Command Feedback and Response (CFR) – The evolution of Command and Control in an Immersive and Interactive environment (C2I2).

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ABSTRACT

According to the NATO NEC C2 Maturity Model, there are two key factors about evolution of C2 operational function in the 21st century:

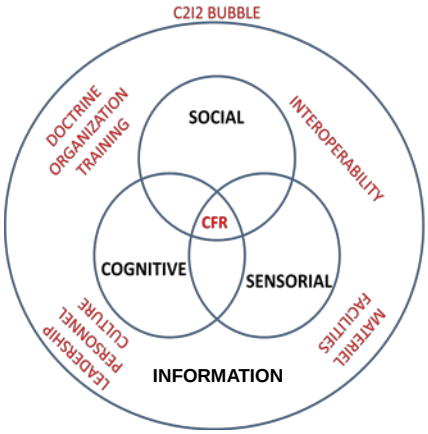
- the extreme uncertainty of next decades military missions space;
- the DOTLMPFI military transformation approach, related to Institutions and Actors in the Information Age, about the ability to leverage new information technologies in a JIIM context.

This complex and dynamic environment will affect next generation of digital C2I systems that should be integrated with analysis capabilities and M&S technology in a full interoperable environment.

The authors introduce a new theory about the leverage of the C2 operational function referred to strong requirements to implement more agile capabilities to support operational planning and decision making processes.

This paper, applying the **Command, Feedback & Response** theory, will present a research and study activity about the impact of an immersive/interactive environment, that the authors named "C2I2 bubble", to improve the efficiency and the effectiveness in the cognitive-sensorial and social domains.

In this sector the authors have considered the most advanced technology for information visualization, using Augmented Reality techniques and advanced HMI for remote collaboration.



1. INTRODUCTION

The rising of extensive use of social networking, the new generation of mobile devices and the latest M&S trends and technologies, associated to the virtual worlds and augmented reality and ubiquitus Internet access, are addressing the most studies and research activities to design the next generation of Command and Control.

Taking into account these trends, the authors develop their research considering what they named CFR. The authors define CFR as the evolution of next generation Command and Control Operational Function applied to a "*Crowdsourced environment*" driven by "*Virtual Cross Functional Teams*". They looking at the benefits of dispersing leadership throughout "virtual" teams and "virtually dynamic" organizational structure that can be changed in real time (self-synchronized) to responce faster to the mission evolutions. This environment is enabled by the support of portable devices, immersive and virtual technologies meshed with augmented reality using standardized interoperable languages.

From an operational point of view, CFR represent the moving from traditional command and control organization and processes to the true collaboration and team working in a combination of the two operating simultaneously.

In a military environment Crowdsourcing can be referred to the increasing ability, especially facilitated by new media technologies, to leverage the knowledge, talent, expertise and interest of large groups of people — Commanders, Analysts, Staff employees, Augmentees, Specialist and Warfighters, in a boundless-like Command Post, where the "*people needs to know*", are far beyond their physical location.

People belonging to different staffs and organizations can be put togheter joining a Virtual Cross Functional Team passing from a hierarchical Command and Control – based organization to a much flatter one running off of social networking groups.

This concept, far beyond the traditional staff/line management (that remain however the pillar of a military type of organization structure), can leverage human resources and dynamic organizations to implement more agile capabilities to support operational planning and decision making processes. To work properly this concept need to be used with a positive approach to information sharing (intelligence paradox) in a Network Centric Value Chain (fig. 3), represented in the information cognitive, physical and social domains, SAS-065 (2010).

By the way CFR takes into consideration not only the differences between the “line/staff” and the “crowdsourced management organization”.
In complex endeavures SAS-065 (2010), the authors want to show the idea that the concept of “Unity of command” could be improved by the CFR concept of “Multidimensionality of command”.
In addition, in crowdsourced organizations based on virtual cross functional team, the commander could be able to leverage resources creating self-synchronized relationship with subordinated parallel, and upper level of command gathering the feedbacks and addressing responces as orders to the assigned units.

2. STATE OF THE ART TO DEVELOP A REVISITED C2 CONCEPT

The developing of CFR theory takes into consideration the NCW and NEC paradigms applying Web 2 and Web 3 technologies making virtual and realtime dynamic the C2 relationship between people and the belonging to organizations in an EDGE C2 level. NATO NEC *C2 approach is basically characterized by a robustly networked collection of entities having wide spread and easy access to information sharing information extensively interacting in a rich and continuous fashion and having the broadest possible distribution of decision rights. The objective of EDGE C2 is to enable the collective to self-synchronized*, SAS-085 (2010). Starting from the scientific and technology state of art, the authors define the boundaries of a CFR model taking inspiration from the following concepts:

2.1. Crowdsourced, Cross Functional Team Organizations and a related Maturity Model.

Crowdsourcing is the idea to call the collaboration of an undefined group of people, it gathers those who are most fit to perform tasks, solve complex problems and contribute with the most relevant and fresh ideas, Howe (2006).
The terms coming from the act of outsourcing tasks, traditionally performed by an employee or contractor, to an undefined, large group of people or community (a "crowd"), through an open call.
But crowsourcing is also the *channeling the experts desire to solve a problem and then freely sharing the answer with everyone*, Van Ess, (2010).
Crowdsourcing also has the potential to be a problem solving mechanism for government and no profit use, Brabham (2008).
For this reason it is possible to think about a Government Crowdsourced organization as a distributed problem solving model. Even if in the classic use of the term, problems are broadcast to an unknown group of solvers in the form of an open call for solutions, this model can be adapted and implemented into a traditional military staff/line management organization introducing the concept of Cross Functional Team (CFT) (fig. 1).
To face today's complex challenges, the authors need to incorporate a wide range of capabilities, skills, and different perspectives. Cross functional teams are regarded as a means to manage social collaboration and concept creation.

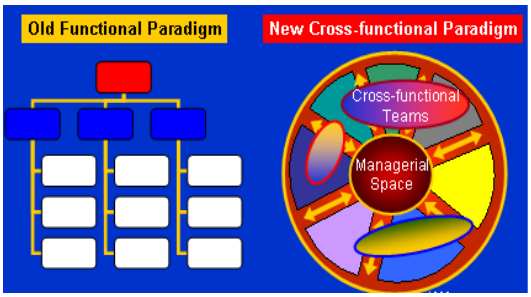


Fig. 1 functional paradigms, http:// www.1000ventures.com.

This kind of organization has been used for the first time in a military environment, at IJC Headquarters (ISAF Joint Command, Afghanistan). After it was adopted in 2010 during deployment of HQ MNC NE (Headquarters Multinational Corps Northeast) in the same operational theatre.
CFT can be thought as an evolution of a "traditional" military staff organisation. In a traditional staff organization all the principal functional areas are devoted to work together only for a specific efforts and each area specialists add up their studies and conclusions to the general plan. Coordination and synchronization is demanded to the leadership, Palm (2011). All processes at the HQ are maintained by CFT and the role of functional areas is to provide "in-depth" knowledge of their respective areas. CFT were created as a direct answer to the Afghanistan complex environment and latest NATO's to develop Comprehensive Approach and create a better holistic situational understanding, to enable combined planning and conduct comprehensive counter insurgency operations. CFT enable the HQ’s to be more fast, flexible and agile. Actually NATO is conducting (2011) an investigation thorough the CFT concept in different training events (Little Eagle I 2011, Exercise Compact Green 2011, Bold Eagle Exercise 2011). The implementation of Cross-Functional Team concept requires a change of everybody’s mindset because it is a mesh between the staff and line management organization. Even though the basic military planning, execution and analysing principles remain untouched, there are new requirements

for information sharing, intensity of social interaction and team work. The positive effect of different teams is based on the theoretical perspective of information processing states that diversity in teams will increase the range of perspectives and enhance opportunities for knowledge sharing, and improve the outcome in terms of quality and creativity.

CFR implements the Cross Functional Team Concept from a hierarchical to a flatter perspective of Command and Control in a Crowdsourced environment using the Virtual Cross Functional Team approach, supported by the latest social networking technologies and portable devices.

The above concepts well fit a Command and Control organization shaped on the CFR that, according to the N2C2M2 model, can fulfill the EDGE C2 level.

The object of EDGE C2 is to enable the community to be self-synchronized. It requires that a solid, shared understanding would exist across the contributing elements connected by a robust network. The N2C2M2 was developed to create a conceptual model, and then to test it in an experimental environment using ELICIT. ELICIT is an online multiuser platform for conducting experiments in information sharing and trust", SAS 065 (2010).

The application of this model could be used to evaluate the maturity level of a C2 approach in a complex environment to address new mission challenges.

This way of thinking about C2 is compatible with current NATO Allied Command Transformation (ACT) thinking on Future Capable Forces which puts the emphasis on Mission Command within federated complex coalition's environments.

The model defines five levels of maturity that are linked to the five NNEC capability levels ranging from conflicted C2 to Edge C2.

Each level corresponds to a different region within the C2 Approach Space, it contains the different possible approaches to accomplish the functions that are associated with command and control (fig 2). This approach space can be viewed from two perspectives.

First, it can be used to think about C2 within existing organizations. Second, it can be used to think about how a disparate set of independent (inter-dependent) entities, that is, a collective, can achieve focus and convergence. The latter is taking into consideration by the developing CFR concept.

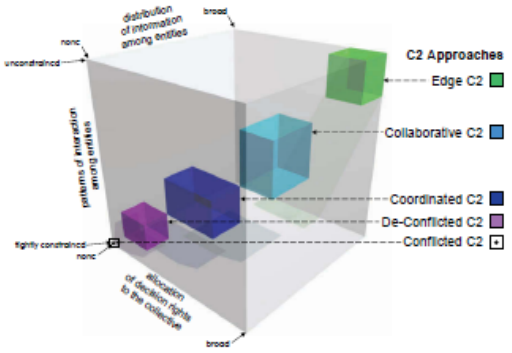


Fig. 2 C2 approach spaces, SAS 065 (2010)

2.2. From common languages to a C2 crowdsourced interoperable architecture

In a crowdsourcing environment is also fundamental to communicate in a common understandable and effective way. The state of the art of last upcoming C2 technology, regarding common languages to achieve interoperability and immersive and interactive devices to best perform and visualize information, are following explained.

Web 2.0 and Web 3.0 technologies make the core of the social networking environment.

About the adoption of a common understandable and standardized language, for the CFR concept the authors are focusing on the C-BML (Coalition Battle Management Language). C-BML define an unambiguous language to describe a commanders intent and generate executable descriptions of a mission that can be used by human forces in real operations supported by C2 systems, by simulated forces in simulated operations, and by robotic forces in real or simulated operations, http://c-bml.org.

C-BML is under standardization by Simulation Interoperability Standards Organization (SISO), in the C-BML Product Development Group. The resulting language is intended to be applicable not only to simulation systems, but also to operational command and control systems, and robotic systems.

C-BML aims to guarantee interoperability with other standards and languages like MIP bl.3 (JC3IEDM defined by NATO Stanag 5525 currently under ratification) and MSDL (Military Scenario Description Language). It is a language defined by XML schema used to transfer scenario operational data from C2 systems to simulation systems. C-BML implements the Command and Control lexical Grammar (C2LG) and currently it interoperate with the Operations

Intent and Effects Grammar (OIEG) ver. 1.1.

C2LG is an implementation of a Domain Specific Grammar. C2LG it is considered necessary because there is no grammatical approach within the C2IEDM (MIP bl. 2) and JC3IEDM (MIP bl. 3) that represent Command and Control information tin such a way that is needed to from a BML, Schade and Hieb (2006-2008).

OIEG is a language designed to support the exchange of Intent and related information objects in Command and Control (C2) systems and simulators. OIEG is built upon Lexical Functional Grammar and also separates the vocabulary from the grammar. OIEG is intended to be used as exchange mechanism and not for direct reading.

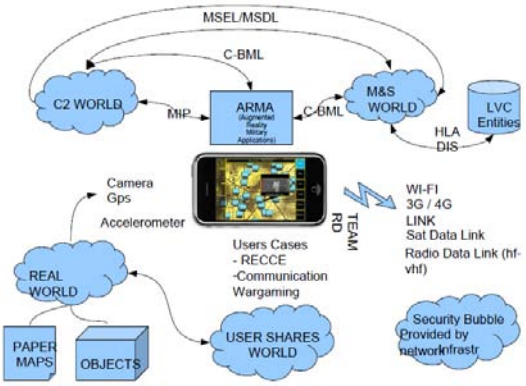
The state of the art of this implementation is performed by SCEMANTA tool, developed by SAAB. It is able to transfer data from an operational scenario designed into a C2 system (SITAWARE) to a constructive simulator (SWORD) via MSDL. In addition it is able to address orders and tasks from a C2 system versus the simulated entities and then it is able to address task and reports from the simulated entities to the C2 system (C-BML <-> JC3IEDM).

The simulation architecture could be run in standalone or in a HLA federation (i.e. HLA 1516 evolved as state of the art technology) with or without external intelligent agents, able to drive special behaviors and addressing them to simulate special purpose constructive entities.

An architecture like the above mentioned, could be used to test and experiment a C2 organization maturity level, using the ELICIT platform that is related with experimentation, teaching, and analysis to investigate the cognitive and social impacts of C2 approach and organizational structure (e.g. information sharing, trust, shared awareness). In this way it could be possible to analyze the level of maturity achieved by an organization taking the advantages of the latest C2 and M&S technologies.

From the perspective of the development of the CFR concept, the authors want to introduce the possibilities offered by the latest technologies to improve the efficiency and the effectiveness in the cognitive sensorial and social domains of a crowdsourced immersive interactive environment.

Starting from the assumption that to improve the level of awareness shared by users experienced in a crowdsourced environment, it is important to stimulate their cognitive and sensorial apparatus using immersive and interactive techniques. The best way to this kind of stimulation can be achieved using a CAVE system (Cave Automatic Virtual Environment) that put users is an immersive virtual reality environment. An alternative to CAVE could be performed by holographic projectors. The above solutions require fixed installation and are not so easy to deploy. The widespread of more and more powerful portable devices like Smart phones and tablet pc's equipped with camera, 3D and augmented reality applications, make possible to increase the user level of immersion and interaction in a crowdsourced environment thank to ubiquitus internet access. The autors believe that augmented reality represents the key factor and the best way to achieve an immersive and virtual experience implementing solutions that comprehend virtual world's synthetic environments. In the followed schema is represented a logical architecture.



3. CFR IN A COUNTERINSURGENCY SCENARIO

The reference scenario to show a CFR model is thinked around the ISAF Mission, fullfilling and augmenting the Afghan Mission Network concept.

A possible CFR scenario could be designed at tactical level with an observer equipped with a special Augmented Reality (AR) mounted optical system. He could acquire a target (insurgents, terrorist, riot groups, etc.), using target acquisition methods (e.g. via passive AR technologies). He could send (automatically) a light-weight text information (e.g. in a C-BML format) to the **Crowdsourced Command Center** where it could be processed (in real time) to create the related target entities in a virtual immersive tactical 3D map, using for example, an MSDL schema (e.g. avoiding to send the real video image).

The virtual cross functional team can access and assess this information directly in the crowdsourced environment, exchanging pieces of information, suggesting task and orders, to find the right solution

to the crowdsourcer. He can directly visualized information throught the optical devices, using the same light-weight text technology with AR techniques.
In addition a crowdsourced integrated Operational Analisys tool could submit the available data collected in the virtual immersive environment providing to the crowdsourcer the suggestion for the best TTP's or weapon system that could fit the commander intents in the best way to accomplish the task, according to the desirable effects. So far enabling the warfighter to accomplish the assigned tasks in the best way.
In this context, looking at a complex operational environment characterized by the employment of dispersed forces that operate isolated in self-syncronized way, with different tasks and missions (e.g. combat forces, combat support forces, training and mentoring forces, civil-military cooperation forces, etc.), a crowdsourced environment can optimized the flow of information. Virtual cross functional team, transversal to the hierarchical chain of command, can then fulfill and address the needs of knowledge in different situations.
An example could be found looking at the CIMIC cooperation where the needs of knoledge and awareness of common shared situation is not referred only to a military dimension but also to the civilian one focusing on local problems. More or less is the same when we are thinking about the exchange of information between coalition and host nation forces and several other Government and No Government Organizations as characteristics of a JIIM environment.

4. COMMAND FEEDBACK AND RESPONCE – A WAY TO RE-THINK COMMAND AND CONTROL

Rethinking Command and Control does not mean discarding everything about we have learned up to now. The idea is to draw a model revisiting assumption and building a new concept upon what remain valid. Taking ispiration from the youngest generation and from the latest social and technological trends that are changing the world (thinking about the North African and Middle East uprising) and the effects and impacts of social networks to share and broadcast information, it is possible to understand the power of crowsourced environment run with social networking approach to problem solving.
Applying crowdsourcing to a military organization this principle can work with some adjustment. For understandable reason of security the "crowd" cannot be "a so open community" as the traditional concept. The crowd is made by all people that can access to the mission community.
Users (the Virtual Cross Functional Team members) — that the authors consider the "military crowd" — in this case form a trasversal online communities, not hierarchically organized, that submits solutions.
In this case the military crowd also can sorts through the solutions, finding the best ones.
These best solutions are then owned by the entity that broadcast a task or an operational problem (Commander's intent and Mission Statement) in the first place — the crowdsourcer (what the authors call the Commander) and the winning individuals (users that suggest the adopted solution), in the crowd should be rewarded as the motivations of individuals to participate albeit belonging to different level of command.
From a technological perspective a crowdsourced organization based on a virtual cross functional team needs a robust network, metaverses technologies and devices that can stimulate users using augmented reality techniques and immersive interactive technologies in a virtual worlds syntetic enviroment.
The CFR crowdsourced model is based also on the assumpion that because of technological advances have allowed for cheap consumer electronics, the gap between professionals and amateurs has been diminished, Howe (2006).
Traslating this assumption in the military environment, the basic idea is that talented and skilled people can be found at all level of command and in all kinds of duty and often not related with their ranks. More often they can share their experience and skills giving their contribution to the mission success.
A crowdsourced environment implemented with immersive and interactive technologies represent a crowdsourced command center where a Commander supervise command and control activities in a CFR paradigm. This environment is also named by the authors "C2I2 bubble".
It can be represented with the Network Centric Value Chain schema (fig. 3), by the bounded area from the overlapped domains.

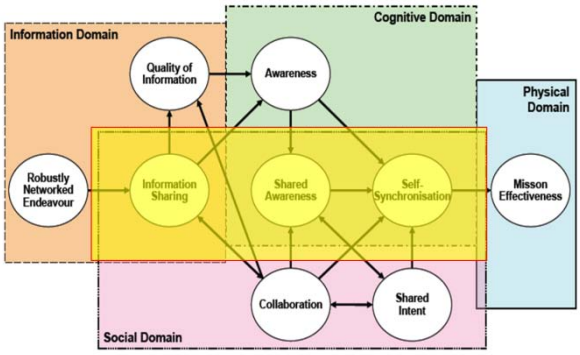
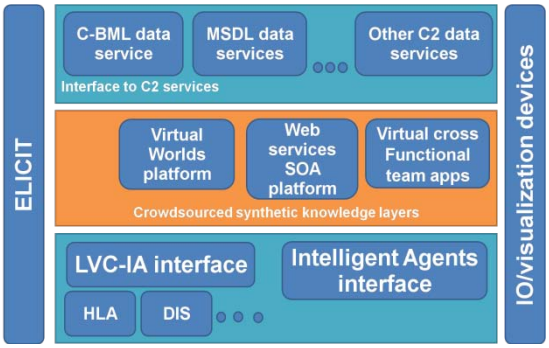


Fig. 3 C2I2 Bubble in the Network Centric Value Chain, SAS 065 (2010)

From the CFR perspective could be possible to experiment the CFR concept building an architecture implementing the ELICIT platform to test and evaluate the CFR concept and its level of maturity, focusing on information, cognitive, and social domain phenomena.



5. CONCLUSION

Crowdsourcing and the Cross functional Team internet-working are the enabler of the CFR theory. CFR needs to be enhanced with emerging M&S technologies like the last Augmented Reality and Virtuality techniques to be more effective.

About the balance between Information Sharing and Information Security is importatant to refer to the intelligence paradox introduced by the authors. The paradox explain that there are *two main approaches to the information assurance*:

1. *protect an information and not share it to people that could need it, thinking about the damages or the disadvantages that could occur if it leaks (negation of information as a hidebound process)*
2. *share an information and not protect it, thinking about which damages could be avoided or which advantages could be achieved if it is awared by people that could need it (affirmation of information as a bounteous process.*

To achieve a crowdsourced organization model comparable to an EDGE C2 maturity level, within virtual cross functional team, it is imperative to adopt a bounteous process. The complex endeavours requires Risk analisys and Information Value Assessment as key factors for an effective full bounteous process.

The adoption of CFR approach it's only a matter of decision making procedures in the “mind and in the hands” of the Decisor. He should act as the responsible in the evaluation of information risk assessment.

In a crowdsourced organization model, if the principle of the affirmation of information is not agreed and supported or not practiced, the whole environment doesn't work. In this case team working and cross functional team cannot be effective, causing overhelming and/or lack of information.

Main issues, regarding a crowdsourced organization model in a military environment, are:

- the needs to access the skilled community (the virtual cross functional team), where people are pre-enptive assessed and accredited or dynamically self-assigned;
- the cyber security of networks;
- the Human Culture factor related to its resilience nature to changement.

Thecnology, in this case, is a support that can facilitated and optimized the functionality of the proposed model.

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APPENDIX A

Acronims

C2: Command and Control
C2I: Command Control Intelligence.
C2I2: Command and Control Immersive and Interactive.
CFR: Command Feedback and Responce
CFT: Cross Functional Team
DOTLMPFI: Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, Leadership, Interoperability.
ELICIT: Experimental Laboratory for Investigating Collaboration, Information-sharing and Trust
HMI: human/machine interface.
HQ: Headquarter
JC3IEDM: Joint Command, Control and Consultation Information Exchange Data Model.
JIIM: Joint Interagency Intergovernmental Multinational
M&S: Modelling & Simulation.
N2C2M2: NATO NEC C2 Maturity Model
NCW: Network Centric Warfare
NCW: Network Centric Warfare.
NEC: Network Enabled Capability
TTP's: Tactics, Techniques and Procedures