“Reading the mind of the enemy” through an enhanced multi-domain Commander’s Critical Information Requirements (CCIR) process

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Abstract. CCIRs are information requirements identified by commanders during the planning phases as being critical to facilitate their key decisions and to secure their desired strategy. In the context of increasing complexity, speed and deluge of data which characterize modern warfare, events can occur simultaneously in multiple domains and quickly overwhelm the Decision Cycle for operators.

For such situations, we have designed a comprehensive CCIR Process augmented by new technologies which will offer a solid performance level to ensure timely and relevant sense making and responses. We have named it “ANTICIPE”. ANTICIPE stands for Augmented Near real Time Instrument for Critical Information Process Experiment.

The innovative idea is to break down a CCIR into 2 sub-levels of information, so called triggers and cues (or Weak Signals), which are linked by rules defined during the planning process. This CCIR Space constitutes an ontology which will be used as mining architecture.

ANTICIPE captures data from all available sources in the operational HQ (documents, chat, mail, Voice Communication System, C4I notifications, open sources) while transforming those data into knowledge artefacts. At this stage, mining is done autonomously and a Cues Appearance Data Base is implemented.

Based on a crisis scenario, the concept paper will showcase the comprehensive workflow through which information sources are processed to discover critical information. It will introduce and discuss the various adaptive HMIs, based on Cognitive technologies. It will especially focus on the various multi-domain ones, data transparency functions and associated confidence measures.

Keywords: Decision making, Natural Language Processing, Multi-domain operations, CCIR, HAT Agent.

1 Introduction

1.1 Context

In the context of increasing complexity, speed and deluge of data which characterize modern warfare, events can occur simultaneously in multiple domains and quickly overwhelm the Decision Cycle for commanders and operators.

Considering the Military decision cycle of a JFAC commander for instance, all key processes are still run in a traditional way and although mobilizing a lot of people through the entire battle rhythm, their performance level is becoming more and more fragile facing the complexity and information overload.

In this context, human brain may not be sufficient. There is strong need to fuse multi-domain sources of information and augment human abilities by new technologies to be able to make sense of it and understand rapidly crisis dynamics. Furthermore, when the tempo of operations accelerates sharply, assisted thinking is needed to avoid overload, unnecessary filters and cognitive bias we encounter in any operational organization.

Today, AI enriched systems open the way towards a fully digitalized and Augmented Decision-Making process.

In fact, the information revolution has deeply changed the way headquarters of military forces operates and makes decisions. Military Forces have unprecedented ability to capture, transmit and receive data and it is growing exponentially. This high volume of information can camouflage the critical information a Commander needs to make appropriate decisions at the earliest and to ensure successful execution of his plan.

For such situations, our research team has redesigned one of the most important C2 processes, the Commander's Critical Information Requirements (CCIR) process, and used new technologies to make timely and relevant decisions. CCIRs are information requirements identified during the planning process and fall into one of three categories:

- those necessary for the anticipated major decisions;
- those making it possible to verify assumptions and;
- those ensuring the protection of own forces and center of gravity.

The name of this project is **ANTICIPE** (**A**ugmented **N**ear real **T**ime **I**nstrument for **C**ritical **I**nformation **P**rocess **E**xperiment.) This project is notably developed within the framework of the NATO Scientific and Technology Organization (STO) and foresees to conduct experimentation during a large NATO exercise, STEADFAST JUPITER/JACKALL in December 2020.

1.2 Multi-domain Operations

Possible future adversaries have demonstrated the capacity to conduct hostile actions in all domains. In this context, Western advantages may not be persistent as rival states develop anti-access weapons and tactics in all global commons.
This observation has motivated the development of the concept of Multi-domain Battle or Multi-domain Operations. Although this approach of warfare is still evolving, it can be roughly described as a combination of capabilities employed simultaneously to create multiple effects within a domain or in multiple domains in order to provide multi-dilemmas to powerful adversaries.
We can easily understand that this will only happen through the collection of data by a global network of sensors, platforms and weapons, everything being highly synchronized by a modernized C2 where high velocity decision-making has to be implemented.

As shown in the figure below, the USAF is conducting interesting studies to define how future C2 structure should be designed for Multi-domain operations.

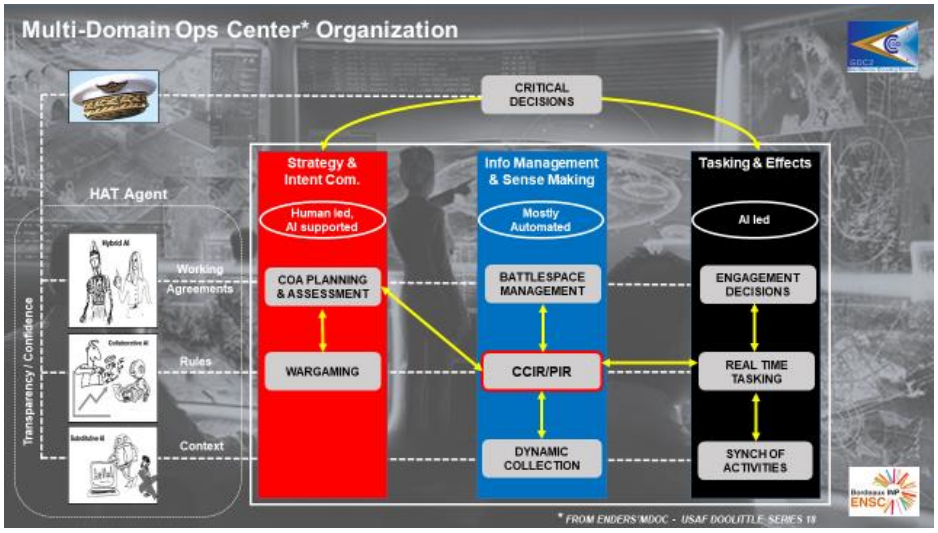

Fig. 1. A Multi-domain Operations center Organization from ENDERS'MDOC, USAF DOOLITTLE SERIES 18

The CCIR process is placed as the key and central process, around which the future MDOC is designed. Our ANTICIPE project is totally aligned with these on-going studies.

1.3 An innovative data model

The idea of ANTICIPE is the simple but innovative notion to divide a CCIR into two levels of information, the trigger and the cue (weak signals), which are linked by rules

defined by the human planners. Today CCIR are limited in number and maintained manually. In the face of complexity, operators have to find them immersed in exponential masses of data, degrading anticipation and insights. Our tool will provide an enormous capacity to track weak signals and triggers.
Thanks to this decomposition, combined with an automated collection process, we are building a universal system that can apply at all levels of command: strategic, operational or tactical.

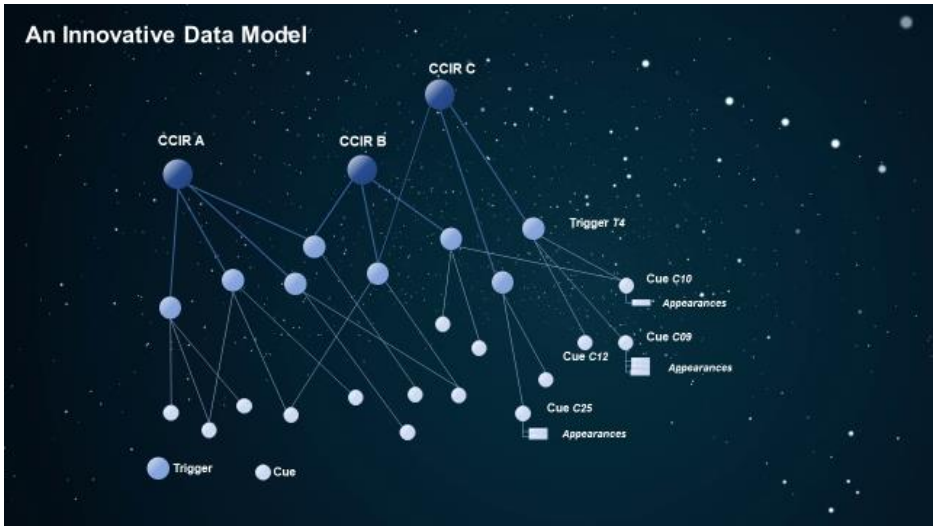

Fig. 2. Representation of what we call the CCIR Space and the rules linking the various elements.

Furthermore, cues, triggers and CCIR are identified by domain and sub-domain which allows, as and when they appear, to understand how the enemy is operating in multi-domain.

By collecting and processing "critical information" so rapidly, the commander is expected to be able to “read the thoughts of the enemy”. The defined process thus makes it possible to constantly answer a list of key questions like: Status of my Critical Vulnerabilities? Status of my Critical Capabilities? Are they threatened? Are my Assumptions still valid? What might cause key conditions to change? What may hurt most? How is the enemy conducting actions in multi-domains?

This critical information is directly related to the decisions, triggered according to 3 levels presented simply by traffic lights: yellow causing preventive action, orange leading to mitigation actions and red for a major decision. It is indeed a central process, an anticipation tool that focuses staff on key elements and reduces complexity.

2 A broad spectrum Human Autonomy Teaming System

The figure below presents an academic vision of what constitutes our tool for automating this CCIR process and how artificial intelligence is being implemented.
At each level of information is associated one of the 3 aspects of AI applications, namely: substitutive AI for cues finding, collaborative AI for triggers computing, and hybrid AI for the emergence of CCIRs and associated decisions.

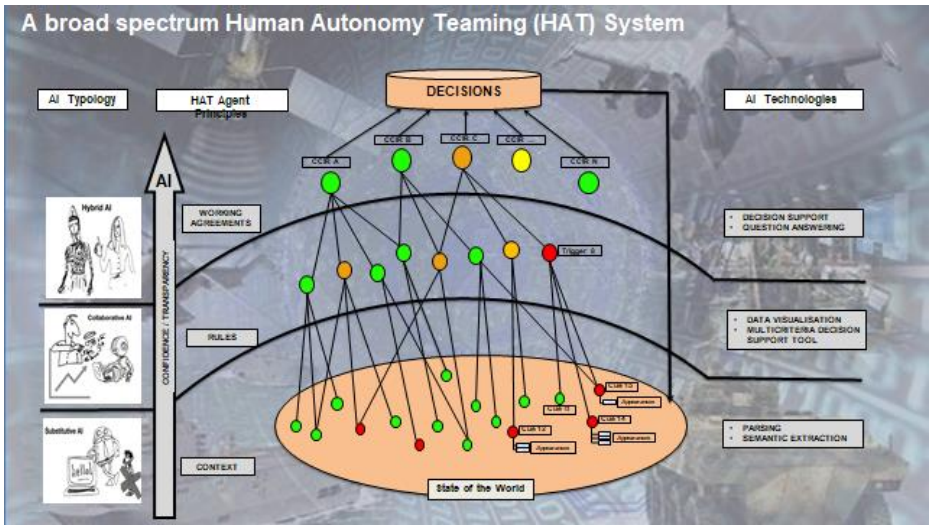

Fig. 3. Academic vision on how artificial intelligence is implemented in our tool.

On the right side of the slide are detailed the different artificial intelligence technologies we are using: Natural Language Processing (NLP), Multi-criteria decision support, Machine Learning, Decision management, Virtual Assistant.
On the left, we describe how our conceptual solution is based on the principles of Human Autonomy Teaming (HAT), and more specifically on its four main aspects, namely context sharing, rules, transparency and cooperation agreements, who decide what.

3 The functional approach

The tool for automating the CCIR process consists of 6 components and the corresponding HMIs.

How basically is the system working? As soon as the system detects a cue, it changes its logical value, impacting the trigger linked by various criteria and weightings, thus causing a modification of the related CCIR. The system then should be able to propose preventive, mitigation or major measures as required by the level (threshold effect) reached by the CCIR.

The point of application of these measures is at the Trigger level. They are presented in a synchronization matrix in order to allow the decision maker to make prioritized choices and better visualized their multi-domain aspect.

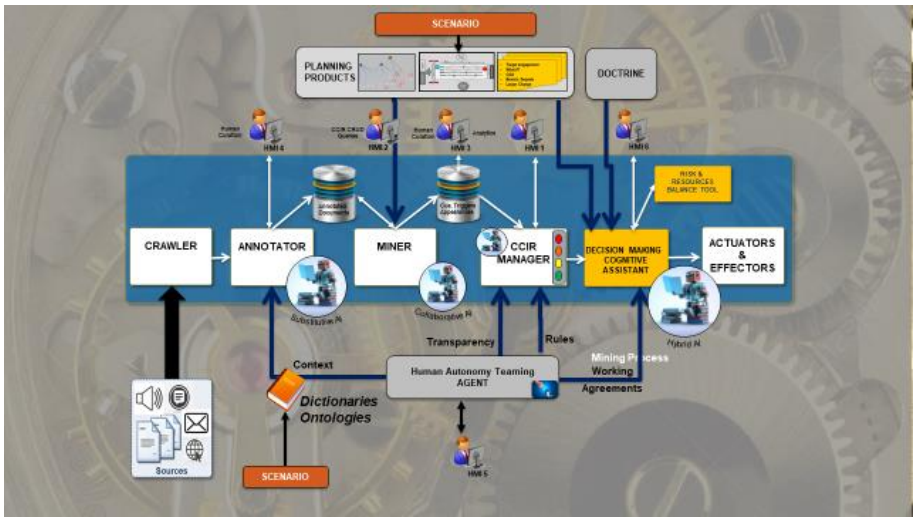

Fig. 4. The various building blocks of "ANTICIPE"

As shown in the figure above, ANTICIPE collects data from all available sources in the operational headquarters (documents, chat, mail, voice communication system, C4I notifications, open source) and converts these data into knowledge artifacts stored in the ANTICIPE database (commented documents and weighted graphics database) for further processing. This annotation process is a team-oriented process.
Mining takes place autonomously through semantic models, ontologies, which leads to the identification of cues and triggers. Currently, an Event Appearance Database is being built, on which human curation can be applied if required. It refers to the CCIR space, the type of source and different weightings.
The part of the Decision-Making Cognitive Assistant at this stage is simulated by an IF-THEN-ELSE model based on teaching and planning products. Meanwhile the research team is already working on decision support tools using war-gaming techniques.

AI, Machine Learning and Decision Support are implemented step-by-step in each building block, taking into account that the current phase of development focusses on building a robust architecture that allows a fast and relevant prediction of the occurrence of critical information. UX Research & Design are another very important part of the development. The academic environment, composed of research fellows and students, in which our team is working, is very helpful in this area.

4 Development strategy

As you know, referring to AI, you need a lot of data to train the model. To this end, we rely on a very rich and comprehensive scenario, used by NATO in 2010. From this scenario, the planning work has produced a CCIR set that we are using for the experiment.

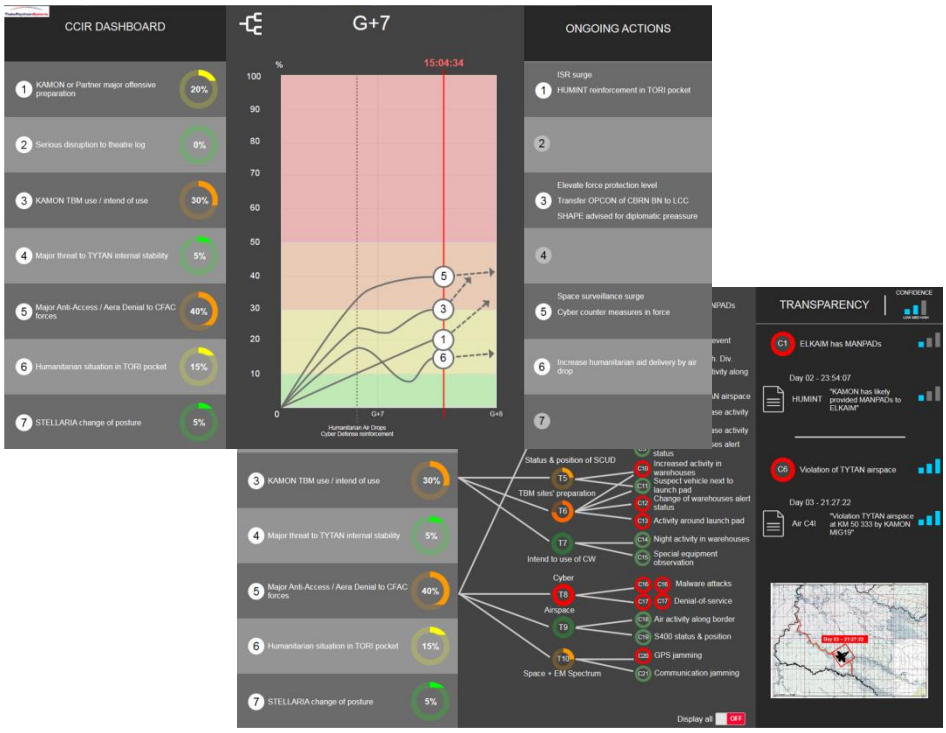

Fig. 5. Some screenshots of HMI views as presented for example in the Current OPs room.

In order to understand what the tool is designed for, the figure above provides an insight on data visualization techniques and type of displayed information. You can notice

- the state of the CCIRs according to their color and the quantified evaluation of their degree of emergence,
- the ongoing actions in relation to each CCIR, summarizing the decision to prevent or mitigate the effects of these CCIRs and
- a historical view of the active CCIRs evolving between the different thresholds.

For each active CCIR, a trend bar presents an assessment of the future development of the CCIR, based on the cue appearance rhythm, cue weighting and other factors. A large number of sub-menus enable in-depth situational awareness. Using the semantic tree view, you can access to the source of the recognized information. Each document is evaluated according to the nature of its origin and other factors.

When the CCIR dashboard presents a change of state of one CCIR that has reached a new threshold, according to the warning criteria, the system reaches the nominee autonomously: COM, DCOM, COS or CJOC Director.

Sense making in this case is not enough, it requires deciding on the best option to solve the problem. An interface then synthetically represents the essential elements that make human decision possible: proposal of actions related to "triggers" in a synchronization matrix; presentation of the state of risk resulting from the proposed measures; displays the resource status of the proposed actions.

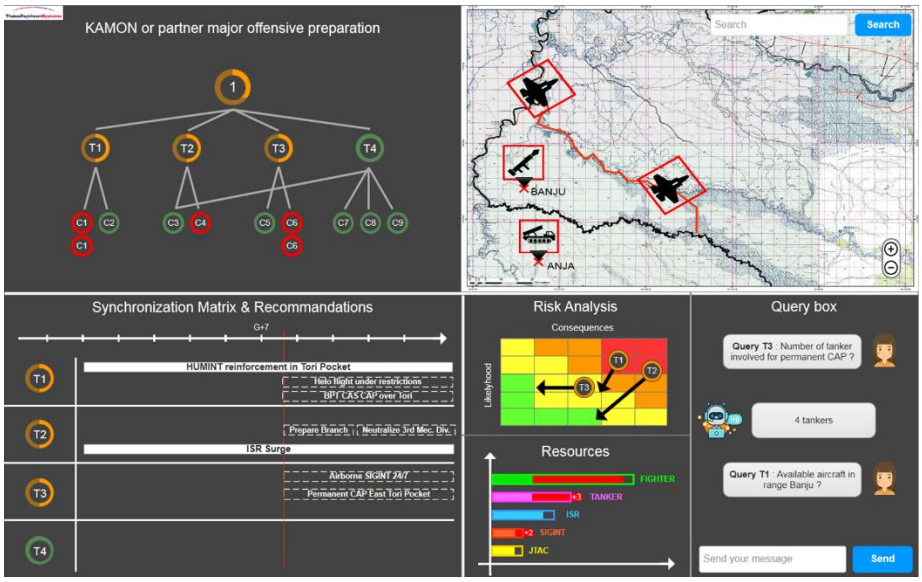

Fig. 6. HMI view of the Decision-Making Cognitive Assistant.

If one of the proposals for actions is selected or deselected, the impact on resources and risks becomes immediately apparent.

The first idea is to allow the commander to deal with multiple dilemmas simultaneously while informing all staff of his intentions and decisions. Individual operators will be able to use this HMI module to implement decisions.

5 “Reading the mind of the enemy”

Additional specific features, such as multidimensional representations of the opponent's actions, are under development. For instance, a multi-domain view allows evaluating the strategy of the opponent, especially between two datasets, as shown on the figure below.

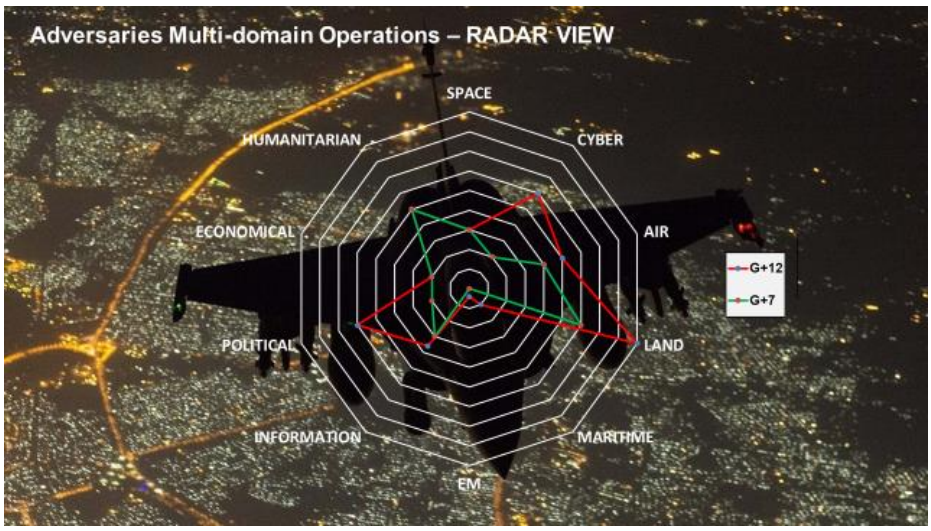

Fig. 7. Multi-domain Radar view.

We also work on a so-called seismograph view that allows to convey several types of mental models:

- To understand the multi-domain strategy of the opponent (amplitude),
- To detect an intensity increase of the adversary in one domain or in several (frequency),
- To detect patterns of actions, typical and repetitive sequences related to the strategy of the opponent, leading to a better anticipation of the adversary behaviors.

The frequency of appearance of the cues is here a determining element of the will of the adversary. A flexible configuration of the graph (domains distribution), allows the Commander to visualize information according to the context and to his needs.

You will notice on the figure below that the weak signals are weighted which makes it possible to refine its judgment, and in particular on the capacities of nuisance of the adversary; the more the "Cues" are heavy, the more it has a high nuisance capacity.

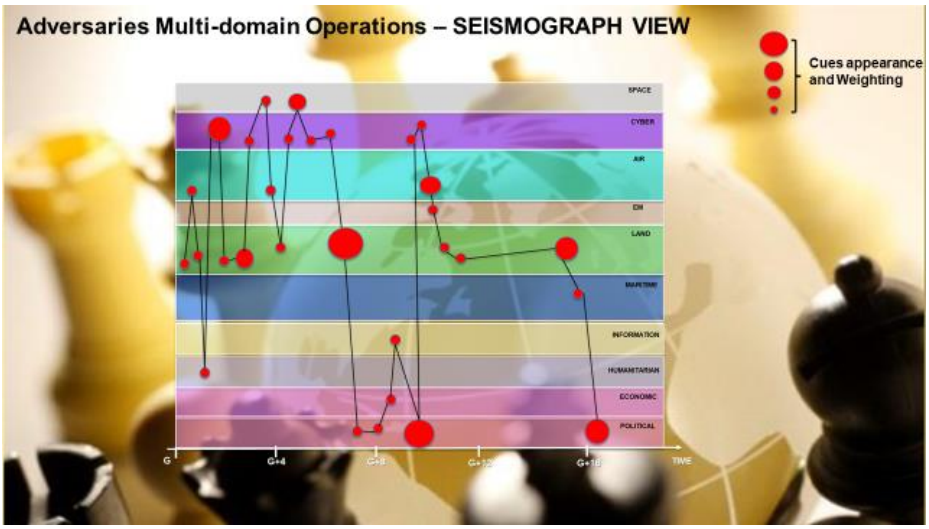

Fig. 8. Multi-domain Seismograph view.

6 Future work and researches

Regarding the development of our system, the first part of the studies and the development documentation are done and passed to 2 different development teams:

- One addressing the NLP part, the semantic extraction engine,
- One coding the CCIR Manager and the decision support part.

We expect perform the integration of these two parts for end of September 2019. A functioning Minimum Viable Product (MVP) should be ready for the end of the year.
Then will start the necessary preparation work in relation to the exercise scenario in cooperation with the training audience of Steadfast JUPITER-JACKALL: creating new dictionaries, building the adapted ontology, and assisting during the planning process in order to get the right Data set.

7 Conclusion

The key quality of the system is to reduce complexity and its primary interest is to make sense from the lowest level of action of the opponent.
According to the famous formula of former SEC DEF Donald Rumsfeld, the system should make it possible to collect and merge a very broad spectrum of information, going as far as "Don’t know – Don’t know". The system will also be performing in the "Don’t know - Know“, because in a 500 operators strong HQs, important information may be stuck somewhere and emerge late or incomplete.

It will above all allow the anticipation, reactivity and high velocity decision-making necessary for multi-domain operations, and will focus the staff on the Commander's strategic Intentions while avoiding cognitive and organizational biases.

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