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The Information Asymmetry of Military Decision-Making. ISR and the Challenge of Situational Understanding

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Abstract

The commander's decision-making depends structurally on the quality of the information received, yet the explosion of data volumes generated by contemporary sensors has transformed this dependence into a reverse problem, that of abundance. This article argues that the classical architecture of the Intelligence, Surveillance and Reconnaissance (ISR) system is built predominantly to support the perception and comprehension of environmental elements, leaving the capacity for cognitive projection that quality decision-making requires insufficiently covered. Drawing on the cognitive decision-making models proposed by Klein, Boyd, and Endsley and on the distinction between situational awareness and situational understanding articulated by Yufik and Malhotra, the paper identifies a structural asymmetry between collection capabilities and projection capabilities, assessing within this framework the integration of artificial intelligence into the ISR decision chain. The article concludes that decisional superiority is achieved through the redesign of the architecture that functionally connects ISR to the cognitive act of decision-making, rather than through the mere accumulation of sensors or of data.

Keywords:
ISR; Decision-Making; Situational Awareness; Situational Understanding; Command and Control; Artificial Intelligence; Decision Superiority.

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Introduction

The commander's decision is the central element of military command, being "the bridge to translate the strategic vision into tangible actions". The quality of this act exceeds in the operational context the professional dimension, becoming "a matter of life and death". The history of military operations confirms this centrality: the quality of situation assessment and decisions made by commanders has consistently been associated with the success or failure of campaigns (D'Alessio, et al. 2024, 2-3).

The current operational reality amplifies the stakes of this dependence through speed, structural uncertainty, the multi-domain character of confrontation, and massive volumes of data generated by distributed sensors. The commander faces the challenge of transforming the abundance of data into an actionable decision within increasingly narrow time windows. Allied doctrine explicitly states that "ISR (Intelligence, Surveillance and Reconnaissance) exists to provide the right data to the right user at the right time to support decision-making, creation of effects and conducting operations" (Development, Concepts and Doctrine Centre 2023a, 5). In this understanding, ISR exceeds its traditional role as an auxiliary capability, becoming a fundamental infrastructure of the military decision-making process.

Yufik and Malhotra (2021, 1) raise the conceptual problem of the differences between what the commander needs and what is provided through ISR. Doctrine and the technological investments associated with it are built around the concept of situational awareness, defined as "immediate knowledge of the conditions of the operation". The commander, however, needs situational understanding, defined as "the product of analyzing and judging relevant information to determine relationships among mission variables, facilitating decision-making". The distinction is operational rather than terminological, because sensors provide answers to the questions *what?, where?,* and *when?*, while the decision rests on *what does it mean?, what comes next?* And *what are the implications?*. More data and more processing power do not automatically produce a better decision if the ISR-decision chain is built to maximize situational awareness rather than understanding.

This article seeks to show that the answer to this problem requires redesigning the architecture that connects ISR to decision-making, rather than expanding collection capabilities. The proliferation of sensors and ever-growing data volumes does not automatically produce a better decision when the structures of processing, analysis, and dissemination remain anchored in the logic of an era in which the dominant problem was information scarcity. The argument supports this position by examining military decision-making models, ISR doctrines, and the tensions generated by the integration of artificial intelligence into the ISR-decision chain.

This article is addressed primarily to the structures involved in the design and use of ISR capabilities, as well as to the decision-makers responsible for guiding investments in the modernization of these capabilities. The approach seeks to offer them a conceptual framework through which to assess not only the volume or the technical performance of collection systems, but also their actual contribution to the quality of the decision-making act.

Methodologically, the article rests on a conceptual analysis of the specialized, unclassified, and publicly available literature, articulating three distinct bodies of work: the cognitive models of decision-making, ISR doctrine, and recent research on the integration of artificial intelligence. The confrontation of these three perspectives allows the construction of a unified framework for interpreting the relationship between ISR and the decision-making act, a framework that the existing literature treats only in fragmented form.

The research also presents a number of limitations. The approach is theoretical and interpretive rather than empirical, resting on the analysis of sources rather than on original data. The argument relies predominantly on doctrine and literature from the Anglo-Saxon space, a fact explained by the maturity of the debate in that space, but one that leaves open the need for subsequent validation. The conclusions of the article are theoretical in nature and remain open to verification. They could be tested through case studies applied to recent operations, in which the relationship between ISR products and commanders' decisions can be traced concretely. Furthermore, their transposition to the context of the Romanian Armed Forces, with its particularities of structure and resources, constitutes a distinct research direction that the present article does not cover.

1. Anatomy of Military Decision-Making. Patterns, Tempo, and Situational Awareness

Understanding the relationship between ISR and the command act requires a prior examination of military decision-making as a cognitive process. The way in which the commander transforms information into action has been theorized in several stages, each bringing successive adjustments to the assumptions about the role of reason, experience, and time in combat decision-making. Reviewing these models allows the identification of the common element that this article will subsequently exploit, namely, the structural dependence of the decision on the quality of informational input.

The rationalist-analytical tradition treated decision-making as a four-step process: identifying the problem, generating options, evaluating them against predefined criteria, and choosing the optimal option. The model, with roots in neoclassical economics and expected utility theory (von Neumann and Morgenstern 1953), influenced military doctrine through procedures such as MDMP (Military Decision-Making Process). Its applicability in real combat conditions was, however, contested as early as the 1950s by Herbert Simon, who introduced the concept of

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bounded rationality. The commander does not have the time, complete information, or cognitive capacity to optimize, instead choosing the first option that exceeds a threshold of acceptability, a process Simon called "satisficing" (Simon 1955).

Simon's critique opened the way for naturalistic decision-making research, later developed by Gary Klein. Studying fire chiefs, military pilots, and police officers in real operating conditions, Klein found that experts do not compare options but recognize patterns. The Recognition-Primed Decision (RPD) model proposed by Klein describes a process in which accumulated experience builds a repertoire of situational prototypes, and the encounter with a new situation triggers the identification of the closest prototype and the activation of the associated course of action (Klein 2017, 24). Subsequent studies have confirmed that experienced officers resort to recognition-based strategies in 95% of decisions, of which 87% involve direct matching with a known prototype (Endsley 1995, 34). The military expert's decision is, from this perspective, an act of recognition, not of comparison.

On the ground opened by naturalistic research, John Boyd formulated the OODA model (Observe, Orient, Decide, Act) in the 1970s, transposing cognitive findings into a competitive framework. The loop describes four recursive phases through which an actor gathers data about the environment, interprets it through the filters of experience and culture, chooses a course of action, and executes it, thereby modifying the environment in which the next loop will operate (Boyd 2012). Boyd's conceptual contribution does not lie so much in the description of the phases, but in the observation that two forces in confrontation traverse decision-making loops at different speeds. The force that decides and acts more quickly penetrates the "inside" of the adversary's loop, forcing it to respond to a reality that has already changed. This advantage, called decision superiority, remains today one of the doctrinal pillars of military thinking. OODA articulates in operational terms what RPD describes cognitively, namely that decision-making, in a military context, is a process governed by tempo, and the commander wins by choosing a sufficiently good option sufficiently quickly, rather than a perfect option obtained through exhaustive analysis. Bollmann and Heltberg (2023, 155) observe that contemporary technologies, particularly artificial intelligence, are used precisely to accelerate the observation and orientation phases of the loop, compressing decision-making time and expanding situational awareness.

Naturalistic models of military decision-making, although different in purpose and level of analysis, converge on a structural observation. The quality of the decision depends directly on the quality of the information input that the commander receives. RPD presupposes a rich repertoire of patterns, but this repertoire is built through direct experience and through intelligence products that extend the commander's indirect experience. OODA presupposes an observation phase rapid and comprehensive enough to feed orientation. In both cases, the primary source of informational input in a military context is ISR.

RPD and OODA describe the mechanism of decision-making but leave open the question of the cognitive content the commander manipulates when recognizing patterns or traversing the decision-making loop. The most influential answer comes from the works of Mica Endsley, who in 1995 proposed the concept of situational awareness as an internal representation of the operational environment that the decision-maker continuously constructs and updates. The author defines situational awareness as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Endsley 1995, 36). The model organizes this representation into three hierarchical levels. Level 1, perception, involves detecting the status, attributes, and dynamics of the relevant elements in the environment, whether enemy forces, system parameters, or terrain features. Level 2, comprehension, goes beyond mere awareness of the elements present and involves "an understanding of the significance of those elements in light of pertinent operator goals", while Level 3, projection, represents the ability to anticipate the future actions of the elements in the environment and provides "the knowledge (and time) necessary to decide on the most favorable course of action to meet one's objectives" (Endsley 1995, 36-37).

Endsley's major conceptual contribution is the firm distinction between situational awareness, decision-making, and performance, treated as three separate constructs with different causal factors. "Even the best-trained decision makers will make the wrong decisions if they have inaccurate or incomplete SA. Conversely, a person who has perfect SA may still make the wrong decision [...] or show poor performance", the author shows (Endsley 1995, 36), emphasizing that this separation allows for the precise diagnosis of the source of failure in complex operations. Its applicability to the military context is direct, providing an analytical framework for locating decision-making vulnerabilities between the collection of information, its interpretation, and the anticipation of evolutions.

Recent empirical validation of the model in a military context comes from the study by Hærem et al. on multiteam systems engaging targets with limited time windows. The authors compared distributed and co-located configurations, measuring situational awareness at the three Endsley levels and correlating it with operational performance. The central result is telling. "Level 3 SA was the only SA level that significantly predicted all three performance dimensions – process performance, speed, and accuracy – while Level 2 SA correlated only with accuracy and Level 1 SA had no significant relation to performance" (2022, 7). The measured correlations confirm this pattern ($r = 0.58$ for process performance, $r = 0.41$ for speed, $r = 0.68$ for accuracy). In the distributed configuration, scores at Level 3 dropped to approximately 25%, a value equivalent to "random guessing", while in the co-located configuration, scores remained high, at an average of 72%. The co-located teams performed approximately 50% better and were 1.75 times faster than the distributed ones (Haerem, et al. 2022, 7-8).

From the ISR-decision perspective, the perception of raw data, however comprehensive, is not sufficient for a quality decision. Contextualized comprehension partially reduces the gap, but the true performance difference comes from the projection capacity, namely from the anticipation of the situation's evolution. Endsley shows that this capacity is the product of the mental models that experience builds over time, which "can largely circumvent these limits by providing for the integration and comprehension of information and the projection of future events (the higher levels of SA), even based on incomplete information and under uncertainty" (1995, 49). The expert commander does not decide better because he processes faster, but because his mental models allow him to reach Level 3, where the novice remains stuck at Levels 1 and 2.

This observation sets the agenda of the article. If quality decision-making depends structurally on Level 3 of situational awareness, then the informational infrastructure that feeds this level becomes the central stake. The examination of ISR as such shows that its doctrinal architecture is built predominantly to support Levels 1 and 2, and adapting to the requirements of cognitive projection constitutes the main challenge of operations.

2. ISR as Integrated Infrastructure. Definitions, Processes, and Recent Transformations

The term ISR covers a complex reality that has evolved significantly over the last two decades and that brings together activities, processes, capabilities, and organizations into an integrated system. The examination of this architecture in the present section will successively cover the doctrinal definition, its components, the TCPED (Task, Collect, Process, Exploit, Disseminate) operational process, the collection disciplines, and the recent transformations generated by commercial ISR and by the explosion of open sources.

American doctrine defines ISR as an activity that "synchronizes and integrates the planning and operation of sensors, assets, and processing, exploitation, and dissemination systems in direct support of current and future operations" (U.S. Army 2013, I-11). The updated U.S. Air Force doctrine complements this definition by stating that ISR operations "comprise the primary activities that feed data and information into the joint intelligence process" (U.S. Air Force 2025, 1). British doctrine offers the most comprehensive formulation, describing joint ISR as "an integrated intelligence and operations set of capabilities, which synchronises and integrates the planning and operations of all collection capabilities with the processing, exploitation, and dissemination of the resulting information in direct support of the planning, preparation, and execution of operations" (Development, Concepts and Doctrine Centre 2023a, 3).

Three observations emerge from these definitions. The first concerns the integrated character of ISR, which brings together under the same umbrella collection, processing, and dissemination, eliminating their treatment as separate functions. The second refers to the dual nature, simultaneously of operations and intelligence, with ISR belonging to both domains and being reducible to neither, while the third concerns its explicit orientation toward the direct support of operations, which unequivocally establishes the decision-making finality of the entire architecture. British doctrine synthesizes this finality by identifying three sets of primary ISR missions, namely the direct support of operations, support to the targeting process, and support to the intelligence cycle (Development, Concepts and Doctrine Centre 2023a, 8).

Although it operates as an integrated system, ISR retains in its doctrine important distinctions among the three components. Intelligence refers to all collection disciplines, the associated capabilities, and the products delivered to commanders. Surveillance refers to "the systematic observation across all operational domains, the information environment, and across the cognitive, physical, and virtual dimensions of places, persons, or objects by various means", while reconnaissance is regarded as "a mission to obtain, by visual observation or other detection methods, information about adversary activities and resources, or data concerning the meteorological, hydrographical, or geographic characteristics of an area" (Development, Concepts and Doctrine Centre 2023a, 3-4) (Development, Concepts and Doctrine Centre 2023b, 176, 179, 180). The functional relationship among the three components is hierarchical. Surveillance and reconnaissance activities produce data and information, which are then transformed into proper intelligence products through the intelligence cycle. ISR is, in this logic, an activity subordinated to intelligence, conducting the collection of the data needed to satisfy intelligence requirements (U.S. Air Force 2025, 2).
The operational core of ISR is the TCPED process. The five phases represent the model through which ISR capabilities are directed and operated in order to achieve the outcomes desired by the commander (Development, Concepts and Doctrine Centre 2023b, 86).

The tasking phase involves receiving external direction and the planning, resourcing, and internal allocation of ISR capabilities in relation to the expected outcomes, including the validation and prioritization of ISR requirements (Development, Concepts and Doctrine Centre 2023a, 5). Collection represents the acquisition of information through ISR means, whether technical sensors or human sources, with the aim of delivering raw data (U.S. Air Force 2025, 18). Processing translates raw data into a format usable for subsequent exploitation, storage, or dissemination, and can be carried out by human operators or by technological processes, depending on the nature of the data (Development, Concepts and Doctrine Centre 2023b, 87). Exploitation involves the examination of data in order to derive and attribute value, through entity extraction (detection, recognition, classification, identification) and through contextual analysis that adds knowledge and experience to observations. The final step, dissemination, ensures access to the resulting data, information, and intelligence products, either in near real time or sequentially, following rigorous processing and exploitation (Development, Concepts and Doctrine Centre 2023a, 5). The fundamental doctrinal observation regarding TCPED is that, in the context of modern ISR, these processes "are not linear or circular, being dynamically employed depending on the required outcome, and can be used sequentially, concurrently, or independently" (Development, Concepts and Doctrine Centre 2023a, 4).

ISR has undergone a structural transformation in the last two decades, moving from a fragmented, platform-centric approach to an integrated capability. British doctrine observes that "technological advancements have blurred the lines between operational domains, with ISR capabilities in one domain now able to support others simultaneously". Access to information is shifting from a hierarchical, top-down model toward an access-based model, in which information flows freely across all levels of command (Development, Concepts and Doctrine Centre 2023a, 9). Hoehn and Smagh describe this transformation as a shift "from a manpower-intensive force optimized for permissive environments to an automation-intensive force capable of defeating peer adversaries in highly contested environments" (Hoehn and Smagh 2020, 2).

One of the most significant developments is the growing importance of commercial ISR capabilities. British doctrine acknowledges that these capabilities, whether government-owned and contractor-operated or contractor-owned and contractor-operated, "can sometimes exceed those of military and government sources, particularly in space-based collection and the PED of publicly available information" (Development, Concepts and Doctrine Centre 2023a, 40). These capabilities are subject to the same tasking mechanisms as military ISR, but may have contractual, political, or legal constraints specific to each provider.

The emergence of OSINT as a major discipline represents probably the most disruptive recent evolution. British doctrine explicitly states that ISR, "traditionally reliant on specialized military platforms, is now seeing publicly available information vastly exceed defense sources in volume and variety", including data from social media, smart devices, the internet, and urban sensors (Development, Concepts and Doctrine Centre 2023a, 40). With the increasingly widespread global use of social media, publicly available information has become "a vital source of battlespace information, offering insights into adversary intent, capability, and operational execution" (Hoehn and Smagh 2020, 16).

The doctrinal response to these transformations is reflected in concepts such as Joint All-Domain Operations (JADO) and Joint All-Domain Command and Control (JADC2). The U.S. Department of Defense aims to "connect ISR sensors across all warfighting domains (space, air, land, sea, and cyber) directly with commanders and weapon systems, accelerating data sharing to enable U.S. and allied forces to outthink, outpace, and outmaneuver adversaries" (Hoehn and Smagh 2020, 2). This reconfiguration represents an abandonment of ISR operations organized by service and a shift toward integrated multi-domain capabilities, in which "the right data is available to the right actors at the right time to focus on delivering effects" (Bollmann and Heltberg 2023, 156).

ISR relies on several collection disciplines, known generically in international literature as INTs. These include Human Intelligence (HUMINT), Signals Intelligence (SIGINT), Imagery Intelligence (IMINT), Geospatial Intelligence (GEOINT), Measurement and Signature Intelligence (MASINT), Open-Source Intelligence (OSINT), Technical Intelligence (TECHINT), Cyber Intelligence (CYBINT), and Acoustic Intelligence (ACINT) (Development, Concepts and Doctrine Centre 2023b, 77-81). Recent doctrine emphasizes multi-INT operations and all-source fusion, recognizing that "no single sensing type provides a complete solution and individual sensor observations reveal their true value when collated, correlated, and analyzed together" (Development, Concepts and Doctrine Centre 2023a, 56). Fusion, defined as "the blending of intelligence, information, and data from multiple sources or agencies into a coherent picture where the origin of individual items is no longer apparent" (Development, Concepts and Doctrine Centre 2023b, 28), goes beyond simple correlation and adds context, insight, and foresight. Doctrine acknowledges, however, that the traditional linear fusion model has limitations at the operational and higher tactical levels, being insufficiently adapted to fleeting targets and to "unknown unknowns" type uncertainties (Development, Concepts and Doctrine Centre 2023a, 56).

The transformation of ISR, however, exceeds the technological dimension. The concept of problem-centric ISR "changes linear intelligence processes and the practice of undertaking processing, exploitation, and dissemination within disciplinary channels by adopting greater mission command within the ISR enterprise". This type of organization "task organizes resources around the operational outcome required, combining analysis, PED, and collection against specific operational problems" (Development, Concepts and Doctrine Centre 2023a, 65). The conceptual evolution reflects a doctrinal awareness in which the classical ISR architecture, organized by disciplines and platforms, is insufficiently adapted to the rhythm and complexity of current operations.

3. The ISR-Decision Chain. Situational Awareness as Cognitive Articulation

The previous chapters have established, separately, that quality military decision-making depends on the commander's capacity to anticipate the evolution of the situation and that ISR represents an integrated architecture for the collection, processing, and dissemination of operational data. The articulation of ISR functions with the three levels of the Endsley model allows for a precise analysis of the contribution of each phase of the TCPED process and, at the same time, the identification of its conceptual limits. Sensors and collection platforms feed Level 1, providing the raw perceptual input, whether imagery, electromagnetic, human, or geospatial. Processing and exploitation operate partially at Level 2, transforming raw data into contextualized understanding through entity extraction and sensor fusion. Level 3 of situational awareness, namely cognitive projection, however, exceeds the proper perimeter of ISR. Intelligence estimates, the anticipation of enemy courses of action, and anticipative products are outputs of the intelligence cycle and of human analytical judgment that intervene after the dissemination phase of TCPED. This observation fixes the conceptual limit of ISR as infrastructure. ISR can support the commander's decision only up to the level of comprehension. Projection, essential for quality decision-making, presupposes cognitive processes distinct from the technological ones of collection and processing.

The central argument of this chapter starts from the observation that the classical ISR architecture is built predominantly to support Levels 1 and 2 of situational awareness, while quality decision-making depends structurally on Level 3. The study by Hærem et al. has empirically demonstrated this asymmetry, identifying Level 3 as the only significant predictor for all dimensions of operational performance (Haerem, et al. 2022, 7). The implication is that massive investments in collection capabilities produce diminishing decisional returns if they are not accompanied by proportional investments in the capacity for cognitive projection, whether human or technologically augmented.

This asymmetry is implicitly recognized by operational practice as well. Hoehn and Smagh observe that the purpose of ISR is to "inform commanders to enable decision-making, support military planning by anticipating adversary actions and defining the operational environment, warn friendly forces of threats, support deceptive techniques and counter adversary deception, identify adversary vulnerabilities [...] and assess combat effectiveness" (2020, 3-4). The list attributes to ISR functions that go far beyond the simple provision of data, entering firmly into the territory of Level 3 of situational awareness. Nevertheless, the capacity to deliver this anticipatory value remains dependent on the quality of the human analysis that intervenes between raw data and the final product.

Yufik and Malhotra synthesize this tension through the distinction they operate between situational awareness, defined as "immediate knowledge of the operation's conditions, geographically constrained in time, essentially, knowing what is currently happening around Soldiers", and situational understanding, defined as "the product of analyzing and judging relevant information to determine relationships among mission variables, facilitating decision-making" and which "enables commanders to understand the implications of current events and forecast future occurrences" (2021, 1). Current collection systems efficiently produce the first type of output. Producing the second remains a structural problem, since it presupposes cognitive capacities for constructing relationships and for mental simulation that the classical ISR architecture does not address directly.

In classical architecture, the ISR-decision flow follows a linear sequence. The commander issues intelligence requirements through planning documents, intelligence structures task ISR capabilities, the collected data is processed and exploited at the discipline level, and is subsequently disseminated to the intelligence cycle or directly to specific recipients. ISR products that enter the intelligence cycle are fused and analyzed and are then disseminated to decision-makers. The model presupposes a separation between collection operations and the analytical process, between raw data and the intelligence product, between the collection phase and the exploitation phase. Hoehn and Smagh (2020, 4) describe the mechanism in explicitly decisional terms: "analysts then derive meaning from information, resulting in intelligence and generating a picture of adversary activity that answers the commander's information needs and ultimately drives decision-making."

The advantages of the classical model are verifiability and analytical quality. Filtering raw data through the disciplines, multi-source fusion, and contextualized human analysis reduces the risk of interpretive error, adversarial deception, and information noise. The disadvantage is speed. The process described consumes hours, days, sometimes weeks, depending on the complexity of the requirement and on the workload of the analytical structures. In operational environments with large time windows, the model works adequately. In contemporary operations, marked by fleeting targets and compressed decisional rhythms, the model becomes insufficient.

The doctrinal response to the limits of the classical model consists of the compression of the ISR decision chain. British doctrine explicitly states that ISR "can directly support operations by providing real-time monitoring and direct passage of situational awareness and force protection information to a commander or other force elements" (Development, Concepts and Doctrine Centre 2023a, 5-6). This formulation amounts to a redefinition of the relationship between ISR and the intelligence cycle, with ISR being doctrinally authorized to deliver directly operational products without mandatory passage through the complete analytical filter. The concepts that formalize this compression are "sensor-to-shooter" and the F3EAD cycle (Find-Fix-Finish-Exploit-Analyze-Disseminate) from the targeting process. Both describe flows in which ISR products reach the decision-maker unmediated or directly trigger kinetic actions, particularly in counter-terrorism and counter-insurgency operations. The exploitation and analysis phases are displaced after the action, feeding the classical intelligence cycle retrospectively for the planning of future missions.

The gain in speed, however, comes with a structural cost. Hoehn and Smagh (2020, 5) identify the declared objective of the U.S. military as the conduct of the ISR process at "machine speed, an accelerated pace achieved by employing artificial intelligence and cloud computing", capable of compressing the cycle to "seconds to single-digit minutes, enabling U.S. and allied forces to outthink, outpace, and outmaneuver its adversary on the battlefield". Achieving this objective, however, presupposes the transfer of certain analytical functions from human operators to automated systems, which raises the problem of verification and of trust in algorithmically processed ISR products.

Bollmann și Heltberg (2023, 9) synthesize this tension through the observation that the abundance of data and the ever-increasing speed of the decision cycle can produce "information overload and information over-reliance", leading to "inertia and paralysis of action" and leaving decision superiority in the adversary's favor. The compression of the ISR-decision chain does not, therefore, solve the fundamental problem of the articulation between data and decision. It reformulates it at a higher speed, shifting the question from the temporal plane to the qualitative one. Who validates ISR products processed at machine speed, and what mechanisms ensure that speed does not compromise the quality of the cognitive projection that decision-making requires?

The synthesis of this chapter leads to a conclusion with direct implications for the orientation of investments in ISR capabilities. Situational awareness as a bridge between ISR and decision-making is not an automatic product of the volume of data collected, but the result of an architecture that functionally links the sensors to the cognitive capacity of the decision-maker. This architecture has three simultaneous components: a collection component, which feeds Level 1; a processing and fusion component, which builds Level 2; and an anticipation and projection component, which sustains Level 3. The weakening of any of the three components compromises the quality of the decision, regardless of the robustness of the others. At present, operations disproportionately stress the projection component through temporal pressure and through the volume of data. The doctrinal response through chain compression addresses speed, but leaves open the question of how situational understanding is built under conditions of automated processing.

Artificial Intelligence and the Limit of Understanding. Augmentation or Substitution?

Collection capabilities produce ever-growing volumes of data, feeding Levels 1 and 2 of situational awareness, while the capacity for cognitive projection, essential for quality decision-making, remains limited by human cognitive constraints. Artificial intelligence (AI) is proposed in the literature and in doctrine as a response to this asymmetry. Examining this proposal, however, requires a nuanced approach that avoids both technological enthusiasm and reflexive rejection, identifying with precision what AI can and cannot do in the ISR-decision chain.

The most telling indicator of the problem that AI seeks to solve is the distribution of intelligence analysts' time. Hoehn and Smagh point out that analysts spend approximately 80% of their time searching for data and only 20% interpreting it, a ratio that exactly inverts the priorities that the process should serve (2020, 16).

The cause is structural. The volume of collected data far exceeds human processing capacity, and the classical TCPED architecture treats each disciplinary flow separately, fragmenting the analytical effort. AI and machine learning are the technologies that promise to automate the search and filtering phase, freeing the analyst's cognitive capacity for the comprehension and projection phases.

This promise is also explicitly reflected in British doctrine, which states that "automation, artificial intelligence (AI), and machine learning (ML) are increasingly central to ISR, particularly in processing, exploitation, and dissemination (PED), due to the finite capacity of human analysts". The technology can offer "speed, concurrency, scalability, and accuracy advantages over humans in processing and analyzing vast and diverse datasets" (Development, Concepts and Doctrine Centre 2023a, 73). Meerveld and Lindelauf (2025, 106) describe the role of AI as that of an "oracle-like adviser", capable of mitigating information overload and analyst fatigue, supporting in particular the observation and orientation phases of the OODA loop.

The application of AI in ISR has moved beyond the experimental phase, with several operational programs of the U.S. military illustrating the current technological maturity. Project Maven, launched in 2017, develops computer vision algorithms for the characterization and identification of targets from video footage and imagery (Pellerin 2017). Minotaur, developed by Johns Hopkins Applied Physics Laboratory, is an automated intelligence correlation processor that analyzes data from multiple sensors and enables rapid filtering and prioritization (Koscak 2022). TITAN (Tactical Intelligence Targeting Access Node) is an AI/ML-assisted mobile intelligence processing station, designed for the rapid dissemination of intelligence products directly exploitable for targeting (Palantir n.d.).

The empirical results of applying AI to aerial situational awareness are telling. Li et al. present a unified architecture based on graph neural networks and computer vision for the automatic recognition of aerial swarm configurations. The system achieves an accuracy of over 90.1% in the recognition and partitioning of aerial formations, over 85% in tactical scenarios with irregular flight intervals, and over 80.4% even under significant disturbances of position and heading (Li, et al. 2025, 1). The system operates at a latency of milliseconds, with a throughput of approximately 30 frames per second (2025, 13). These values translate the declared objective of "machine speed" into concrete performance, demonstrating that AI can perform recognition and classification tasks at speeds and volumes incompatible with human processing. The aggregate effect on analytical capacity is equally significant. Hoehn and Smagh (2020, 34) estimate that AI-assisted tools can enable analysts to process two to three times as much data within the same timeframe. This gain is not, however, a simple multiplication of existing capacity, but a qualitative redistribution of analytical effort from search and filtering toward interpretation and anticipation.

The application of AI in ISR can be mapped onto the Endsley model, which allows for a precise evaluation of its contribution to the commander's decision-making. At Level 1, AI extends perceptual coverage, automating the detection and classification of objects in volumes of data that the human operator could not parse. At Level 2, horizontal multi-source fusion systems and automated correlation systems build integrated contextual images, going beyond the limits of classical disciplinary channels. The real challenge appears at Level 3, where AI has to support cognitive projection, namely the anticipation of the situation's evolution and the understanding of the implications for decision-making.

Yufik and Malhotra propose the concept of the "gnostron", a theoretical architecture based on virtual associative networks and active inference, which seeks to confer on the technology the capacity for situational understanding, defined as the formation of mental models that approximate human comprehension. The difference from the classical paradigm of machine learning is structural. "Conventional AI and cognitivist psychology have focused on learning and reasoning while being *fanatically uninterested* in the role of understanding", the authors observe, adding that current machine learning systems "are capable of detecting and identifying objects, but are limited in apprehending relations and explaining their decisions". A proof-of-concept demonstrator for target recognition showed a reduction in complexity of nearly two orders of magnitude, while preserving an acceptable error amplitude (2021, 8,16). These results suggest that moving beyond Level 2 toward Level 3 is technologically possible, but requires a conceptual reconfiguration of AI that treats understanding as an objective distinct from detection and classification.

The integration of AI into the ISR-decision chain also raises a series of risks that the literature treats seriously. One of these is algorithmic opacity. Yufik and Malhotra (2021, 20) synthesize the black box problem, stating that neural networks with millions or billions of parameters make it impossible to fully understand the mode of operation, and the responses to all possible inputs remain unknown. This opacity creates a justified reluctance in delegating critical decisions to AI, particularly in situations where errors, such as the misidentification of an aircraft, can have catastrophic consequences. Bollmann and Heltberg (2023, 156) confirm that trust in AI for decision-making remains problematic due to the difficulty of justification and of compliance with ethical and legal perspectives, especially in the case of self-learning algorithms.

Another category of risks concerns the cognitive rigidity of automated systems. Yufik and Malhotra (2021, 6) draw attention to the phenomenon of "pathological tunnel vision", in which mental models, whether human or technological, shaped by experience, can consolidate interpretive rigidities. Historical military errors are often the consequence of judgments confined within flawed templates. The transfer of these templates into AI does not solve the problem, but automates it at a higher speed and with a higher degree of institutional trust in the output.

A third category of risks concerns the organizational and cognitive effects of direct access to data for all levels of command. Bollmann and Heltberg (2023, 160) identify the temptation of micromanagement, through which strategic leaders with access to real-time imagery intervene in tactical decisions, undermining subordinate initiative and the principle of mission command. At the same time, abundant access to data can paradoxically produce a cognitive distance from the battlefield, particularly when tactical decision-makers do not possess the technological knowledge to understand the limits of the tools they use. Vasile (2026, 21) describes this tension at the strategic scale through the concept of a "battlefield singularity", in which the volume and speed of information generated by AI exceed the capacity of human commanders to understand it in context. Meerveld and Lindelauf (2025, 111) warn that these risks are insufficiently addressed in the formal science literature, being treated predominantly by the social sciences, which produces a disciplinary asymmetry in the understanding of the phenomenon.

AI does not solve, in its current form, the fundamental problem of the articulation between data and decision. Automated detection and classification systems extend processing capacity at Levels 1 and 2 of situational awareness, but leave open the question of the cognitive projection required at Level 3. The research directions represented by the "gnostron" suggest that overcoming this limit is possible, but implies a conceptual reconfiguration of AI that integrates understanding as a distinct objective. The short-term operational answer lies in hybrid human-machine architectures, in which AI augments the capacity of analysts and commanders without substituting their judgment. Yufik and Malhotra (2021, 21) describe this aspiration as a "shared situational understanding" between human and machine, capable of amplifying the human grasp of the situation, increasing trust, and reducing costly errors through substantive-level interaction rather than through the sharing of computational details. Such an architecture presupposes that the human remains the final decision-maker, while AI functions as an instrument of cognitive extension, not as an autonomous arbiter of the decision. This requirement is, at the same time, the condition of the legal and ethical compatibility of AI integration into military operations, particularly with regard to the use of lethal force.

Conclusions

The commander's decision remains, despite all technological transformations, an essentially human act, in which responsibility is indivisible, and the consequences are measured in lives. Everything discussed in the previous pages gravitates around this fundamental observation. No quantity of data, no speed of processing, no algorithmic accuracy absolves the commander from the burden of deciding and of being accountable for the decision made. This reality sets the stakes of the article and, at the same time, the limits of any reflection about ISR.

The argument built throughout this work has sought to show that decision superiority is not born from the abundance of information, but from the capacity to transform that information into understanding. The cognitive models of decision-making, from Klein's pattern recognition to Boyd's competitive loop and to Endsley's situational awareness, converge on the same observation. The commander wins when he/she correctly projects the evolution of the situation, and this projection is the product of a cognitive architecture that experience builds over time, and that only quality information input can feed. ISR is, in this logic, the infrastructure that makes projection possible. Without ISR, the commander decides in a vacuum. With a poorly calibrated ISR process, he/she decides on the basis of an incomplete or distorted image of reality. With an ISR well-articulated with the cognitive process of decision-making, he has the chance, but not the guarantee, of a good decision.

The asymmetry identified in this article lies precisely here. Massive investments in collection capabilities have produced an architecture capable of flooding with data, but incapable, by its very construction, of systematically producing situational understanding. Sensors answer questions about what is seen, where, and when. The decision, however, rests on questions about what it means, what comes next, and what its implications are. The distance between the two sets of questions is not bridged by more sensors, but rather by a reconfiguration of the entire ISR-decision chain, in which processing, fusion, and anticipation gain the same importance as collection. Artificial intelligence offers powerful tools for this reconfiguration, but it does not realize it automatically. It can extend perception and comprehension, accelerate multi-source fusion, and thin the data volume for the analyst. Situational understanding, in the proper sense of the term, remains, however, a cognitive competence that is not, for the moment, solved by algorithms.

The modernization of ISR in allied armed forces, including in the Romanian Armed Forces, must not be a race to acquire more sensors or to integrate more platforms. It must be a process of redesigning the relationship between human and technology, between collection and analysis, between data and decision. The wisest investments will be those that reduce the gap between Level 1 of situational awareness, excessively fed by sensors, and Level 3, undernourished by projection capacities. These investments are less spectacular than the acquisition of a drone or a satellite system, but more consistent with the commander's real need. They encompass the training of analysts, the development of fusion tools, the integration of AI as a cognitive assistant, and, above all, the cultivation of that intangible competence called "digital coup d'œil", the commander's capacity to discern meaning in the midst of abundance.

How is a hybrid human-machine architecture practically built, in which the commander remains the decision-maker, but AI systematically augments his projection capacity? What are the institutional mechanisms that can guarantee that the speed of the technology does not turn into decisional precipitation, and that algorithmic opacity does not erode the individual responsibility of the commander?

How do these requirements translate into national doctrine and into officer training programs? The answers to these questions will not come solely from the specialized literature, but will require a sustained conversation between those who build the capabilities, those who use them, and those who reflect on their strategic and ethical implications.

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DECLARATION OF CONFLICTING INTERESTS

The author declares that there are no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

DECLARATION ON THE USE OF AI

Claude Opus 4.7 was used to improve readability and language, as well as to assist with the translation of the article into English. After using this tool, the author reviewed and edited the text as necessary and takes full responsibility for the content of the article.