
# Commanding HQ Integrator Data supported strategic management

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## European Defence Challenge IV

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# 1 Abstract

Commanding HQ Integrator (CHI) aims to provide a data-driven solution to assist the armed forces in resource management and mission planning. It enables leaders and managers to interact with their assets and to gain useful insights into all levels of operations. In the decision process, CHI proposes solutions for the user to evaluate and to choose from. Providing data-driven solutions reduces the stress associated with the decision process and the risk of human error. However, the users maintain the responsibility to make ethical and sensible decisions. CHI can decide and act autonomously using a set of rules and models built on data. This data can be open-source data, but also internal data scattered across the organisation in different formats, lay-outs and languages. Using data-driven decision models comes with many technical challenges and also rises the topic of explainable and ethical artificial intelligence. This paper addresses the possibilities Commanding HQ Integrator offers as a data-driven application, as well as its challenges.

# 2 Introduction

The use of artificial intelligence in the collision avoidance system of a Tesla Model X could predict a car crash ahead and react even before the actual crash happened. [6] Even if there is a lot of data available, it is not always possible for humans to process and interpret it on time. Studies show that the influence of stress, which will always be present in military operational environments, has a significant impact on the decision making process. The use of force, the initial reactions and decisions will be affected by the stress level of a situation. [10].

Even tough many military leaders have demonstrated their ability to maintain a clear understanding of situations and make sound decisions, even in high-stress circumstances. This does not imply that these managers should not receive reinforcement from supplementary instruments, potentially affording them an alternative perspective on the prevailing circumstances.

Military organisations collect and process vast quantities of data relating to operations, logistics, personnel, and resource utilisation, employing advanced technologies and analytical tools. These data sets offer insights into complex operational dynamics, risk assessment, resource allocation, and strategic planning. This growing amount of data that is currently available in the military organisations is not yet used optimally.

The demanding and high-pressure contexts in which military leaders are required to effectively manage their troops and assets present significant challenges. Studies have shown that the decision making process can be very disturbed when there is a lack of sleep and a high stress level. [5] More than half of a test group (59%) consisting of military officer students fired their guns in a situation where the targets they were ordered to fire at with live ammunition suddenly turn out to be human beings and not humanoid dummies. Only one of the students had a good reaction and tried to warn the others to cease firing.

This paper starts with a description of the current status, the decision making process of military leaders will be discussed. An example of air defence shows how the integration of information from multiple platforms and systems can create a better situational awareness. Chapter 4 mentions how the issue of different data formats can be solved by using an integration layer. The use of reinforcement learning in order to create a model will be explained as well. Commanding HQ Integrator (CHI) is proposed in chapter 5 as a technical solution for the decision making support for managers.

# 3 Current situation

## 3.1 Relying on commander's skills

Military management involves a complex array of tasks and decision-making processes crucial for the effective functioning of armed forces. Decision-making within the military necessitates swift and precise choices, often under high-stress conditions, considering factors like enemy actions, terrain, and available resources. These decisions, whether strategic, tactical, or operational, profoundly impact mission success, troop safety, and the overall outcome of military endeavours. A balance between adaptability, comprehensive analysis, and adherence to established protocols is vital for effective military management and decision-making processes.

In the dynamic and high-stakes environment of the military, managers often find themselves faced with critical decisions that demand swift and independent action. The nature of military operations necessitates that managers possess the autonomy and decisiveness to make crucial choices on their own.

A fundamental principle in military decision-making is the concept of decentralised command. In this framework, managers are empowered to assess situations, analyse available information, and make decisions autonomously based on their training, experience, and understanding of the mission objectives. This approach ensures that decisions can be made rapidly and efficiently, even in the absence of direct supervision or guidance.

In operational theatres, time is a critical factor in decision-making. The hierarchical chain plays a pivotal role, enabling swift decision-making by leaders. Their ability to make rapid decisions ensures that each level of the command chain has enough time for efficient mission execution.

All of this results in a situation where the top management decisions have to be taken under high pressure with important time constraints. The military leaders don't have time to organise a meeting and listen to multiple ideas before taking a decision on how they would manage their assets. Being the one person that has to take all of the decisions with time constraints could make the leaders uncertain about their management. [3]

Offering commanders potential management solutions derived from a data-driven system can significantly aid their rapid decision-making. A technical tool that presents solutions to the manager can validate their choice and boost their confidence or introduce a fresh perspective for consideration.

## 3.2 Air Defence example: Enhanced situational awareness

Following the preceding section outlining the present state of top management decision-making in military contexts, this section will introduce an example of a data-driven decision-making environment. A primary duty of air forces is protecting national airspace boundaries through air defence measures. Situational awareness is paramount in air defence, as it provides a clear understanding of the airspace and potential threats within it. The ability to gather, process, and comprehend real-time information

about the aerial environment allows air defence units to make informed decisions swiftly and effectively. This awareness empowers them to detect, assess, and respond to any unauthorised or hostile aircraft, ensuring the safety and security of the airspace.

Figure 3.1 gives a visual overview of the basic air defence concept. The platforms from the navy and air force are able to communicate with a command and control system. For the air force in specific, a Command and Reporting Centre (CRC) organises the communication between pilots and air defence controllers. Command and control systems gather information from radars, use the information from the platforms and can include information from ground troops in order to create situational awareness for the air defence controllers, which can guide the pilots. Additionally, the command and control of surface-to-air missiles (SAM) can be organised with a command and control system.

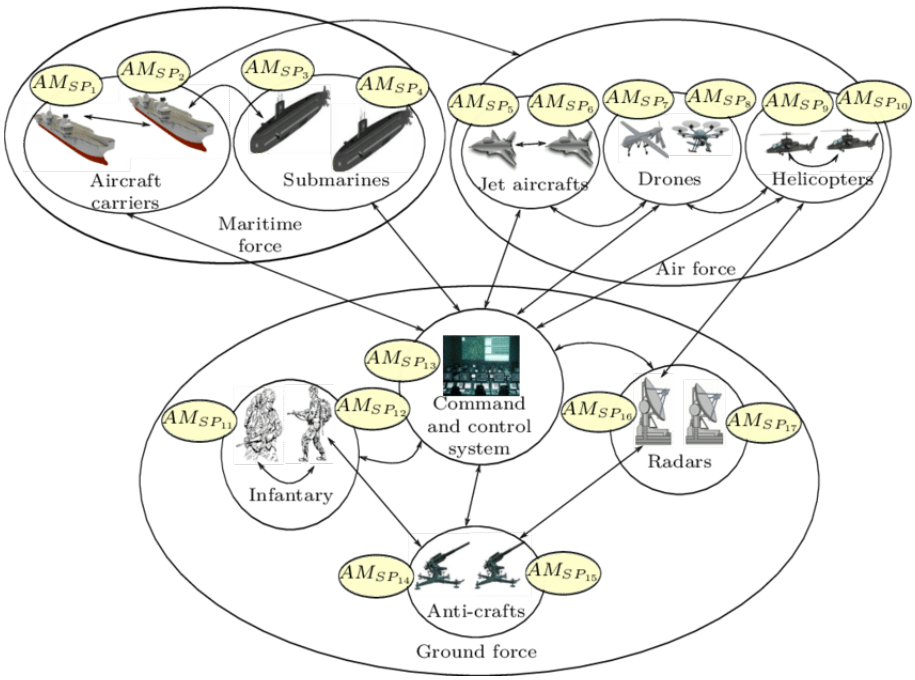


**Figure 3.1** Schematic overview of integrated air defence [4]

In order to combine all of these different data sources, the command and control system should be able to integrate and process multiple data formats, tactical data links in this case. The compatibility with different platforms has to make sure that for example a new aircraft type can be integrated in the system without additional modifications. Currently, tactical data links like Link 1 and Link 16 are respectively used for the sharing of flight tracks from the command and control system and the communication between aircrafts and a command and control system. [9]

The significance of interconnectivity among multiple systems continues to escalate in relevance. This interconnectedness not only accelerates the growth and learning of data-driven systems but also streamlines the integration of novel systems through shared data protocols. The lessons learned from the F-35 program in Italy emphasise the critical nature of integrating both on-board sensor data and diverse off-board data sources.[8] The aircraft has the capability to process various data sources and is also equipped to transmit this data to other systems.

# 4 Decision making support

This paper proposes a technical solution that can support military leaders in their management decisions. A decision support system should be able to process as much useful data as possible. In a next step, all of this data should be used to train a decision making support system.

## 4.1 Data integration

The military is currently using lots of different and independent systems that are processing and formatting data independently. It is impractical to expect nations to redesign the internal functioning of their systems, given the vast diversity of both legacy and new technologies in use within an army. Achieving compatibility among all these systems on such a broad scale is an infinite challenge.

However, other solutions are more realistic and can be implemented more easily in order to increase the compatibility of the variety of systems in the military. The concept of middleware in software development can be extrapolated to a similar solution for the data sharing and integration of the useful information for military management decisions. This concepts has been discussed in recent research [7]. The Integration Layer in figure 4.1 shows the common layer that can be used for interpretation by a data-driven decision making solution.

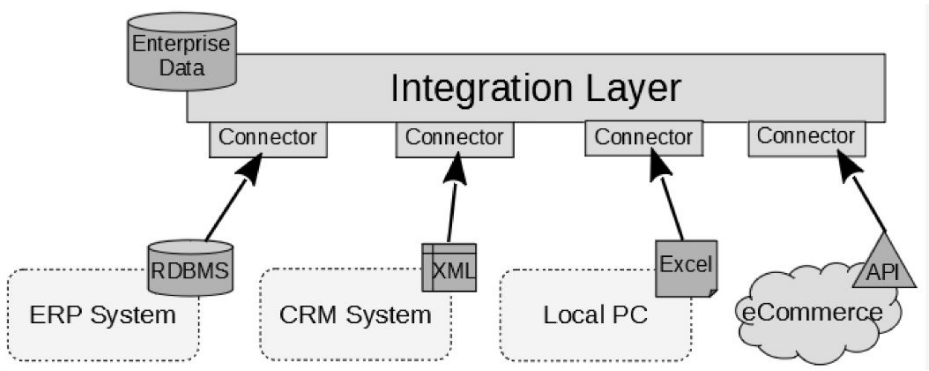


**Figure 4.1** Data integration layer [7]

Instead of requiring that all of the different systems use the same standardised data protocol, it is easier to implement an output of useful information in a common data format. The internal functioning of the system should not be changed, there should only be one connections that allows communication to the data-driven decision making system in a common data format.

## 4.2 Reinforcement Learning

Reinforcement learning represents a cutting-edge paradigm in artificial intelligence that mimics how humans and animals learn from interaction with their environment. Unlike traditional machine learning approaches that rely on extensive labelled data sets, Reinforcement learning empowers agents to learn by trial and error, making decisions to maximise a cumulative reward signal. It operates on the principle of exploration and exploitation, where agents explore various actions to discover optimal strategies while exploiting their existing knowledge. This dynamic learning framework has found

applications in diverse domains, from robotics and autonomous systems to game-playing agents and recommendation systems. Reinforcement learning's ability to adapt to evolving environments, tackle complex decision-making tasks, and master a wide range of applications has positioned it as a pivotal technology with the potential to revolutionise industries and transform how machines learn and interact with their surroundings. [2]

The conceptual overview of reinforcement learning is shown in figure 4.2. Unlike a rule-based programmed system, the only thing that is known for reinforcement learning is the desired end result. There are no hard coded reactions for possible situations. The model will try lots of different actions, which will result in different end states. The end state or the environment in the figure will probably not be the desired result after the first random try. The agent, for example a simulated aircraft that should reach a specified goal, will be able to observe the state of the system after an action. Good decisions by the model, which result in a state closer to the desired end state, will be rewarded.


**Figure 4.2** Reinforcement Learning: conceptual overview [1]

Reinforcement learning is a type of artificial intelligence where an agent learns to make decisions by interacting with an environment. This means that unlike other types of artificial intelligence, there is no need for lots of training data in order to create a model. Specifically for the use of a military decision making system, this means that existing simulators could be used for the training of the system. This could be in addition to provided data from operations or training exercises, but will certainly increase the amount of available training options for the decision making model.

# 5 Commanding HQ Integrator (CHI)

## 5.1 Technical proposal

Our technical solution for management support in the military will be discussed in this chapter: Commanding HQ Integrator (CHI). A data-driven decision making support system is proposed in order to help military leaders in their decision making process. As the time constraint for these decisions is of the essence, the model has to be trained in advance. The calculation time during the operations should be kept to a minimum.

Reinforcement learning is proposed for CHI. Military battle manager simulators that are currently used for training purposes are ideal for training the model for strategic management decisions. By setting up a connection between two or multiple existing simulators, these simulators can be used to train each other and try lots of scenarios without a human intervention.

The military is always organising exercises on every level. The first implementations of CHI can be integrated in these training and test activities, in order to let the system grow. The system can for example take the decisions for the opponents in the training scenario.

At first, the participating nations for the project have to create data outputs for their systems where they can export the useful information for the decision making. This goes from logistical process systems to the tactical weapon systems or command and control systems. The network where this data can be shared should have the same security classification as the highest classification present between the sources. Data diodes can be used in order to create a one way data stream and make sure that there is no leakage of information to a lower classified network. CHI will also be classified at the highest needed classification level. As the first implementation of CHI should be for the high level management decisions, the high ranked military leaders will be using the system from their head quarters (HQ). This static environment facilitates the installation of the classified system in a secure way.

A model for CHI has to be built from the available data and by using the existing simulators for reinforcement learning. The managers have to be included in a first filtering of the data that will be included in the model. They are the ones with the best knowledge of the frequency at which data has to be updated in the decision process. The location of ground forces or an aircraft has to be updated very often, but the amount of available resources in a warehouse will not change at the same frequency and can have some more delay in the system. The goal is to have sufficient information for the best management decisions, without creating an overflow in the system by repeating the same information.

## 5.2 Additional decision limitations

Management in the military concerns obviously not only the tactical decisions, which are specific for the military environment. CHI can easily implement a juridic set of rules in the decision making model. The goal is to create warnings when management decisions could lead to violations of civil and/or military laws. The reinforcement learning strategy can't be used for the integration of the legal aspect. Reinforcement learning doesn't use a set of rules, while laws allow less creativity concerning their interpretation. In this specific case, a type of artificial intelligence that can interpret the law texts and

can create a set of rules or make decisions based on these laws will give better results.

Of course, just like for the other management skills, the goal is not to take all of the knowledge from the leaders. CHI should be used as a support tool during the decision making process and warn the leaders when needed. As the use of artificial intelligence and data-driven decision making solutions are pretty new in the military, it is clear that current procedures will not be replaced immediately.

## 5.3 Implementation in military management

It's clear that CHI can't be implemented in one day, the implementation has to be done step by step. At first, internal meetings and meetings with multiple managers from the military industry have to be organised in order to discuss which existing systems can be integrated in CHI.

The second step should be concerning the integration layer (see chapter 4). Clear documentation should be provided to the different nations, which allows them to create a compatible output data stream from their systems. The different systems will have to be able to transmit data on the network of CHI. Courses and informational briefings for the technical staff will be necessary during this phase.

During the implementation of the data integration layer, the existing simulators can already be used for the training of models for the decision making process. The concept of reinforcement learning allows the reach the desired end state without having to program every possible method or situation. The existing simulators can be used to train each other, which reduces the dependency on large data sets for the training of the model.

Combining all of the different systems which will allow the creation of a data-driven decision making support system will be the third step. Without artificial intelligence, it would be impossible to combine and integrate all of the different systems in the military. For artificial intelligence, the amount of useful information can help to increase the quality of the decision making model. Currently, there is already a lot of information available in the military industry, but combining the information from these different systems and looking for links and interpretations with artificial intelligence can provide solutions which are impossible to find for a human.

Once there is a good first prototype of CHI, it has to be integrated in virtual training environments. Military leaders should be able to train with the system and explore the possibilities. Changing a well known way of working will take some time, but it allows the system to grow. The virtual training setups are important for the accreditation of CHI, Due to strict regulations in the industry, rules for change management should be followed before this new tool can be installed in an operational environment.

## 5.4 Practical use of CHI

Once CHI has been approved for use in an operational environment, an application of workstation can be installed in the command post of the military leaders. The final goal is that top management can make better decisions, based on all of the available data. The data was always available, but the centralisation and the processing of the information can be the key to success.

The military industry will depend more and more on modern technology, this technological revolution implies an increasing amount of information. The famous statement "Knowledge is power", often attributed to Francis Bacon, can certainly be applied to the military industry. The difference with the past is the large amount of information that is available. In order to have good knowledge, all of the

available data should be processed and interpreted.

The use of CHI will allow the managers to have a better overview of their operations while taking into account every aspect of the operation. From the logistical supply chain aspect to the tactical operations, everything can be included in order to have the best situational awareness as possible. CHI will reduce the stress level of the managers, because it provides a clear overview of the situation and can propose strategic solutions.

The combination of the military tactical aspect, the logistical systems, but also for example medical data bases and the civil and military law texts provides a complete overview of the situation. The ethical impact is very reduced, because the end decisions stay at the level of the military commander. Their decision making can go faster and with more confidence due to the data-driven decision making support system CHI.

## 5.5 Future research

This paper is limited to the conceptual overview of CHI, which is understandable for the bigger public and and political leaders. It should be seen as a first proposal for this new way of working and the technical solution for military management. After approvals, more detailed technical research should be organised in order to fully explore this proposed technical solution. A comparison between multiple options for the integration layer is an interesting start point. Afterwards, the creation of the decision model can be detailed.

# 6 Conclusion

This 10-pager provides a technical solution for management in a military environment. Commanding HQ Integrator (CHI) has been proposed as a data-driven decision making support system. A system that should support military managers in their decision making process. The military environment is very stressful, which makes the job of the military decision makers even harder. Certainly the time constraints and the fact that military commanders should make decisions which could cost lives were considered for this work.

The current situation of the military decision making process has been discussed. It is clear that a decision making support system can be very useful in order to boost the confidence of the military leaders and provide them with new solutions. The benefit of an augmented situational awareness by sharing information has been explained with the air defence example.

Compatibility is essential for the use of CHI, the system should be able to process all of the available data. An integration layer has been proposed, there all of the existing systems should create an additional output with the common data format, instead of changing their internal communication or protocols. The possibility to build a model that doesn't required hard coded rules, by the use of reinforcement learning has been explained. The goal is to use currently existing simulators and training software for this and let them train each other. This requires less data sets, or historical data.

The essence of this paper, the Commanding HQ Integrator (CHI), has been discussed. The data-driven decision making support system for military leaders will allow them to have a better overview of the operations. Every aspect from logistics to the tactical operations or the civil and military laws can be integrated in the system. Providing confirmation or new solutions will improve the management decisions, "Knowledge is power".

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