over the past twenty years, the netcentric transformation has affected the US military, and to a lesser extent, the European nations most active in the defence field, namely France and Great Britain.

It is easy to imagine that, in the next decade, the possession of *Network Enabled Capabilities* represents a discriminating factor between "first class" and "second class" armed forces, in terms of interoperability, efficiency, effectiveness, deployability, responsiveness, precision, lethality and force protection. The netcentric challenge is the main challenge for all European armed forces in the next future, including the Italian ones. This is particularly true for the Army which for a number of reasons has less familiarity with netcentric capabilities than the Air Force and the Navy.

The digitization and networking of Armed Forces' systems and equipment has a unique spillover effect on network's nodes. Indeed, while a procurement program aimed to build a specific platform has a limited impact on the other Armed Forces' capabilities, a digitization program of brigade level forces (and in perspective of the entire Italian Army) has a significant impact on a wide range of means, platforms and weapon systems. This impact affects both the asset legacy and the capabilities which have to be developed by all Armed Forces. For example, the digitization program by requiring the networking of Air Force's next UAVs influences their requirements in terms of data exchange *gateway*,

and thus their production, maintenance and upgrades. All five operations domains – land, air, maritime, space and cyberspace – are affected by spillover effects of the digitization process. Therefore, the strategic relevance of the efforts to adapt the national armed forces and particularly the Army into the NEC, as done in Italy by Forza NEC program is evident.

In theory, this transformation could be addressed in two ways: either replacing the equipment in service with a new generation of means with netcentric capabilities, or creating a systemic architecture in which new items will be gradually introduced while maintaining the current ones in service until their life-cycle ends. The first solution would involve an investment not affordable by Italy, and therefore the latter solution had to be chosen although more difficult. A systemic review of the asset legacy is necessary, in order to develop the architecture where new and old capabilities can be plugged in. In other Forces, rather than build a new digitized and separated Army to replace the old one in the medium term, it was decided that digitized force packages should be created and plugged in, so as to cover all the requirements in the long term. The Forza NEC program planning will cover the next twenty years, and throughout this period the term "transformation" will be the keyword of our Armed Forces. However, considering that technological evolution will never stop in the meanwhile, this will be a permanently dynamic process.

The spiral approach represents a compromise between the necessary transformation's gradualness and the operational need to deploy newly developed capabilities as soon as possible. Though, it is also aimed to test them on the field and then make the necessary corrections, in order to avoid the pursuit of unnecessary and un-utilizable technology luxuries which in the past substantially increased procurement program's costs. Furthermore, this approach will allow for the adequate training of personnel and the collection of feedback from the officials on the ground in order to improve or change that new equipment.

The Italian approach to digitization therefor requires close cooperation between the Armed Forces and industry, based on knowledge and information sharing. This would make the military officials more familiar with the technological issues and the industry experts more familiar with military ones. The close relations between military and defense in-

dustry is the prerequisite and, at the same time, the real strength of the "Forza NEC" program. On the other hand, the United States chose a *top-down* approach, embodied by the *Future Combat System* program, but it was then abandoned due to unsustainable costs and the difficulties to implement it at operational level. In fact, it would create "first class" forces to be used separately from "second class" ones, which is not possible considering the current large-scale operations abroad in fast changing theatres.

The digitization process has strategic relevance not only for the Armed Forces but also for the defense industry by representing a new field of research, innovation, investments and productions. In fact, the innovation of software and electronics is much faster than the hardware's one. For example, while the transition towards a lighter and more durable composite material for the production of aircrafts' wings is gradual and incremental through the years, the software development proceeds through huge leaps within a few quarters. Therefore there are greater opportunities for research and production of netcentric software and electronics than for hardware, and they are potentially unlimited. Such constant upgrade and update is necessary to counter opponents which take advantage of the technological innovation available in the global market in an asymmetric way and without ethical constraints, and to remain interoperable with technologically advanced Allies. As a result, the "open architecture" which marks all Forza NEC's nodes makes any component ready to be updated and upgraded in future in order to prevent its rapid obsolescence.

However, the necessity to transform the Italian Army capabilities into netcentric ones within the not too distant future does not mean we need to buy all the technologies available regardless of their usefulness. An excessive reliance on NEC potential capability, as well as on any technology which marked the mi

Military evolution, presents several risks. The first and perhaps the most dangerous risk for the Armed Forces, is the so-called *technological hubris*, which is the over-reliance on the technology capability to understand the situation on the ground, to take the right decisions, and to always give a decisive advantage toward the opponent. Even if military history is full of examples in which the faith of technological su-

premacy as a winning factor led to bitter failures, this attitude periodically returns.

Technology can actually provide greater and clearer information on the *Common Operational Picture*, but their assessment is up to the officials according to their personal expertise and background which is something more than a mere computer database. Furthermore, Technology can automate, speed up and ensure the implementation of tactical or operational decisions, but cannot replace the decision of officers and commanders on the right option to choose. Technology eventually may give decisive advantage on the opponent, but this advantage can be countered through asymmetric tactics, or can be nullified by deficiencies of the armed forces technologically superior on training, logistics, relations with local players or international partners, and other important aspects of current military campaigns.

A second and equally important risk, especially in times of reduction in the defense budget, is the real cost-effectiveness of new technologies, including those for the creation of netcentric forces. In this context, the military user is required to take certain decisions that are not so different from those made by civilian consumers. For instance, is the 3.0 version of a certain system much better than the 2.0 to justify the complete replacement of the related software and hardware within a few months? Rather, is it more efficient to use the 2.0 version for another year and then to move directly to the 4.0 version which in the meanwhile will be made available? Obviously in the defense field, soldiers' lives are at stake and therefore the best available technology must be deployed in the theatre.

However, sometimes the best available technology is not the most high-tech, but rather its which better fits with the soldiers' skills and attitudes, and better matches the doctrines, strategies and mission requirements of the Armed Forces. In other words, during the assessment process of netcentric technology, other technological innovation, a broader and deeper evaluation than mere technical analysis is required by the political-military decision-maker. The goal should be to make better use of technical potentialities without wasting valuable resources in systems which are scarcely usable and ineffective on the field. The saved resources can and should be reinvested in the maintenance and updat-

ing of NEC capabilities, as well as in a wider and more intensive training of the personnel which utilizes these capabilities.

With regards to the international dimension and export prospects, the Forza NEC program presents several opportunities. In fact, software re-programming options are so huge that it is possible to assume a complete re-design of Forza NEC architecture, in order to meet both the requirements of third countries Armed Forces and export Forza NEC technologies. Simultaneously ensuring that the codes of the Italian Army's systems are not leaked. As *Information Technology* and electronics are some of the fastest growing sectors, in the future there will be a demand for netcentric services and products that will necessarily push the suppliers competing to find solutions.

The Atlantic Alliance, in particular the U.S., will encourage NATO countries to make the C4ISTAR systems more connected and interoperable. Progresses in this direction have already been made in Afghanistan through the *Afghan Mission Network* project. Even the EU and in particular the *European Defence Agency* has shown interest in netcentric capabilities and a form of cooperation in this sector could be realized in the future. Therefore, international efforts to standardization will be strong. They will also face less resistance in netcentric sector than in other areas, because it is easier to re-program software than to re-create hardware. For example, it is easier to re-program the Armed Forces C2 systems than to re-build a carrier desk to enable it to host a certain aircraft which was not envisaged by the initial requirements. This is one of "open architecture" advantages and it represents a real chance for international cooperation.

Finally, few countries are able to develop and implement an ambitious and complex program as Forza NEC. The others will necessarily rely on foreign suppliers, trying to find a compromise between the resulting limited technological sovereignty and the urgent need to digitize and integrate their land forces. For some countries an alternative solution could be the international cooperation, which is also promoted especially within NATO in order to reach interoperability and standardization among Allies. Also, the possibility of saving money through costs sharing and production increasing should encourage cooperation between two or more countries aimed at acquiring the same set of capabilities.

However, some limitations will affect export and cooperation's potentialities, and will require appropriate actions at political and military level. First, the need to maintain operational sovereignty on the platform or weapon system is very common. Also, there may be an intention to maintain within the domestic industry the technical and industrial capabilities necessary to product and upgrade a certain technology, in order to ensure an adequate security of supply in the future. Moreover, with regard to exports' potentialities, it should be noted that the Forza NEC program is tailored on Army's requirements and aims to digitize and network existing and future capabilities of Italian armed forces.

However, the Forza NEC architecture can serve as a model for future and similar programs, developing best practices and providing lessons learned that the Italian defence industry can utilize in the future. On this basis, a foreign armed force could buy a similar package of supplies and services which will be tailored to foreign client's requirements. Specifically in terms of vehicles, soldier equipment, reporting procedures, command and control, testing & simulation process, force packages to be digitized, etc. Also, these differences usually affect other types of exports or joint development, but the effects are clearly larger with regards to the digitization of a brigade level force.

Finally, technological dependence on C2 systems, or even C4ISTAR systems, with its flow of information in during military operations, is a matter of political and military concerns that should not be underestimated. In fact, in these cases the supplier would not only be responsible for the function of platforms, but also for access to its entire military backbone. With regards to Forza NEC exports, these codes must differ from the original Italian ones, otherwise the package's buyer may have access to classified elements of the Italian Army's backbone.

Finally, both the joint development and the export of Forza NEC as a whole have many difficulties. In contrast, it would be easier to export specific services and products developed under the program. In fact, constraints would be fewer than those compared with the export of the entire package, and the new, innovative and high-tech equipment might see important opportunities in the international defense market. In the security market, new and increased requirements generated by asymmetric threats may find solutions in the Forza NEC's experience. In this

context, the challenge for the defense industry is to utilize its experience and adapt its products to less demanding requirements making them cheaper than the original ones, in order to compete with those offered by civilian companies.

In conclusion, NEC capabilities represent a great challenge for each player involved in the defense field. The Armed Forces, and particularly the Army, will have to demonstrate the ability to handle this long and important process of transformation. Policy-makers should ensure that the necessary resources are perpetually available, despite the fact that results will only be achievable in the long term and will not be that open to public opinion.

Finally, industry will have to manage a complex process of modernization at a technological, industrial and managerial level. It is a challenge that Italy can win.

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Finito di stampare nel mese di settembre 2015
con tecnologia *print on demand*
presso il Centro Stampa "*Nuova Cultura*"
p.le Aldo Moro n. 5, 00185 Roma
www.nuovacultura.it

per ordini: ordini@nuovacultura.it

[Int_9788861348790_17x24bn_LM03]

Information Technology (IT) has had and will continue to have a deep impact on the defence sector. The most advanced countries, not only the U.S. but also France, Great Britain and Italy, over the past few years have undergone a transformation of their Armed Forces aimed at exploiting the strategic advantages of IT.
The goal pursued in Europe, and also promoted by NATO, is Network Enabled Capability (NEC). That is combining equipment and soldiers, as well as different doctrinal, procedural, technical and organizational elements, into a single network to obtain their interaction in order to achieve substantial strategic superiority. In practice, this also occurs with a strong, efficient and secure telecommunications network, and through the netcentric modernization of Armed Forces' capability and systems aimed at connecting them to the network.
This research paper analyzes the military's netcentric modernization and transformation programs – still in progress – in France, Britain and Italy, with special focus on the joint program led by the Italian Army called "Forza NEC". Opportunities and challenges of "Forza NEC" have been considered according to the Italian Armed Forces' requirements, developed during two decades of experience in international military operations, as well as in the light of the evolution of strategic doctrines at a European and transatlantic level. Particular attention has been devoted to the interaction between industry and the Armed Forces, and to the involvement of many Italian companies in different Forza NEC activities, as this represents one of the pillars of the procurement program.

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ISBN 978-88-6134-879-0
9 788861 348790
9788861348790_176_RM_3