

Air C2 French academic research collaboration

« Command & Control » (C2) is a method and a set of high-technology tools designed to optimize the way to dominate a complex situation. Deeply impregnated with technology, C2 is designed to plan, synchronise, direct and control groups of people and means made available to commanders to carry out comprehensive objectives. In our vision, C2 corresponds to the implementation of a theoretical "machine" in support of a strategy, relying on communication and information systems, data processing devices, in order to implement decisions. This machine includes a set of processes, methods and knowledge management techniques we recognize as the « C2 cognitive circle ».

At the end of the last century, cognitive computing was looking at the complementarity between human and machine, whereas Applied Cognitive Science (Cognitics) was interested in the integration of human and systems (IHS), conceiving the symbiotic anthropotechnical duo as a single element capable of solving global problems where an isolated man or a system are less efficient than a man enhanced by technology.

The aim of the present research program is to bring big data, data analytics, cognitive computing and other Artificial Intelligence tools to C2, (i) to simplify human-machine integration (UX), (ii) to contextualize the complexity of informations in order to obtain the best and most comprehensive situation awareness (KX), and (iii) to enhance teamed men-machines' performance (HX).

« Ecole Nationale Supérieure de Cognitique » (ENSC) is a French academic center training engineers and PhD's to address tomorrow's scientific and technical challenges in applied cognitive sciences and cognitive technology (IT, IoT, AI, VR, NBIC ...). ENSC is an interdisciplinary research center in IT-HSS (Information technology & Human and Social Sciences). It promotes an holistic approach to human and machine cognition, natural and artificial intelligence, human-system engineering and hybrid interfaces, knowledge management and decision-making, human engineering and technological enhancement, artificial intelligence and usability of digital environments, human centered design for the hybridity of an anthropotechnical world. ENSC operates the Human Engineering for Aerospace Lab. (HEAL) in a 50-50 partnership with Thales.

Part of ENSC's research portfolio addresses the theoretical development of Air Command and Control (C2), together with ONERA Provence Research Center and the French AWC.

« ONERA Provence Research Center » (OPRS) is an aerospace research laboratory, part of the « Office National d'Etudes et de Recherches Aérospatiales », a public/industrial/commercial establishment in charge of valorising French research in aerospace. It is located on the Salon-de-Provence air base. Within a set of scientific thematics (Theoretical and Applied Optics, Electromagnetism and Radar, Systems Control and Flight Dynamics, Expertise in Human Factors), it develops a reflexion on collaborative cognition and, in partnership with ENSC, on « metacognition » and artificial intelligence for « augmented intelligence ».

Team present at Norfolk COTC (dec. 13-15th 2016) and main authors :

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- Prof. Bernard CLAVERIE - PhD., Psychophysicologist - Director of ENSC - Applied cognitive sciences research group of IMS lab. CNRS (Bordeaux)
- Dr. Laurent CHAUDRON - PhD., Artificial Intelligence Scientist - Director of ONERA Provence Research Center (Salon-de-Provence Air Base)

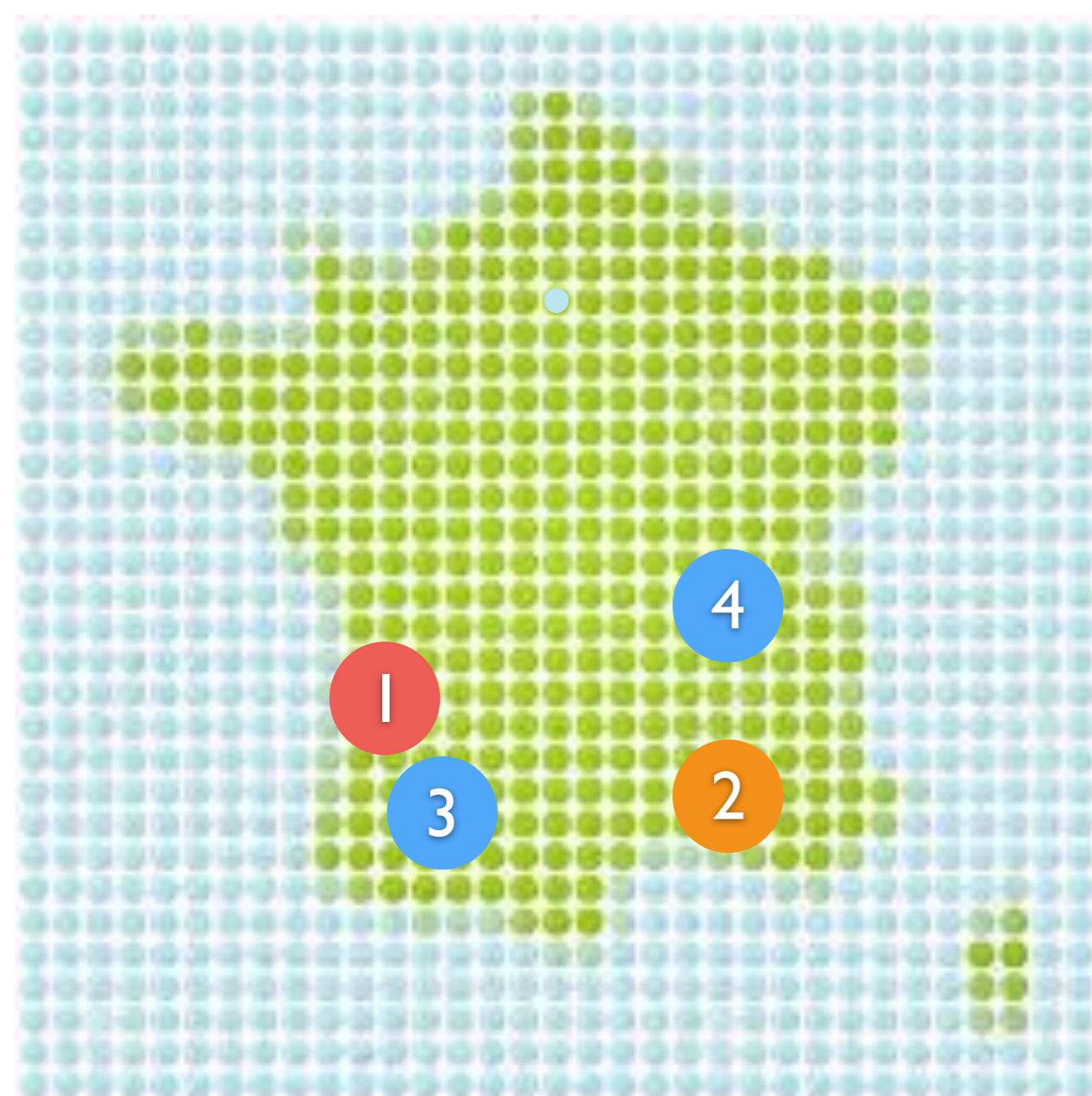
in collaboration with :

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- Br.Gen. Jean-Pascal BRETON - Head of Centre d'Expertise Aérienne Militaire (CEAM) - French Air Warfare Center (Mont-de-Marsan Air Base)
- Baptiste PREBOT - Cognitive sciences engineer - ENSC-IMS scientist (Bordeaux)
- Prof. Jean-Marc SALOTTI - PhD., Artificial Intelligence Scientist - ENSC - Applied cognitive sciences research group of IMS lab. CNRS (Bordeaux)

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<p>1 ENSC-IMS</p> <p>Academic C2 research. ENSC carries the « Carnot » research/company partnership on « Cognition » and the Human Engineering for Aerospace Lab. (HEAL) with Thales.</p> <p>Bordeaux</p>	<p>2 ONERA</p> <p>The Provence Research Center is a part of ONERA. It collabores with ENSC and AWC. ONERA carries the « Carnot » on « Aerospace systems engineering ».</p> <p>Salon-de-Provence (Marseille)</p>	<p>3 CEAM-AWC (FAF)</p> <p>The « Centre d'Expertise Aérienne Militaire » is the French Air Warfare Center. MOU with ENSC. Implementation and testing of the Nato Air C2 System.</p> <p>Mont-de-Marsan</p>	<p>4 CASPOA (FAF)</p> <p>NATO Centre of Excellence. Collaboration with AWC. Analysis and Simulation Center for Air Operations (CASPOA)</p> <p>Mont-Verdun (Lyon)</p>
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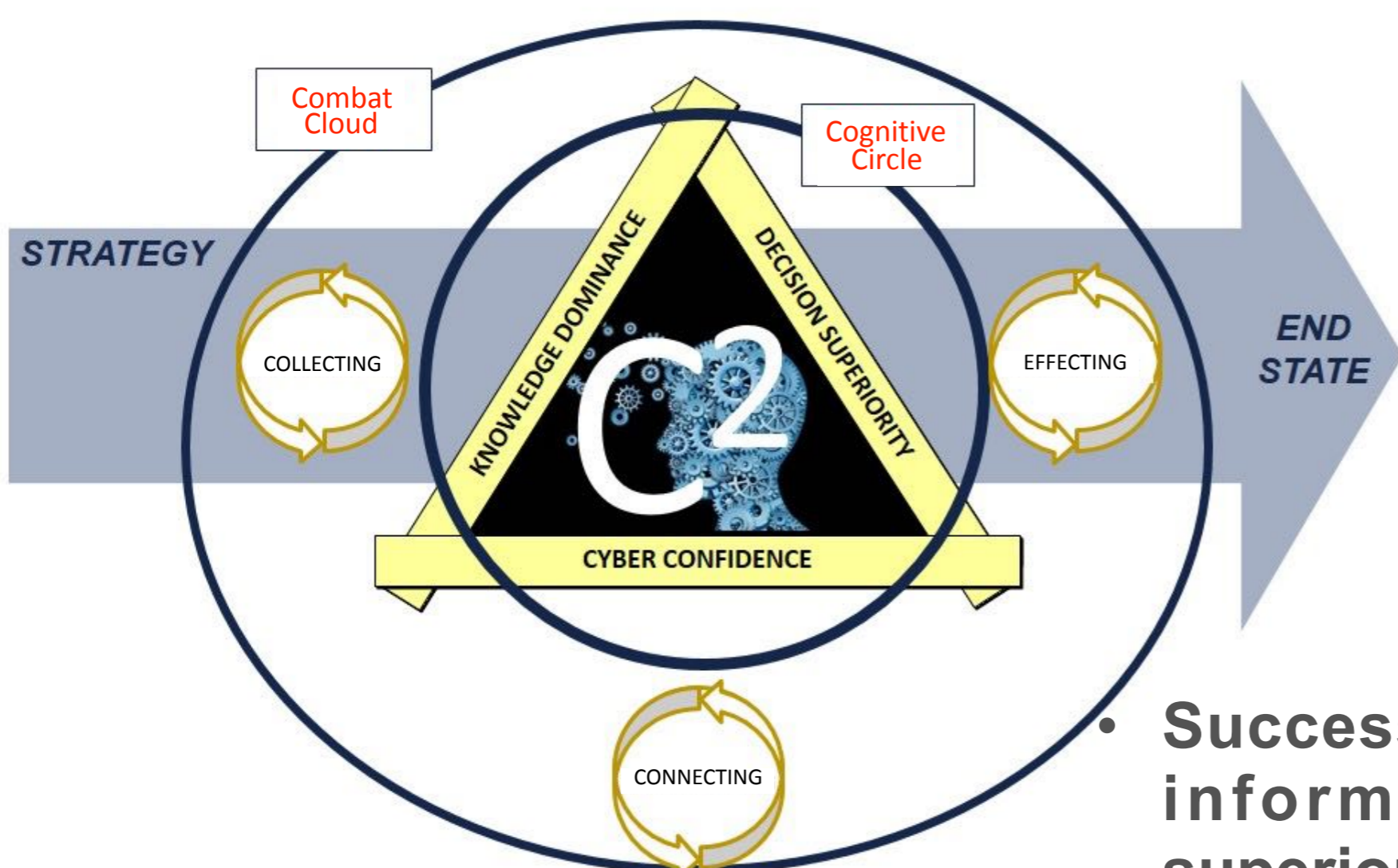


- Academic
 - 1 Academic and theoretical research (ENSC-IMS)
- Dual
 - 2 Research on practical applications (ONERA)
- French Air Force
 - 3 Air Warfare Center (French Air Force)
 - 4 Military academic teaching and training (Nato CoE)



Our research project settings

Our vision

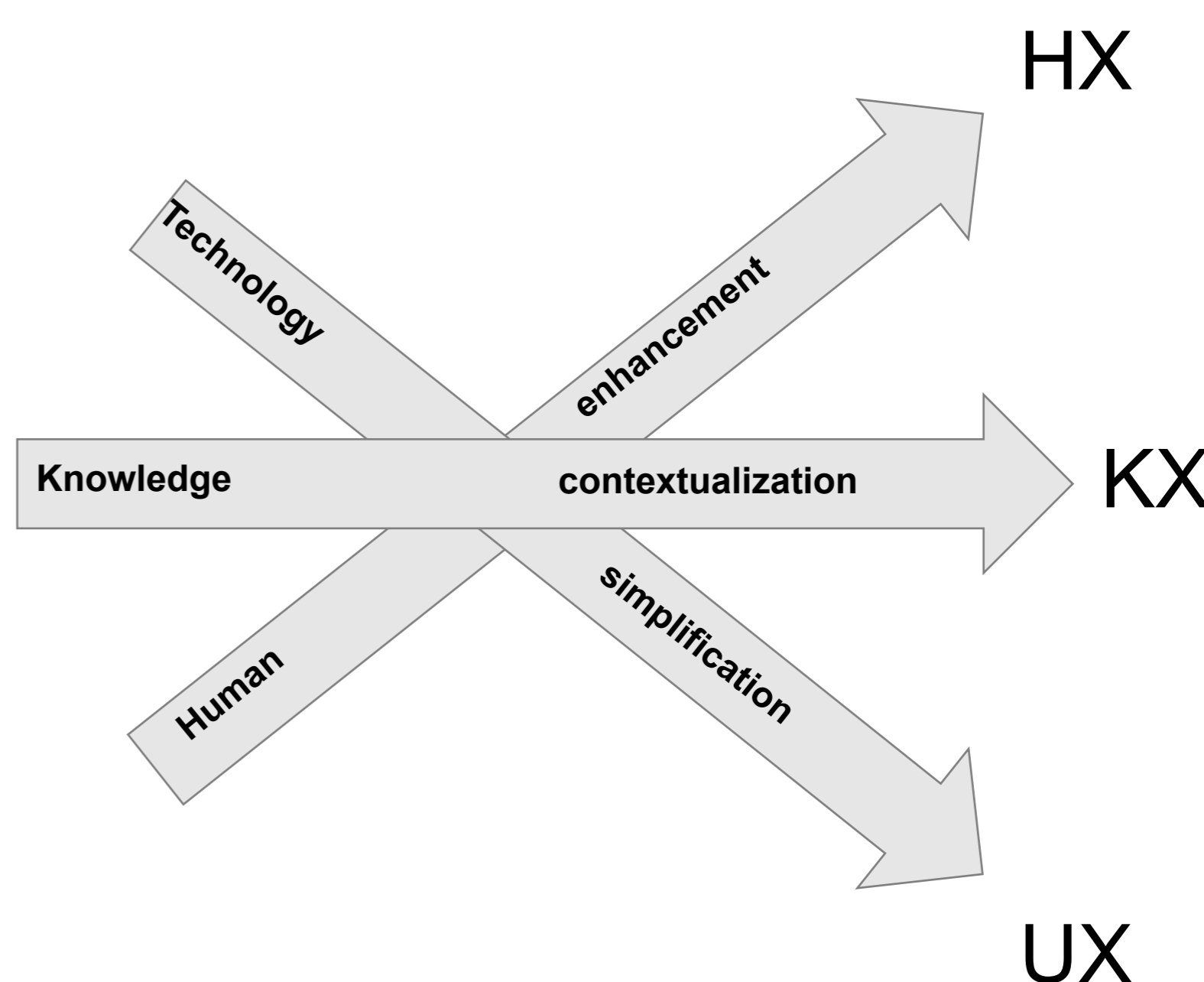


- A theoretical “machine” in support of a strategy.
- Processes, methods and knowledge management techniques as the C2 “cognitive circle”.

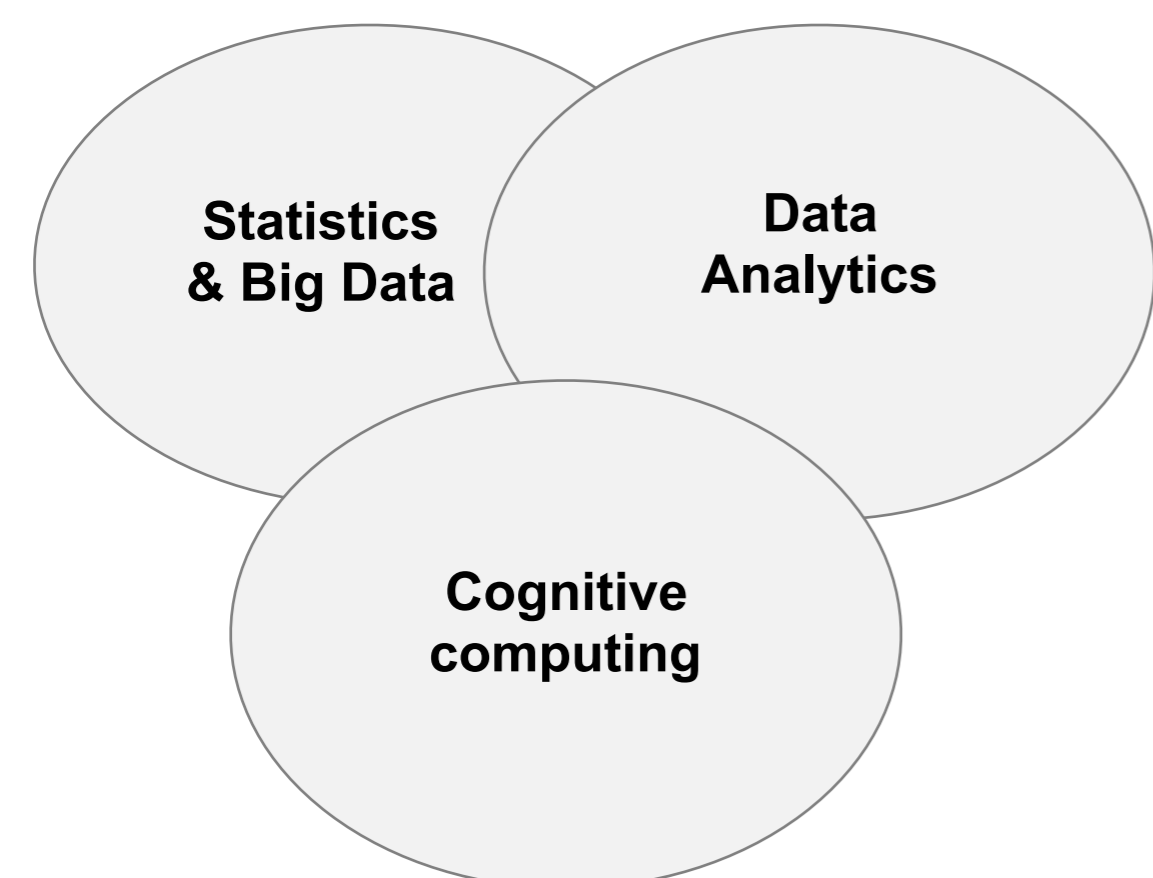
- Successful C2 relying on 3 pillars: information dominance, decision superiority and cyber confidence.

Our methods

- UX for User eXperience: refinement of interfaces, user's experience (comfort, performance, safety, control of error) and human-system articulation.
- KX for Knowledge eXchange: information processing enhancement, making knowledge directly and smoothly accessible, and shared.
- HX for Hybridity eXtension: how AI increases the performance of humans collaborating with systems, opening the way towards hybridity.



The tools

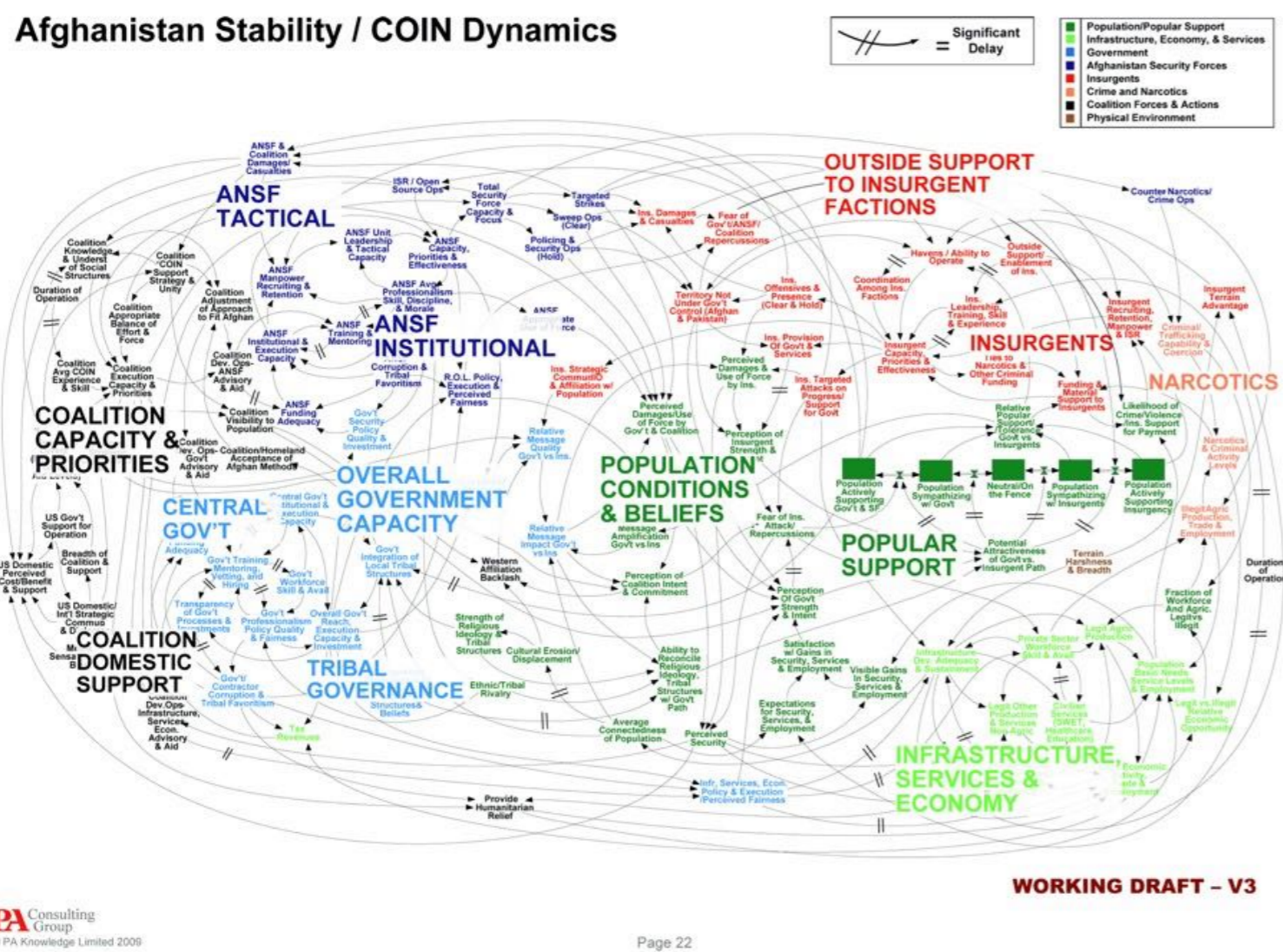


- Data, whether in fixed forms of statistical tables or in the uncertain cloud of big data, requires an ever increasing amount of information processing assistance.
- The "analytics" allow to take advantage of this massive processing capacity to understand them in order to predict.

- "Cognitive computing », akin assisted intelligence, is an additional step in the "intelligent" exploitation of data in order to create learning systems of filtering which help the user in his reflections.

To be effective, C2 evolutions shall rely on the three conceptual cognitive methods : UX, KX and HX.

Our aim: Shaping the future of C2 by a symbiotic human/machine approach of complexity

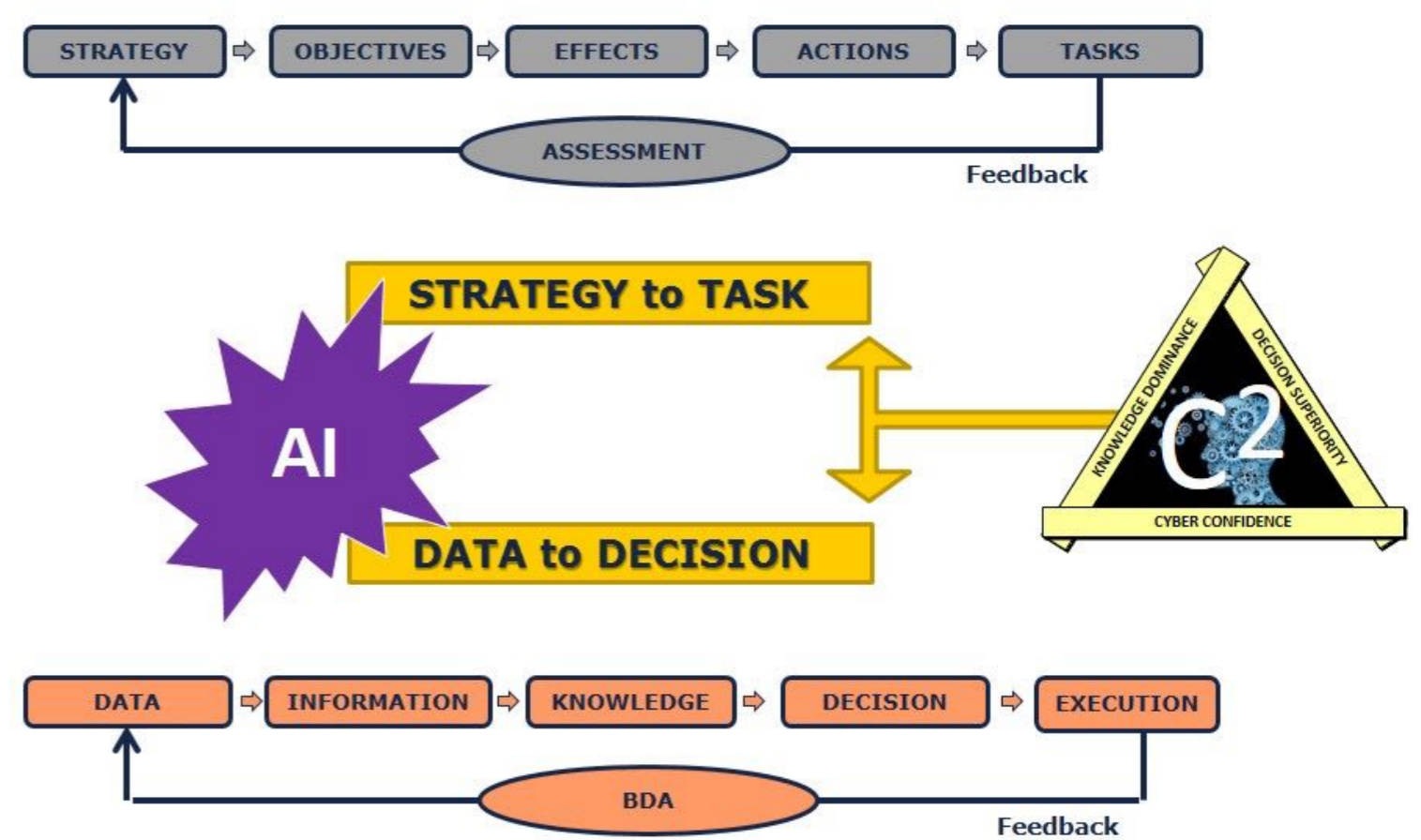


General Stanley A. McChrystal

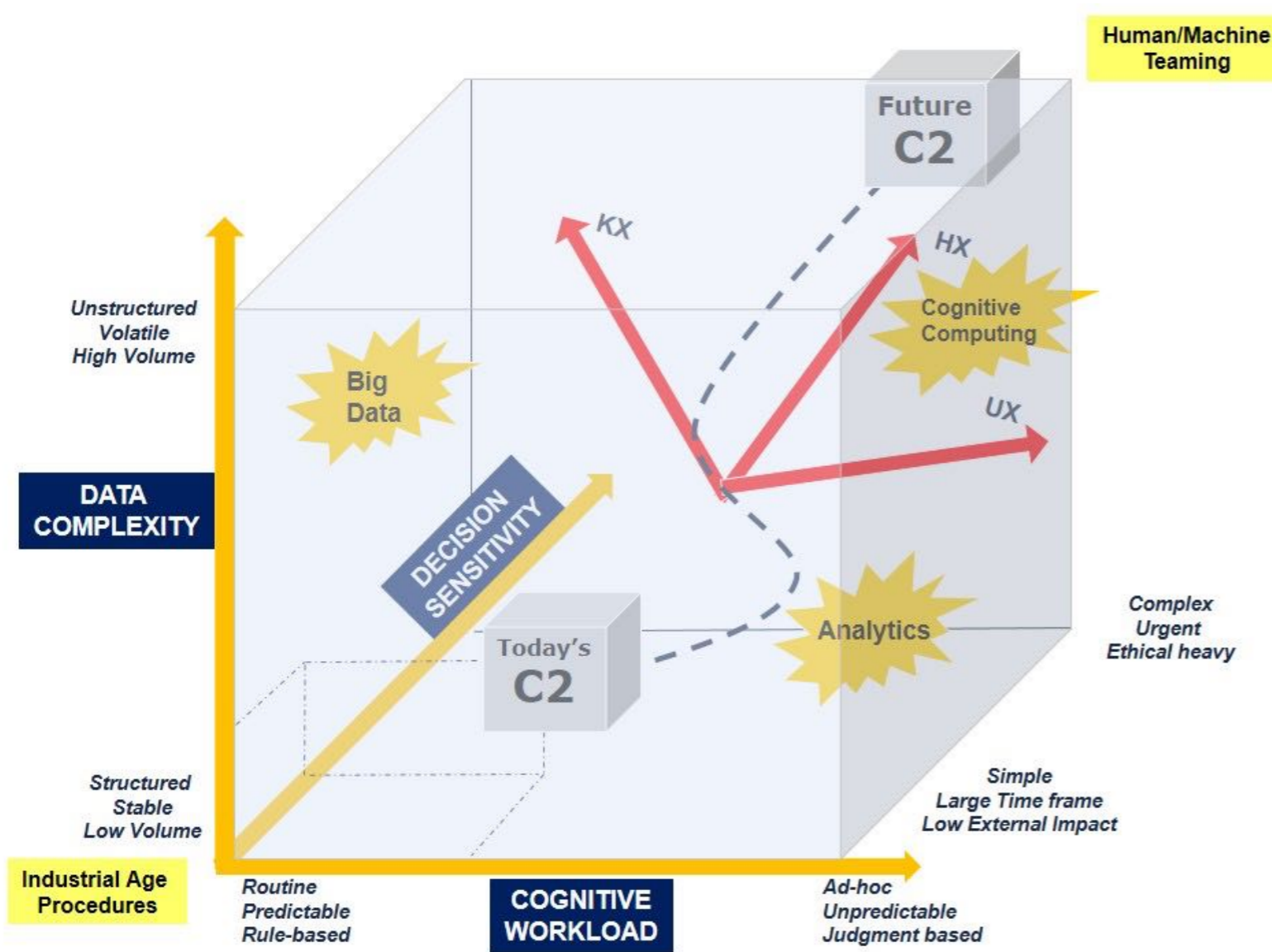
« When we understand that slide, we'll have won this war. »

2 overarching processes

- C2 may artificially be described by 2 overarching intertwined processes.
- We intent to focus on the Strategy-to-Task process because it contains more key processes sensitive to knowledge and innovation, therefore being likely to be enhanced by technology.



Our Project

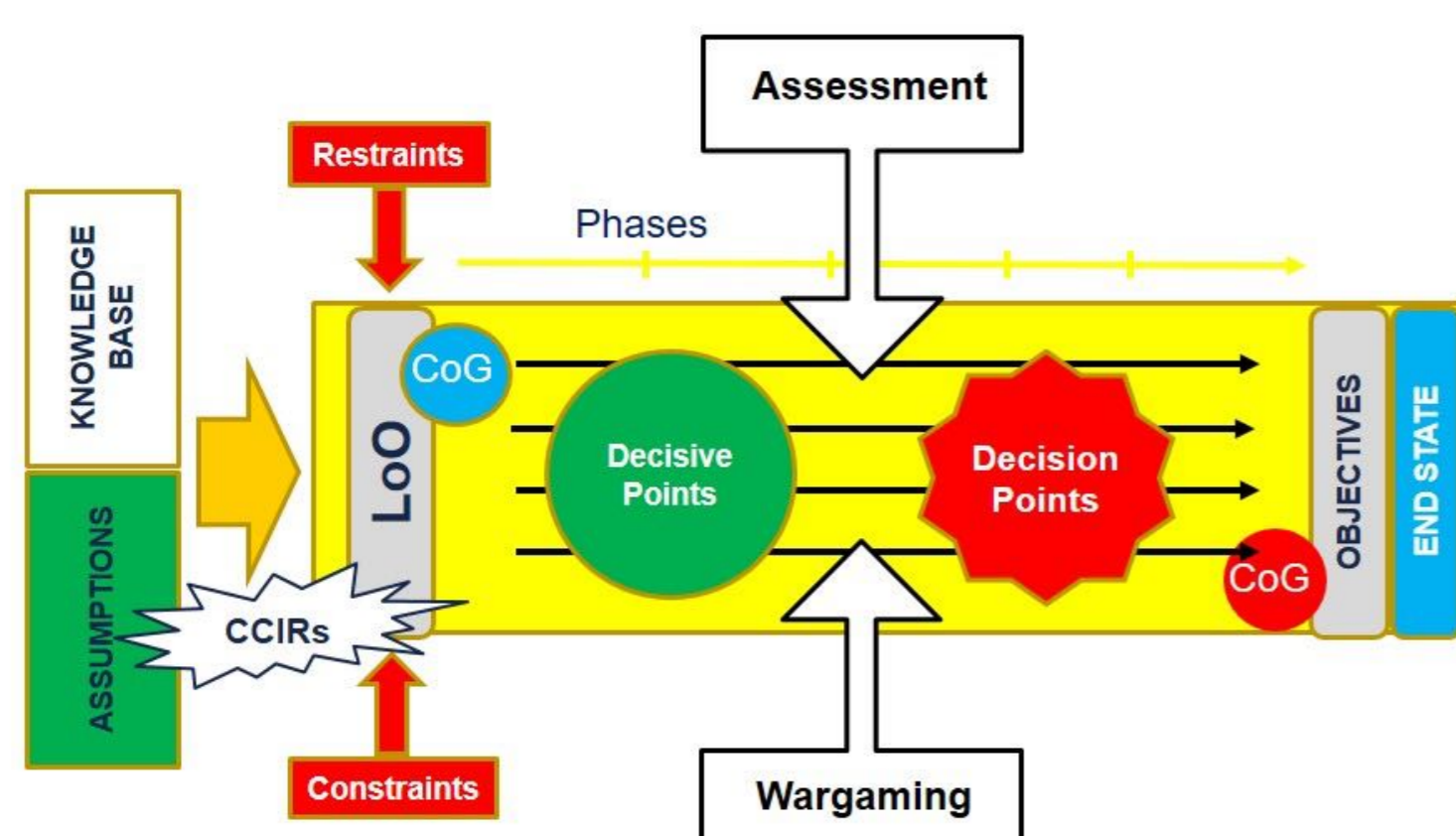


- From industrial age procedures to Human/Machine teaming.
- The only way to deal with complexity is to build on a methodology that, thanks to a symbiotic Human and Machine cognition, will leverage a shared consciousness of crisis' dynamics and thus will enhance quality and speed of decisions, in order to better master the desired effects.

Our project defines a path leading to a future C2. It is based on the dual choice we make to focus on strategy-to-task and to enhance it thanks to big data, data analytics and cognitive computing, allowing for a better understanding of crises' dynamics, a prerequisite for any successful outcome.

How will these technologies influence the main processes driving the decision cycle in a C2 organization?

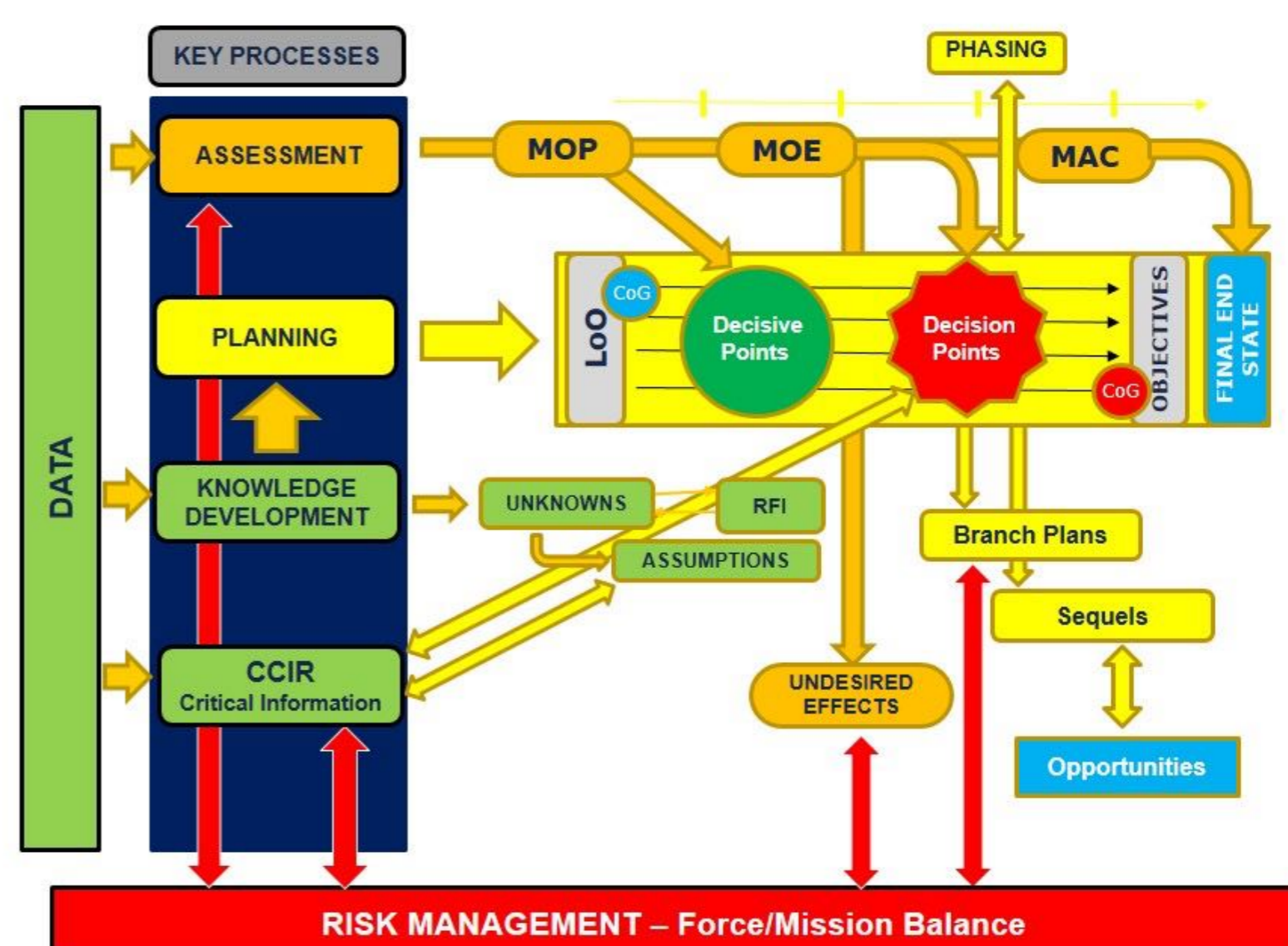
Operational Design



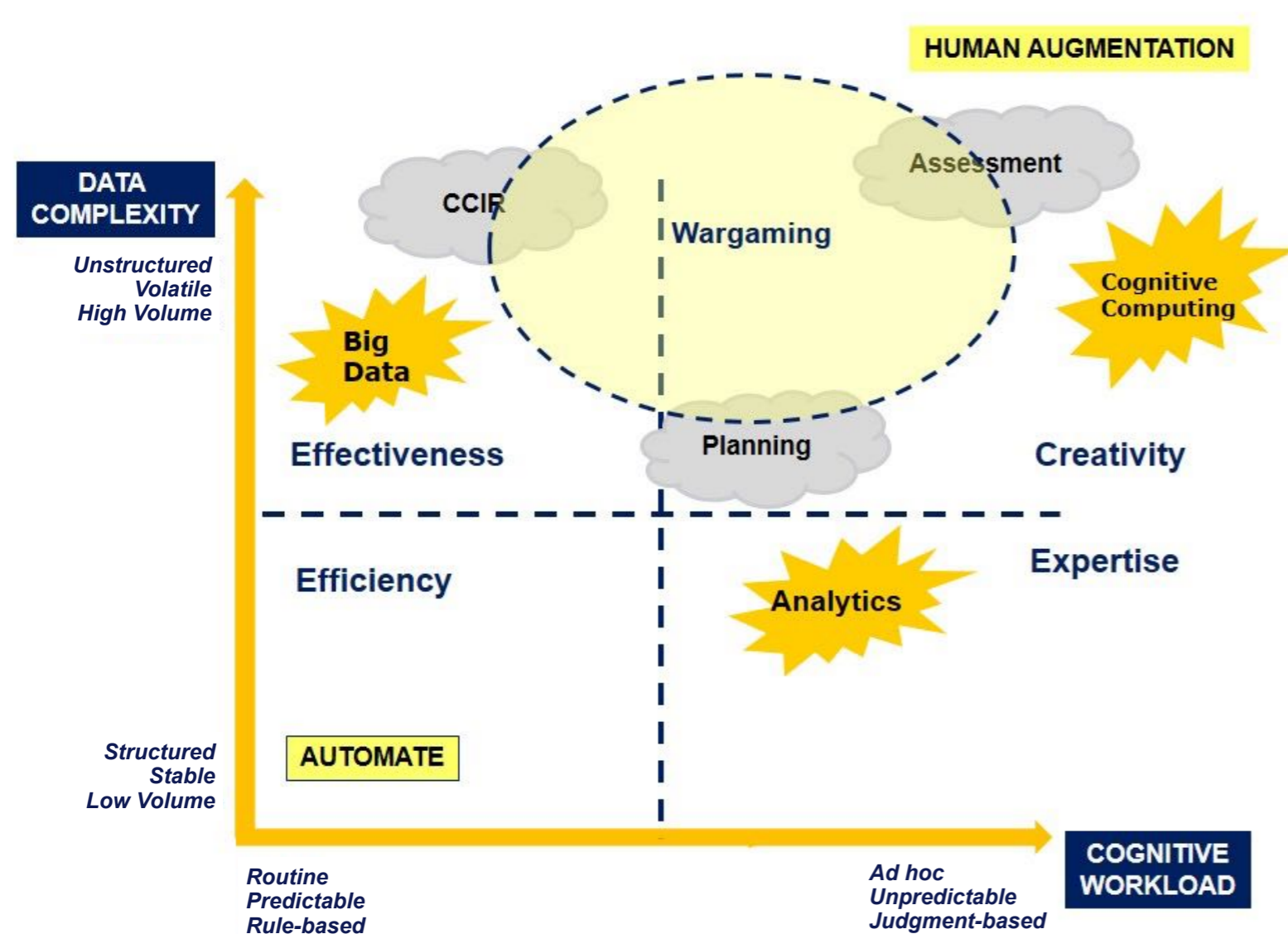
- A commander's planning tool, continuously revised and improved.
- Until today best, powerful, sense-making representation to build an operational consciousness of the situation and easy to share.
- 3 key processes identified: Assessment, Wargaming and CCIRs.

Representation of key processes

- In the context of today's complex, lengthy operations where people are the stake, the volume, structure and volatility of information entail highly intensive and difficult processes to make sense of it.
- In fusing in near real time ISR products, open data and social networks information, C2 operators will benefit from more accurate indicators and warnings (CCIRs), improve planning (Wargaming) and get a better insight of the effects they are creating (Assessment).
- Great enhancement of the risk management process, Commander's most critical challenge.



Mapping of key processes*

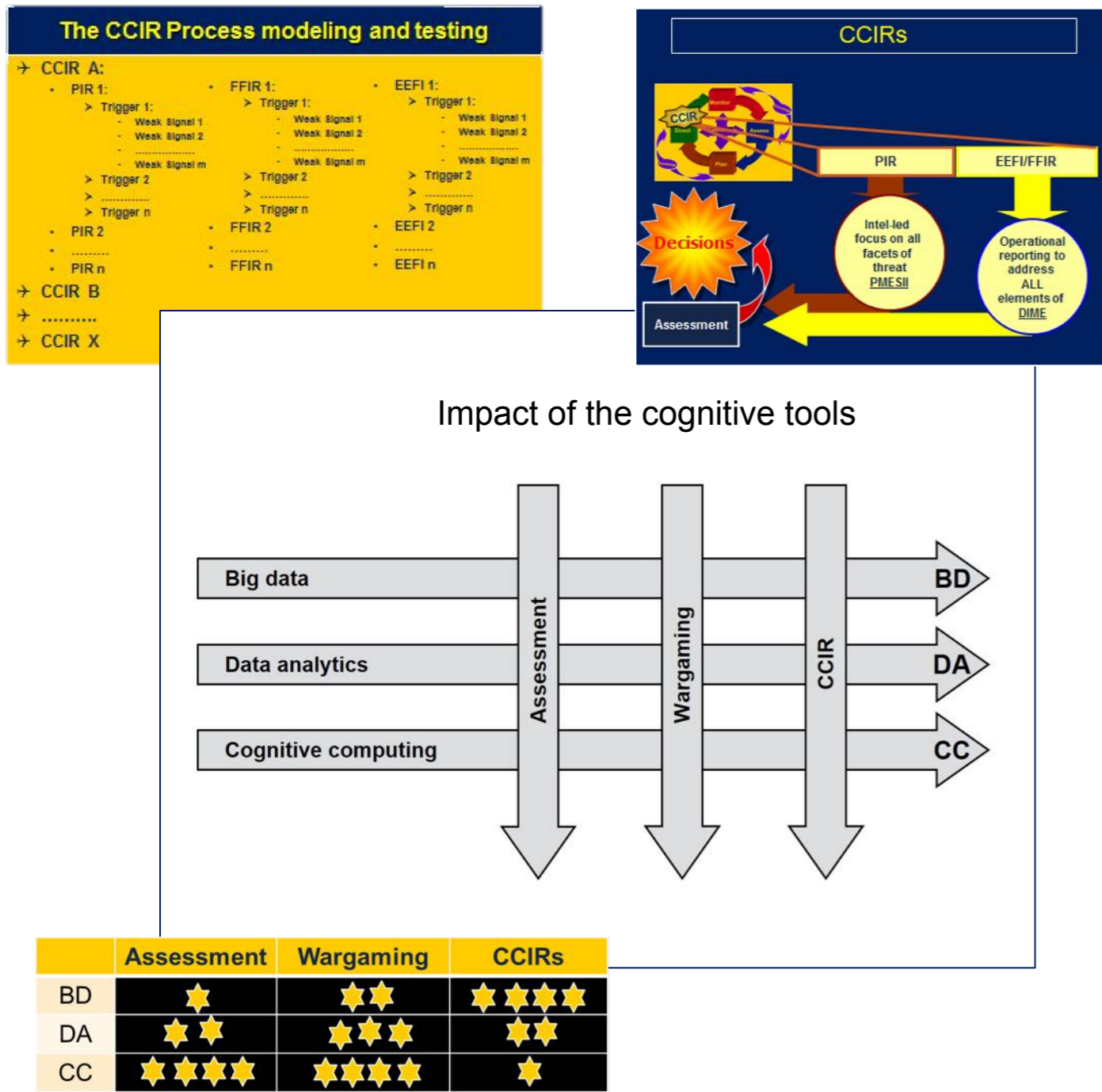


- The key identified processes are depicted in relation with their respective cognitive workload as well as their used data complexity.
- Cognitive Computing augment understanding of conflict dynamics, adversary CoAs and stimulate creativity in helping decision making.

- Big Data and Analytics help human in monitoring activities, handling of routine questions and developing predictive SA.
- These processes are the best kind of collaboration between humans and machine we will get, leading to Intelligence Augmentation.

In our cognitive based vision of C2, operational design and associated processes, once augmented, should remain the most important tools for the Commander to overcome complexity and lead a high quality strategy-to-task process.

Our project is made of three consecutive and related research programs

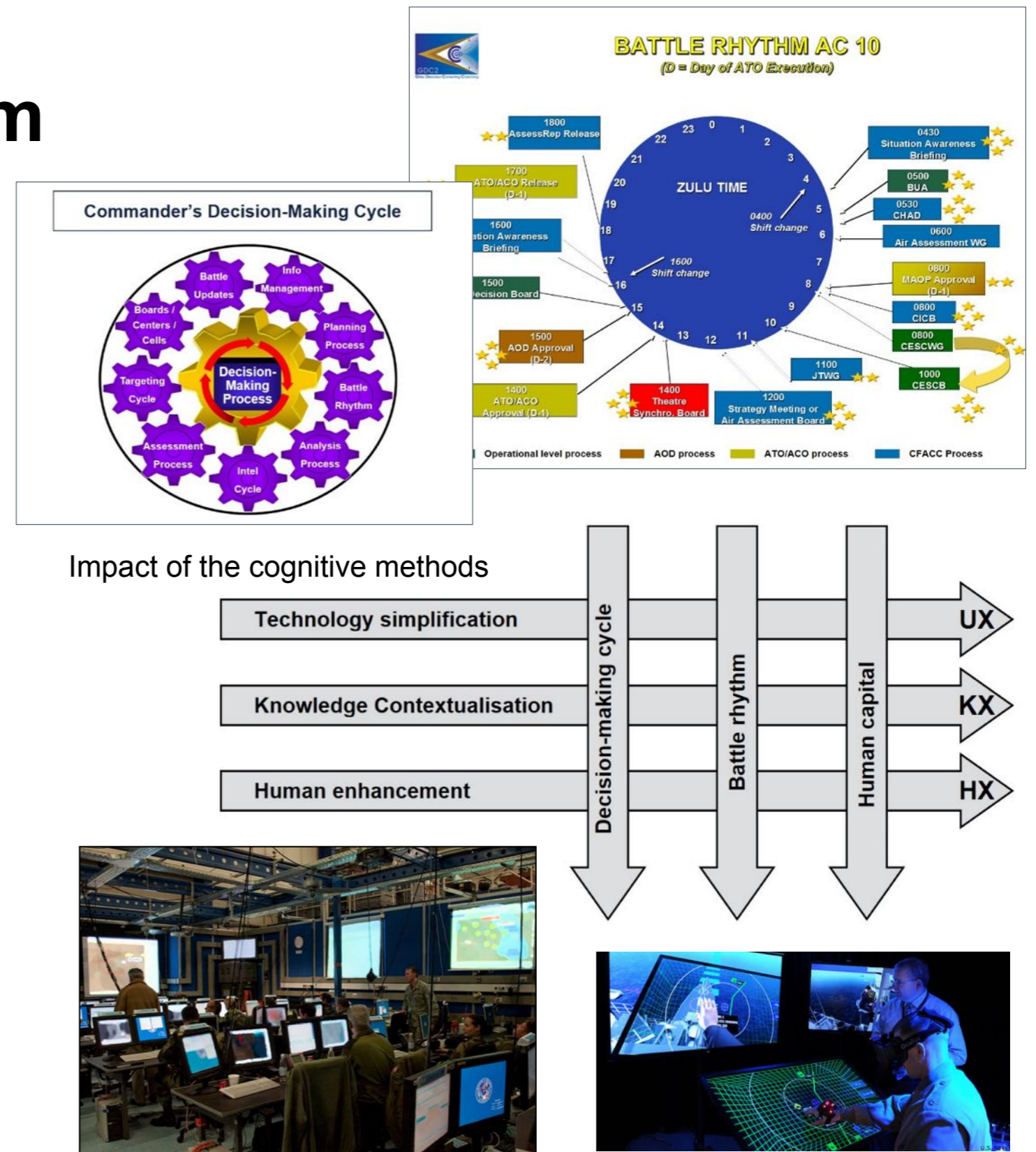


The first research program

- CCIRs, then Assessment and Wargaming will be examined through each of the cognitive tools.
- This program will be rooted in the collaboration between ENSC, Carnot Cognition (14 labs), ONERA Provence RC and CNRS Labri-Imb.

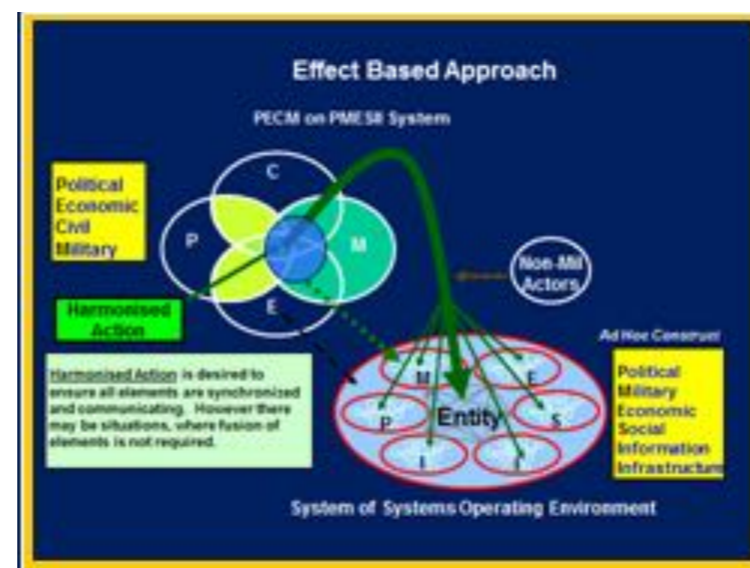
The second research program

- The implementation of our methods will largely impact decision-making cycle, organization, manning and training requirements for the personnel. This research program provides a first insight on these evolutions and their impact on efficiency, quality and speed of decisions, and C2 battle rhythm. Collaboration between ENSC, HEAL and some Carnot Human Engineering labs.



- We can expect having created a robust improvement in awareness and consciousness thanks to an integrated human and machine cognition. This will enhance integration of C2 HQ functions, and allow C2 approach space to evolve towards a more distributed C2.

A resulting research program



- After various experimentations and exercises, EBAO was progressively introduced in NATO but a few years later it was considered that the concept had not matured enough, was too mechanistic and was demanding the involvement of very large staff to assess effects.

- New technologies are likely to change this. These results could lead to a possible re-evaluation of the relevance of EBAO.

Experimentations will be conducted in cooperation with CASPOA CoE (Lyon)

Cognitive tools and our three dimensional methodology could generate the missing link towards EBAO implementation.