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A Framework for Adaptive Human-AI Teaming in Military Contexts

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Abstract

Artificial intelligence (AI) is enhancing military planning by expanding computational capacity, accelerating information synthesis, and strengthening decision support across complex operational environments. As multidomain operations, persistent sensing, and compressed decision timelines continue to shape the future battlespace, the effective integration of AI will depend upon structured approaches that align computational capability with commander intent, human judgment, and accountable command. Existing doctrine establishes the importance of meaningful human control while encouraging AI-enabled decision support; the present work advances those principles by providing a practical framework for adaptive human-AI collaboration throughout military planning. Herein, we operationalize Synthesized Command and Control (SYNTHComm) within the U.S. Army's Military Decision-Making Process (MDMP) by defining complementary roles for commanders, staffs, and AI-enabled systems across each stage of planning; an adaptive autonomy function is introduced that calibrates human-AI collaboration according to mission complexity, temporal compression, and information uncertainty while preserving commander authority, accountability, and operational judgment. SYNTHComm conceptualizes command as a governed cognitive enterprise in which computational cognition and human reasoning function as complementary capabilities that enhance planning, adaptability, and decision quality. The framework contributes a scalable, doctrinally compatible model for integrating AI into military planning and command and control, advancing human-AI teaming, adaptive autonomy, and cognitive governance in support of future multidomain operations. Although this article applies SYNTHComm to the MDMP as a representative planning framework, the governance principles advanced herein are intentionally designed to be extensible across joint command-and-control architectures, AI-enabled decision-support systems, and future human-AI operational environments. In this way, SYNTHComm functions as a governance framework for AI-enabled command and control and military decision-making, rather than merely a systematized process for employment of autonomous weapons. We view its primary application to be the allocation and governance of AI-enabled decision support throughout the MDMP, where AI augments planning, intelligence fusion, course-of-action development, operational assessment, and staff decision support, while all the while preserving commander authority. So, although governance principles presented herein may be employed or adapted to inform future autonomous capabilities, SYNTHComm does not assign autonomous lethal decision authority per se, and thus should be understood and regarded as a command governance architecture.

Keywords

Artificial Intelligence, Command and Control, Military Decision-Making Process, Human-AI Teaming, SYNTHComm, Adaptive Autonomy, Cognitive Governance, Decision Superiority, Multidomain Operations, Military Planning

1. Introduction

The contemporary operational environment has exceeded doctrinal assumptions that underpin military command and control (C2) [1]. Existing command architectures were designed for an operating environment characterized by constrained information flows, sequential decision processes, and deliberate human analysis. That environment no longer exists given that persistent sensing, ubiquitous connectivity, and exponential data generation have replaced information scarcity with information saturation. Advances in intelligence, surveillance, and reconnaissance (ISR), integrated communications, artificial intelligence (AI), and multidomain operations have accelerated the speed, scale, and complexity of military operations. Commanders now operate within an environment defined by persistent multidomain sensing, continuous data generation, denied, degraded, intermittent, and limited (DDIL) communications, and increasingly compressed decision cycles. The resulting gap between available information and human cognitive ability to synthesize operational understanding has imposed a decisive challenge and defined limitation upon current capabilities of command [2].

In attempt to bridge this gap, military organizations are increasingly employing AI to extend analytical capacity and accelerate processes. Contemporary AI-enabled systems aggregate and fuse data, generate predictive assessments, identify patterns, and produce recommendations at speeds unattainable through human analysis alone [3]. While such attributes offer substantial operational advantages, particularly within contested environments where decision superiority determines strategic outcomes, integrating AI into C2 systems also introduces burdens and risks that extend beyond mere issues of technological implementation. As AI becomes progressively embedded within military planning, assessment, and decision-support functions, a critical issue arises as to how such systems can affect authority, responsibility, and autonomy given the distribution of tasks between machine-enabled processes and human judgment. Per Department of Defense Directive 3000.09 the fundamental requirement is to preserve human involvement and control in the use of AI systems to achieve decision advantage and missional adaptability in military operations [4].

Yet DoDD 3000.09 does not define or describe how such control can or should be asserted and/or sustained. Current guidance directs integration of AI to C2 architectures, but affords little direction regarding the allocation of autonomy, the placement of AI within decision-making processes, or the conditions under which machine influence should expand or contract. The result is a doctrinal schism: absent a formalized framework to guide and govern human-AI integration, and autonomy, any distribution of tasking and responsibility would tend to be ad hoc, and vulnerable to inconsistencies, overreliance and/or underutilization. This ambiguity can create operational risk by undermining decision authority, and constrains the military from fully leveraging emerging AI technology within increasingly complex battlespaces.

We posit that this doctrinal gap demands address. As we have previously opined, our model of Synthesized Command and Control (SYNTHComm) can afford a structured framework for adaptive human-AI integration within military decision-making [5]. SYNTHComm conceptualizes AI as an integrated cognitive layer that enhances human judgment across the Military Decision-Making Process (MDMP), acknowledging that neither humans nor AI systems independently possess the optimal combination of speed, contextual understanding, adaptability, and strategic reasoning required for future operations [6]. The MDMP serves as the Army's primary planning methodology for translating commander guidance into synchronized operational action. Since its codification in *Field Manual 101-5* (1997), the MDMP has provided a disciplined framework for structuring analysis, evaluating alternatives, and producing executable plans [7] [8]. Although the process has demonstrated enduring value as a mechanism for imposing rigor on military planning, the contemporary operational environment increasingly demands capabilities that exceed the cognitive and temporal limits of traditional staff-centric approaches. Persistent ISR, large-scale data generation, multidomain operations, and compressed decision cycles place unprecedented demands on commanders and staff, elevating the value of machine-enabled support within the planning process.

Accordingly, AI offers more than incremental efficiency gains. AI-enabled planning systems increase operational tempo by accelerating information synthesis, expanding the number of feasible courses of action (COAs), enhancing predictive analysis, and reducing the cognitive burden associated with processing large volumes of operational data [9]. These capabilities enable staff to focus on judgment, adaptation, and decision quality rather than information management. As AI capabilities mature, the critical question shifts from whether AI should support the MDMP to how autonomy should be allocated across the process to maximize operational effectiveness while preserving command authority and accountability [10].

In the SYNTHComm model, operational advantage emerges instead through the deliberate complementarity of human and machine capabilities. Our model first establishes why the absence of a formal autonomy-allocation framework constitutes a significant doctrinal liability in contemporary operational environments. SYNTHComm is then presented as a grounding architecture for distributing roles, decision authority and responsibilities among human operators and AI-enabled systems throughout the MDMP. This introduces a dynamic adjustment function that enables flexible allocation of autonomy in response to mission complexity, temporal compression, operational risk, and informational uncertainty. This adaptive framework preserves the safeguards necessary for meaningful human control while enabling the speed, flexibility, and cognitive scalability required for success in modern warfare.

It is important to note that existing doctrine and contemporary scholarship have established the imperative for meaningful human judgment, accountable command, and the responsible integration of artificial intelligence into military operations [10] [11]. Comparatively less attention has been devoted to governance of the dynamic relationship between human judgment and artificial cognition as command requirements evolve under conditions of increasing operational complexity, temporal compression, and uncertainty. This unresolved doctrinal and operational challenge provides the foundation for the development of our model of Synthesized Command and Control (SYNTHComm). Rather than proposing another AI capability or prescribing fixed levels of autonomy, SYNTHComm advances a governance architecture that adaptively allocates cognitive functions between commanders and AI-enabled systems according to operational conditions; thereby preserving command authority, accountability, and mission responsibility while enhancing decision quality, speed, adaptability, and operational effectiveness.

Current Department of War (DoW) policy establishes foundational principles governing AI-enabled military operations. Central among these is Department of Defense Directive (DoDD) 3000.09, *Autonomy in Weapon Systems*, which articulates the policy requirements for integrating autonomous and semi-autonomous capabilities while preserving appropriate human judgment, accountable command, and responsibility for military action. Although the directive establishes essential governance principles for autonomous capabilities, it is primarily focused on weapons systems and provides comparatively limited guidance regarding the broader governance of AI-enabled decision support throughout command-and-control processes. Consequently, while DoDD 3000.09 positions important policy boundaries, it affords comparatively little operational guidance regarding how autonomy should be dynamically allocated within such constraints across military planning as operational conditions evolve.

Army doctrine similarly reinforces the centrality of human judgment within command. Field Manual (FM) 5-0 describes the Military Decision-Making Process (MDMP) as a disciplined methodology for transforming commander intent into synchronized operational action through analysis, collaboration, and informed decision-making. Likewise, the philosophy of Mission Command recognizes that operational effectiveness depends upon commanders exercising disciplined initiative, accepting prudent risk, and applying professional judgment within conditions of uncertainty. These doctrinal foundations establish that command is fundamentally a cognitive enterprise in which authority, judgment, and accountability remain inseparable. But they were developed before AI systems assumed the capacity to continuously analyze operational environments, generate recommendations, and dynamically support planning across multiple echelons of missional engagement. As such, existing doctrine affords a paucity of guidance on how AI-enabled cognition should be integrated within command relationships.

Parallel advances within the human-machine teaming and human-centered AI literature have expanded understanding of how computational systems may augment human performance [11]. Research in adaptive autonomy, human-centered AI, explainable AI, trust calibration, and collaborative decision-making consistently demonstrates that effective human-machine performance depends upon dynamically balancing machine speed and computational scale with human contextual understanding, ethical reasoning, and strategic judgment [12]. Rather than viewing autonomy as a fixed technical characteristic, this literature increasingly recognizes that human-AI relationships should adapt according to operational demands, mission complexity, environmental uncertainty, and user confidence. While these findings establish important theoretical foundations for adaptive human-AI collaboration, they remain largely disconnected from military doctrine governing command authority and operational decision-making.

Similarly, contemporary command-and-control scholarship has increasingly emphasized the importance of decision superiority, cognitive advantage, and resilient command architectures capable of operating across multidomain environments. Defense concepts such as Mosaic Warfare, Joint All-Domain Command and Control (JADC2), and DARPA's OFFSET program demonstrate the operational value of distributed intelligence, machine-enabled coordination, and adaptive decision support within increasingly complex operational ecosystems [12]. These initiatives substantially advance technological capability and operational integration; however, they principally address how AI expands military capability rather than how the relationship between human judgment and artificial cognition should be governed throughout military planning and command.

Collectively, these doctrinal, operational, and scholarly efforts establish the strategic importance of meaningful human judgment, accountable command, adaptive autonomy, and AI-enabled decision support. Yet they address these challenges largely in parallel rather than through proposal and/or articulation of a unified governance architecture.

In this light, SYNTHComm was developed to address doctrinal and operational requirements. The framework begins with the construct that military command is fundamentally a governance enterprise that directs authority, allocates responsibility, synchronizes decision-making, and maintains accountability across complex organizations operating under uncertainty. From this core perspective, AI is positioned neither as an autonomous substitute for commanders nor merely as a decision-support tool. Instead, the SYNTHComm model affords AI adaptive cognitive capability through which operational value depends upon how effectively it is governed within existing command relationships. Consequently, SYNTHComm conceptualizes human judgment and artificial cognition as complementary capabilities, the interaction of which requires continuous governance rather than fixed technological classification. Herein, we posit a number of original conceptual contributions that we believe can collectively extend current scholarship on AI, military command and control, and adaptive human-AI teaming. While grounded in established doctrine and contemporary AI research, the SYNTHComm model affords a governance framework that integrates these previously inchoate bodies of work toward a unified architecture for AI-enabled military command in several ways.

First, SYNTHComm introduces a governance architecture for adaptive human-AI teaming that treats command as a continuously governed cognitive enterprise, by offering a framework to govern the evolving relationship between human judgment and artificial cognition throughout military planning and decision-making.

Second, this framework operationalizes adaptive autonomy within the Military Decision-Making Process by establishing a structured method for dynamically allocating cognitive responsibilities according to mission complexity, temporal compression, information uncertainty, commander intent, and operational context. This broadens existing concepts of adaptive autonomy into a more doctrinally compatible command-and-control dynamic.

Third, SYNTHComm introduces the Autonomy Adjustment Function (AAF) as a transparent governance mechanism for calibrating delegated autonomy across the Military Decision-Making Process. The AAF provides commanders with an explainable decision framework for systematically adjusting human-AI collaboration while preserving meaningful human oversight and accountable command.

Fourth, this work advances the concept of cognitive governance as an organizing principle for future command and control. Cognitive governance shifts the focus of AI oversight and regulation from control of autonomous systems to defining and articulating how human judgment and machine cognition collectively generate operational understanding, decision quality, and command effectiveness.

Finally, SYNTHComm provides a scalable doctrinal architecture that can be operationalized beyond the Military Decision-Making Process to future joint, coalition, multidomain, and AI-enabled command environments. Although herein demonstrated within the MDMP, the governance principles developed can be used to establish an expanded conceptual foundation for governing adaptive human-AI collaboration across future military operations.

Taken together, offer that these contributions position SYNTHComm as a governance architecture that integrates doctrine, adaptive autonomy, cognitive governance, and AI-enabled command into a coherent conceptual model capable of informing future military doctrine, operational experimentation, and AI-enabled command and control.

Table 1. Relationship between existing doctrine and the original contributions of SYNTHComm.

Existing doctrine and scholarship	Original contribution of SYNTHComm
DoDD 3000.09 establishes principles of meaningful human judgment and accountable command.	Develops a governance architecture for dynamically allocating autonomy while preserving command authority and accountability.
FM 5-0 and Mission Command establish the Military Decision-Making Process and commander responsibility.	Operationalizes adaptive human-AI teaming throughout the MDMP by aligning cognitive responsibilities with mission demands.
Human-machine teaming literature describes collaborative interaction between operators and AI systems.	Establishes command relationships that govern how human judgment and artificial cognition operate together throughout military planning.
Adaptive autonomy research demonstrates that autonomy should vary according to operational conditions.	Introduces the Autonomy Adjustment Function as a transparent governance mechanism for calibrating delegated autonomy.
AI governance literature emphasizes transparency, explainability, assurance, and trust.	Advances cognitive governance as a doctrinal framework for governing the interaction between human judgment and artificial cognition across military command and control.

Table 1 distinguishes the established doctrinal and scholarly foundations that inform SYNTHComm from the original conceptual contributions advanced in this work.

2. Aligning Autonomy with Command: A SYNTHComm Framework for the Military Decision-Making Process

The convergence of multidomain operations, persistent strategic competition, and increasingly compressed decision timelines in current military operations has elevated decision superiority to be a decisive source of asymmetrical capability. This capability confers advantage via achievement of cognitive superiority: the capacity to transform dynamic, multidomain information into operational understanding, strategic judgment, and synchronized action. As sensing architectures, autonomous systems, and AI expand the volume, velocity, and complexity of available data, there are increasing operational demands to integrate, prioritize, and interpret information within shrinking decision windows. Command and control consequently become the decisive cognitive functions that yoke information to tactical effectiveness and strategic advantage [11].

Indeed, AI increasingly structures the decision space by continuously synthesizing information, identifying operational opportunities and risks, prioritizing competing demands, and generating courses of action at computational speed. In this functional human-machine cooperative, each element (*i.e.*- both human and AI) constitute and contribute to a unified command enterprise in which each provides distinct but reciprocally fortifying capabilities (viz.-AI provides computational scale, persistence, and analytical precision; commanders provide intent, operational judgment, contextual understanding, ethical reasoning, and accountability). As peer and near-peer adversaries converge toward parity in AI-enabled capabilities, technological advantage alone becomes increasingly transient [12]. Decisive advantage will belong to the force that most effectively governs the integration of human judgment and machine cognition to achieve sustained decision superiority. For the Department of War (DoW), superior capability will center upon commanding cognition through deliberate integration of human judgment and machine intelligence to generate decision optimization, sustain operational initiative, and preserve command coherence; and do so in ways that are faster and more effective than an adversary can perceive, decide upon, and respond to in turn.

The foregoing discussion establishes that future command advantage increasingly resides in the complementary orchestration of human and machine cognition. We opine that advances in AI should be viewed as opportunities to strengthen the cognitive architecture of command itself. Operational effectiveness increasingly depends upon aligning computational speed with commander intent, contextual understanding, and accountable decision-making. In this light, SYNTHComm provides a governance architecture that translates these principles into practical command relationships, ensuring that AI augments rather than displaces the cognitive functions essential to military leadership.

SYNTHComm in Practice

As presented, the SYNTHComm model regulates the relationship between human and artificial cognition. The framework allocates autonomy according to operational conditions, commander intent, and cognitive demand rather than the technical characteristics of an individual AI system. Accordingly, SYNTHComm serves as a governance architecture for command rather than a classification scheme for autonomous technologies. SYNTHComm is designed to treat autonomy as a continuously managed command relationship instead of a predetermined binary condition, SYNTHComm reinforces human oversight through clear lines of accountability that enable delegated authority to be redirected or reclaimed as operational conditions evolve. Each level of autonomy functions as a governance mechanism, with predefined capabilities, supervisory controls, and fallback conditions to lower levels of autonomy whenever mission assurance, system confidence, or operational conditions warrant; as follows.

Level I - Decision Support. AI aggregates information, identifies patterns, and generates recommendations. Commanders interpret AI outputs and retain full decision authority.

Level II - Decision Shaping. AI prioritizes information, develops predictive assessments, and refines potential courses of action. Commanders critically evaluate model assumptions, confidence estimates, and recommendations before selecting a course of action.

Level III - Supervised Execution. AI executes bounded functions within commander-defined authorities and operational parameters. Human oversight shifts to supervisory control through established intervention points, review cycles, and override authorities, preserving accountability while reducing cognitive load.

Level IV - Conditional Autonomous Execution. AI independently selects and executes actions within mission objectives under predefined constraints. Human intervention becomes exceptional. This level already exists in limited operational applications and is measurable through the scope of delegated authorities, decision thresholds, and system performance under dynamic conditions.

Level V - Full Autonomous Execution. AI independently determines, executes, and adapts operational actions without real-time human involvement. Human participation is limited to system design, mission authorization, and post-operational assessment. While representing the highest degree of delegated autonomy, this level remains quantifiable through the breadth of operational authority exercised by the system and does not eliminate human accountability for its employment.

We view establishing defined and explicit limits on AI autonomy as a doctrinal imperative for preserving the inseparable relationship between command authority, operational judgment, and accountability and responsibility for military action. Consistent with the principles of meaningful human judgment and accountable command as stated in DoDD 3000.09, SYNTHComm establishes Level III as the proposed governance boundary for AI-enabled participation within the MDMP. This boundary should be regarded as the authors' operational interpretation of how AI can maximize planning effectiveness while preserving commander accountability, informed judgment, and continuous supervisory authority [4]. This represents the point at which AI can substantially accelerate planning and execution while commanders retain meaningful human control, exercise informed judgment, and remain directly accountable for operational outcomes. Beyond this point, increasing levels of autonomous decision-making progressively separate authority from accountability, diminishing commanders' ability to understand, direct, and assume responsibility for military action. Accordingly, Levels IV and V are included to define the broader autonomy spectrum and inform future capability development; but they remain outside the governance boundaries of SYNTHComm as applied to the MDMP given that they are incompatible with regnant doctrinal requirements of accountable command and meaningful human control.

Figure 1 maps the baseline distribution of human and AI responsibilities under optimal operating conditions. Consistent with the framework's autonomy boundaries, Level III represents the maximum permissible level of AI autonomy, ensuring that meaningful human control remains embedded throughout the planning process.

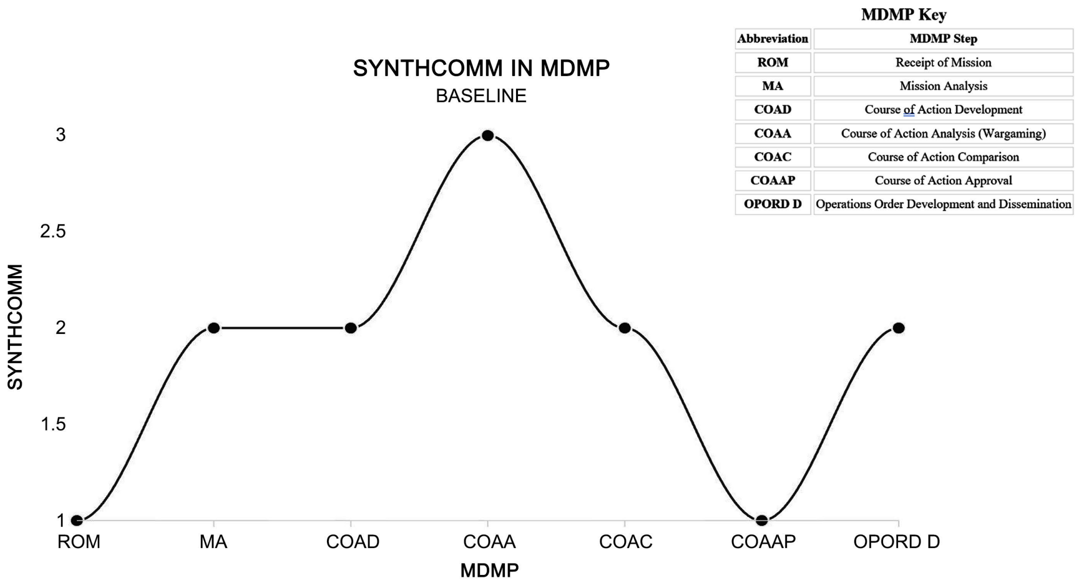


Figure 1. SYNTHComm baseline autonomy framework for the military decision-making process.

Figure 1 illustrates the central design principle of SYNTHComm as applied to the MDMP: autonomy is neither fixed nor uniformly distributed across the MDMP. Instead, autonomy is deliberately aligned with the cognitive and operational demands of each planning phase. Activities requiring command judgment, intent formulation, and decision authority remain human-dominant, while analytically intensive tasks that benefit from computational speed, scale, and iteration receive greater AI support. The resulting architecture balances machine-enabled efficiency and accountable command, positioning AI where it provides the greatest operational advantage while preserving meaningful human control at critical decision points. Accordingly, autonomy rises and falls across the MDMP as the relative demands for computation and judgment shift throughout the planning process.

We offer that the continued evolution of military command and control will benefit from the integration of human judgment and AI as reciprocal capabilities within a unified command enterprise. As AI-enabled systems expand their capacity to accelerate analysis, enhance operational understanding, and support planning, equal attention should be devoted to governing how these capabilities are employed across command processes. The SYNTHComm framework extends contemporary approaches to AI-enabled command and control by offering an adaptive architecture for human-AI teaming that fortifies decision quality, operational adaptability, and cognitive resilience across multidomain operations [5]. We posit that such approaches will become increasingly valuable as military organizations continue to modernize command architectures, and integrate AI to achieve enduring decision superiority in operational environments.

3. Adaptive Autonomy: Moving beyond the Baseline

The autonomy profile depicted in **Figure 1** provides a doctrinal starting point, not a fixed prescription. Contemporary operations unfold under varying conditions of complexity, temporal pressure, and informational uncertainty that continuously reshape the demands put upon military commanders [1]. Static allocation of human and AI responsibilities risks misaligning cognitive resources with operational requirements. Importantly, military doctrine recognizes that effective planning requires adaptation [8]. The MDMP serves as the preferred planning method, yet commanders routinely modify its execution to accommodate mission demands, available time, and operational conditions. Accordingly, SYNTHComm affords this flexibility. The model establishes an initial distribution of responsibilities, yet commanders may adjust autonomy levels as operational conditions evolve. During planning, this adaptation occurs through a deliberate assessment of mission complexity, decision timelines, and informational certainty. These factors determine when and to what extent autonomy should increase to accelerate analysis and execution, or decrease to more fully engage human oversight, judgment and decision accountability.

To formalize this process, SYNTHComm employs an Autonomy Adjustment Function that calibrates human-AI role distribution relative to the baseline architecture. The autonomy adjustment function is intentionally presented as a first-order governance mode rather than a predictive algorithm. Its linear and additive structure is not intended to imply that operational decision-making is inherently linear; rather, it provides commanders with a transparent, interpretable mechanism for reasoning about how key operational conditions could and should influence allocation of autonomy. Task complexity, time compression, and information uncertainty were selected because they represent the primary environmental factors that consistently affect the relative advantages of human judgment and AI-enabled processing during military planning [13]. This function is represented in the following equation:

$$A(s) = clip\,[A(b) + \alpha C + \beta T - \gamma U, 1, 3]$$

$A(s)$ = determined autonomy at MDMP stage "s", relative to current operational conditions

$A(b)$ = baseline autonomy at stage "s", established under optimal conditions (**Figure 1**)

$C \in [0, 1]$ = task complexity

$T \in [0, 1]$ = time compression

$U \in [0, 1]$ = information uncertainty

α, β, γ = weighting coefficients for C, T, and U, respectively

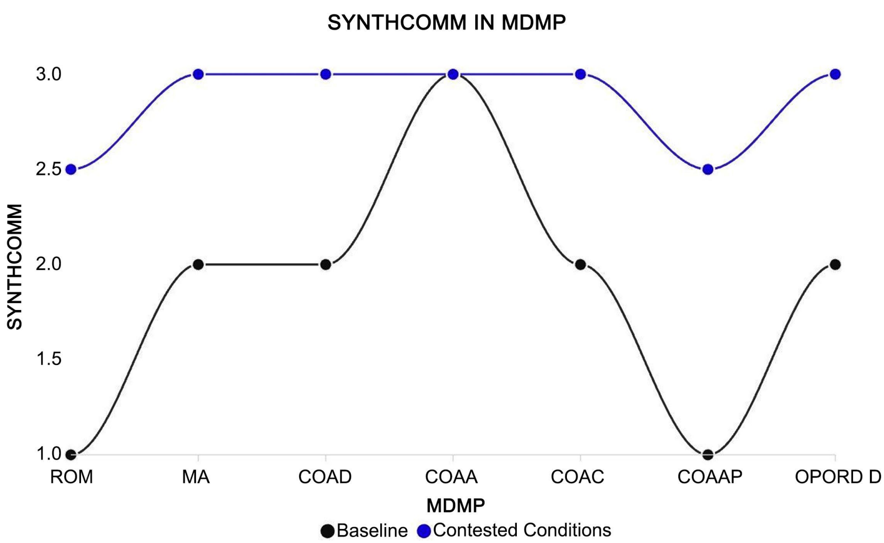
The autonomy adjustment function serves as the operational mechanism of the SYNTHComm framework. Rather than treating autonomy as a fixed characteristic of an AI system, the function dynamically adjusts delegated authority at each MDMP stage according to operational conditions. By incorporating task complexity, time compression, and information uncertainty, it provides commanders with a transparent and repeatable method for determining the appropriate degree of human-machine collaboration. The resulting autonomy value transforms autonomy from a subjective judgment into a measurable command-and-control variable that can be monitored, justified, and adapted as mission conditions evolve.

$A(s)$ represents the level of autonomy assigned at MDMP stage s under current operational conditions, while $A(b)$ represents the baseline autonomy authorized for that stage under optimal conditions (**Figure 1**). C, T, and U quantify the operational factors that drive autonomy adjustments: task complexity, time compression, and information uncertainty, respectively, each on a scale from 0 to 1. The coefficients α, β, and γ determine how strongly each factor influences autonomy allocation decisions. Together, these variables dynamically adjust autonomy from the baseline level to reflect mission demands. The clip function serves as a command-and-control safeguard, ensuring that autonomy remains within pre-established human oversight limits. As operational complexity, time pressure, and uncertainty increase, autonomy may be reduced, while remaining above the minimum threshold required to preserve effective human judgment, accountability, and mission command.

Importantly, the autonomy adjustment function should not be interpreted solely as a mathematical construct. Rather, it represents a governance mechanism through which commanders can systematically align AI-enabled capabilities with evolving operational demands. We believe that the principal contribution of this function lies in establishing a transparent, explainable, and adaptable method for governing human-AI collaboration under conditions of uncertainty. By making autonomy an explicit command variable, SYNTHComm provides a common decision framework that supports operational consistency, doctrinal integration, and accountable command [14].

The coefficients α, β, and γ are each loci of this command judgment. While task complexity, time compression, and information uncertainty constitute first-order variables governing autonomy allocation, commanders must also evaluate higher-order factors that influence confidence in AI-enabled recommendations. Such factors include model confidence estimates, data provenance and integrity, model validation and verification status, communications resilience, sensor availability, adversarial deception, and system performance under degraded or contested conditions. Collectively, these factors modify the weighting coefficients (α, β, γ) by influencing the degree of trust commanders can place in AI-generated recommendations. High-confidence models supported by validated data and resilient communications architectures justify greater delegated autonomy, whereas degraded communications, uncertain data provenance, reduced model confidence, and/or adversarial manipulation warrant increased human oversight and reduced delegation.

Accordingly, the coefficients α, β, and γ should be viewed as doctrinal or command-design parameters established by the employing organization and may be calibrated for different echelons, mission sets, operational environments, or levels of AI maturity. For the purposes of analysis, Figure 2 assumes equally weighted normalized coefficients, where α, β, and γ are held equal. Equal weighting is used here to demonstrate the structural shift in autonomy allocation produced by the equation itself by treating the variables (*i.e.*, time compression, task complexity, and information uncertainty) as equal contributors. Holding the coefficients equal in this way isolates the behavior of the model, so that the shift shown reflects the form of the relationship rather than an assumed weighting among its terms. These coefficients are thus illustrative rather than doctrinal constants, and such equal weighting serves as a demonstrative baseline. In application, the coefficients are intended to be calibrated through operational experimentation, organizational learning, and mission-specific validation, at which point their relative magnitudes may diverge to reflect the demands of a given mission context. Applied, this function provides a simple, explainable, and adaptable mechanism for governing human-AI collaboration under changing operational conditions.



MDMP Key

Abbreviation	MDMP Step
ROM	Receipt of Mission
MA	Mission Analysis
COAD	Course of Action Development
COAA	Course of Action Analysis (Wargaming)
COAC	Course of Action Comparison
COAAP	Course of Action Approval
OPORD D	Operations Order Development and Dissemination

Figure 2. SYNTHComm adaptive autonomy framework under contested operational conditions.

In this function, complexity and time compression increase delegation of autonomy, as both conditions tend to increase the cost of relying solely on unaided human processing. Information uncertainty reduces delegated autonomy, as unreliable inputs make machine-generated recommendations less trustworthy and require greater human validation for use. This function gives commanders a structured way to depart from the optimal baseline without ignoring the limits the model imposes. Under optimal conditions where α, β, and γ are weighted equally, and C, T, and U are zero, the autonomy adjustment function produces the curve provided in **Figure 1** with no deviation in autonomy from the baseline. Conversely, under highly contested conditions (e.g.- with "0.85" task complexity, "0.95" time compression, and "0.3" uncertainty) where α, β, and γ are weighted equally the curve will shift above the baseline to reflect adaptation to environmental conditions. This is modeled by the equation and depicted in **Figure 2** above.

$$A(s) = clip\,[A(b) + (1)0.85 + (1)0.95 - (1)0.3, 1, 3]$$

Figure 2 illustrates the adaptive behavior of the SYNTHComm autonomy function under contested operational conditions. As task complexity and time compression increase, delegated autonomy rises to exploit AI's computational speed and analytical scale. Importantly, **Figure 2** should be interpreted as a governance model rather than a predictive algorithm. The AAF provides commanders with an explicable decision framework for allocating human and AI responsibilities under changing operational conditions. The model thereby enhances transparency and accountability while preserving commander authority over autonomy decisions. Simultaneously, operational uncertainty moderates that increase by requiring greater human judgment and validation before AI-generated outputs influence operational decisions. The resulting autonomy profile reflects a dynamic balance between environmental demands and meaningful human control rather than a fixed allocation of authority. This adaptive relationship represents the central contribution of SYNTHComm. The critical challenge for future command and control lies in determining and governing how increasingly capable AI systems could and should participate in military decision-making. The autonomy adjustment function provides commanders with a structured mechanism for calibrating human-machine interaction according to operational conditions while preserving commander authority, accountability, and responsibility. AI expands computational capacity where speed and complexity demand it; governance establishes the boundaries within which autonomy operates. In this way, SYNTHComm integrates decision velocity with accountable command, ensuring that autonomy remains a function of operational necessity rather than technological capability. We propose that SYNTHComm represents both a framework for MDMP, and an initial doctrinal architecture for governing cognitive collaboration between human commanders and intelligent systems across the future force. Continued empirical evaluation, operational experimentation, and doctrinal refinement will be important to further inform how adaptive autonomy can augment command effectiveness while preserving the enduring principles of responsibility, accountability, and mission command, and responsibility. The conceptual nature of SYNTHComm provides both opportunities and important considerations for continued research, operational evaluation, and doctrinal development.

4. Limitations and Future Research

SYNTHComm is presented as a conceptual governance framework intended to guide the adaptive integration of human judgment and artificial cognition within military command and control. Accordingly, its principal contribution is the establishment of a theoretically grounded governance architecture rather than the presentation of a validated operational model. Although the framework is informed by contemporary military doctrine, adaptive autonomy, human-machine teaming, and AI governance literature, its operational effectiveness remains to be empirically evaluated across representative military environments.

The AAF is intentionally designed as an interpretable governance mechanism to provide commanders with a transparent framework for reasoning about the allocation of autonomy under changing operational conditions. Likewise, the weighting coefficients associated with task complexity, temporal compression, and information uncertainty are presented as illustrative parameters that demonstrate the structural behavior of the governance model rather than fixed doctrinal constants. Thus, their calibration should ultimately be informed through operational testing, organizational learning, and mission-specific validation across different echelons, mission sets, and AI-enabled capabilities.

As well, while the present work operationalizes SYNTHComm within the Military Decision-Making Process, future command and control will increasingly occur across joint, coalition, multidomain, and multinational environments in which differing command relationships, rules of engagement, AI policies, and interoperability requirements introduce additional governance considerations. Hence, continued investigation will be necessary to determine how adaptive autonomy can be consistently governed across diverse operational architectures.

Such future research should transition SYNTHComm from a conceptual governance architecture toward operational doctrine through progressive testing, evaluation and validation. Military wargaming, constructive simulation, digital experimentation, and Military Decision-Making Process exercises provide valuable opportunities to assess how adaptive autonomy influences planning effectiveness, decision tempo, commander workload, operational trust, and decision superiority under contested conditions. Subsequent integration into Joint and coalition exercises can further examine interoperability, assurance, trust calibration, and command accountability while refining the autonomy adjustment function through operational evidence. In the aggregate, these efforts can strengthen empirical foundations necessary to inform doctrine, professional military education, force design, and future DoW governance as increasingly capable AI systems become iteratively available and integrated throughout operational elements of command and control.

5. Conclusion: Toward a Cognitive Governance in Command and Control

Future military command will depend on the ability to integrate human judgment and machine cognition into a coherent decision-making system that operates across multi-domain operations at an accelerating speed of relevance. As decision timelines compress and the volume of available information expands, command effectiveness will depend less on analytical and technological capacity than on the defined distribution of cognitive tasks between human and machine systems. Within this environment, future doctrine should move beyond identifying discrete AI applications to instead establishing formal principles governing the allocation, supervision, and adaptation of machine autonomy throughout command-and-control processes. Technological capability alone cannot produce decision superiority, as enduring military advantage will belong to those organizations that most effectively direct and govern the integration of computational cognition and human judgment into resilient, adaptive, and accountable command architectures. As AI continues to transform the character of C2, and perhaps warfare itself, decision superiority will increasingly depend upon cognitive governance and asymmetrical cognitive capability achieved by the deliberate allocation of authority, autonomy, and accountability across human-machine decision systems. We propose that SYNTHComm can provide doctrinal architecture for achieving this objective, and thus be of value toward advancing command and control throughout the domains and dimensions of AI capability and integration, and across levels ranging from the management of information to the governance of cognition.

The proposed SYNTHComm model shifts the focus of AI governance from regulating individual systems to governing the interaction between human judgment and artificial cognition throughout military command. As AI capabilities continue to mature, future command effectiveness will increasingly depend upon establishing transparent governance architectures that align machine reasoning with commander intent, operational accountability, and strategic objectives. More broadly, the implications of this work extend beyond the Military Decision-Making Process. As AI-enabled systems become evermore integrated across joint, coalition, and multidomain operations, military organizations will require governance architectures capable of adapting human-AI relationships across planning, execution, sustainment, intelligence, and strategic decision-making. We propose that SYNTHComm represents both a framework for MDMP, and an initial doctrinal architecture for governing cognitive collaboration between human commanders and intelligent systems across the future force. Continued empirical evaluation, operational experimentation, and doctrinal refinement will be important to further inform how adaptive autonomy can augment command effectiveness while preserving the enduring principles of responsibility, accountability, and mission command. We opine that continued empirical evaluation, and doctrinal refinement will be essential to transition SYNTHComm from a conceptual governance architecture to an operationally validated framework for AI-enabled command and control. As AI becomes increasingly embedded throughout military planning, intelligence, logistics, cyber operations, and multidomain command, enduring decision superiority will belong to those military organizations that most effectively govern the integration of human judgment and artificial cognition. In this respect, SYNTHComm represents an initial step and proposed method toward cognitive governance in an age of AI-enabled warfare. In so doing, it is our hope to position governance, and not technology alone, as the decisive determinant of future command capability, advantage, and success.

Disclaimer

The views and opinions expressed in this essay are those of the authors and do not necessarily reflect those of the United States government, Department of War, or the National Defense University.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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