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Multi-Domain Concept Centre – Role of University of Defence

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Abstract

The paper examines the role of the University of Defence as the academic engine of a Multi-Domain Concept Centre supporting Multi-Domain Operations in a small-state context. Using document and comparative analysis and stakeholder workshops, it proposes a Concept Development and Experimentation–driven framework integrating doctrine, experimentation, capability planning, and education. Findings show that academic leadership enhances methodological rigor, interoperability, and knowledge transfer. The paper presents an original NATO-aligned model for sustainable multi-domain concept development.

KEY WORDS: *Multi-Domain Operations; Concept Development; University of Defence; Interoperability; Defence Innovation; Capability Development; Modelling and Simulation*

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1. Introduction

Contemporary armed conflicts exhibit a high degree of dynamism, complexity, and interdependence across operational domains. Land, air, maritime, cyber, space, and information environments no longer function as discrete arenas of military activity but form an integrated operational system that places unprecedented demands on command, control, and decision-making processes. In response to these developments, Multi-Domain Operations (MDO) have emerged as a central conceptual framework within NATO, aiming to synchronize effects across domains and enhance decision advantage in contested environments.

Despite the growing prominence of MDO in strategic and doctrinal discourse, significant research and capability gap persists. Existing studies and national initiatives tend to prioritize technological integration, modelling, and simulation, while the methodological, organizational, and educational dimensions of MDO implementation remain underdeveloped [1]. In particular, smaller states face structural constraints that limit their ability to establish institutionalized, academically supported Concept Development and Experimentation (CD&E) processes capable of translating MDO theory into validated operational concepts. As a result, there is a lack of repeatable, evidence-based frameworks that connect doctrinal development, experimentation, and professional military education [2].

The emerging cooperation among international defence companies, industrial partners and the Czech MoD has initiated the development of a Multi-Domain Concept Centre (MDCC), which provides a unique opportunity to address this gap. The planned involvement of the University of Defence enables the initiative to extend beyond its technical foundations and to incorporate a broader conceptual, analytical, and educational dimension.

MDO have evolved from an aspirational vision of cross-domain coordination into a practical imperative for armed forces operating in contested, data-saturated, and politically constrained environments. In MDO, land, air, maritime, cyber, space, and the information environment must be orchestrated to achieve decision advantage, with effects planned, synchronized, and assessed across heterogeneous time scales and operational constraints [3]. Far from being a purely technical challenge, MDO is a socio technical endeavor in which organizational design, cognition and training, concept and doctrine, and the supporting technological ecosystem mutually shape outcomes [4].

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Within this transformation, the MDCC must not be conceived merely as a facility for simulation integration or an IT platform for model federation. Rather, its essential purpose is to provide a conceptual and experimental use-case environment in which hypotheses about cross domain interactions can be formulated, tested, validated, and translated into doctrine, capability planning, and professional military education (PME) [1]. That is, the MDCC makes MDO tractable by structuring inquiry, evidence generation, and institutional learning.

The MDCC's mission extends beyond national boundaries. Because MDO is by its very nature coalition centric [5], the Centre must align experiment design, metrics, and data management with NATO conformant processes and standards. Doing so ensures interoperability by design, facilitates contribution to, or reuse of, Alliance experimentation campaigns, and increases the credibility and uptake of Czech recommendations in multinational settings. The MDCC thereby becomes both a national integrator and a coalition interface for the Czech Republic's MDO implementation, see Fig. 1.

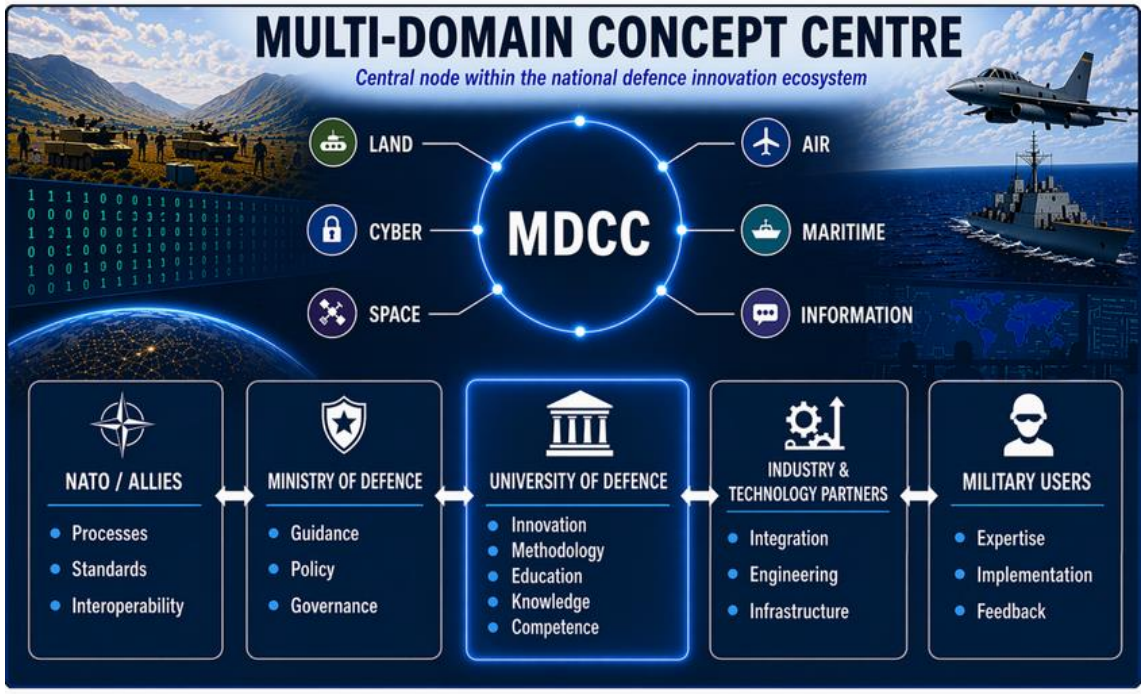

Fig. 1. Multi-Domain Concept Centre (MDCC) – Operational Context.

For smaller states similar to the Czech Republic the MDCC model is especially consequential. Compared with large allies, small states face tighter resource constraints, heavier dependence on coalition capabilities, and thinner institutional infrastructures for experimentation [2]. These conditions can lead to episodic, technology driven trials that lack methodological rigor and continuity, insufficient for maturing complex, cross domain concepts. The MDCC mitigates this risk by institutionalizing an evidence-based cycle, from problem framing to experimentation to recommendations, under a governance model that couples industrial technical capacity with academic methodological inputs delivered by the University of Defence [6].

The purpose of this article is therefore to articulate how the University of Defence can function as the academic engine of the MDCC and to outline a CD&E-driven pathway for implementing the Czech MDO Concept. The article contributes to the current discourse by proposing a structured, evidence-based model for MDO concept development tailored to the conditions of a small state, leveraging NATO CD&E methodology, and embedding it within national defence education and innovation processes.

2. Methods

From a systems perspective, the MDCC functions as a central node within the national defence innovation ecosystem. It is structured as a four-layer architecture designed to support the full Concept Development and Experimentation (CD&E) cycle and to ensure continuous feedback between strategy, experimentation, capability development, and education [7], see Fig. 2.

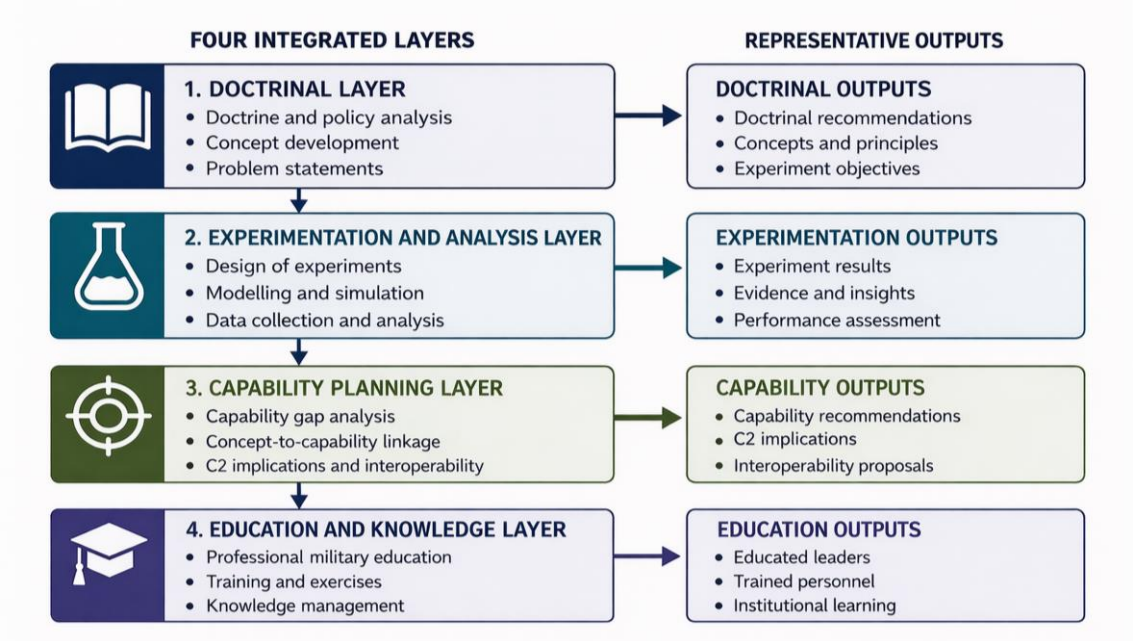

Fig. 2. MDCC Architecture – Four Integrated Layers.

The first layer is the doctrinal layer, which articulates strategic intent, operational concepts, and problem statements derived from national and NATO-level guidance. These doctrinal drivers define priority challenges and provide the initial framing for further analytical work.

The second layer is the experimentation and analysis layer, which forms the analytical core of the MDCC. This layer employs modelling and simulation (M&S), wargaming, and data-driven operational analysis to explore alternative solutions, quantify trade-offs, and identify constraints. Insights generated here directly inform the subsequent refinement of concepts and capability considerations.

The third layer is the capability planning and command-and-control (C2) layer, where experimental results are translated into implications for architecture, requirements, force development priorities, and procurement decisions. This layer ensures that analytical outcomes are aligned with practical defence planning and decision-making processes.

The fourth layer is the education and knowledge layer, which embeds validated concepts, scenarios, and lessons learned within PME, training curricula, exercises, and institutional knowledge bases.

Explicit feedback loops link all four layers, reinforcing the iterative nature of CD&E and preventing experiments from becoming isolated technical demonstrations with limited doctrinal or educational impact.

Based on this framework, the research applies the following structured methods of investigation:

1. Document Analysis - This method examines key strategic and doctrinal documents, including NATO policy papers, national defence strategies, force development concepts, and internal doctrinal materials of the Armed Forces and the University of Defence. The objective is to extract capability requirements and conceptual expectations relevant to MDO.
2. Comparative Analysis - A comparative study of foreign Multi-Domain or Concept Development centres within allied armed forces and defence institutions is conducted. This analysis identifies best practices, organisational models, and lessons learned that may be applicable or adaptable to the national context.
3. Stakeholder Workshops - Structured consultations with subject matter experts from the military, academia, and industry provide qualitative insights into operational needs, capability gaps, and expectations regarding MDCC functions. These inputs support validation of the conceptual framework and refinement of proposed solutions.

3. Results

3.1. Products and Outputs

The MDCC's core mission is to transform strategic guidance and operational challenges into validated concepts and actionable capability recommendations. To ensure traceability and consistency, MDCC activities should generate standardized, NATO ACT, conformant CD&E products aligned with an agreed battle rhythm (e.g., six-month cycles).

The experimental workflow begins with problem structuring, in which doctrinal and operational challenges are reformulated into testable hypotheses. This structured workflow is illustrated in Fig. 3.

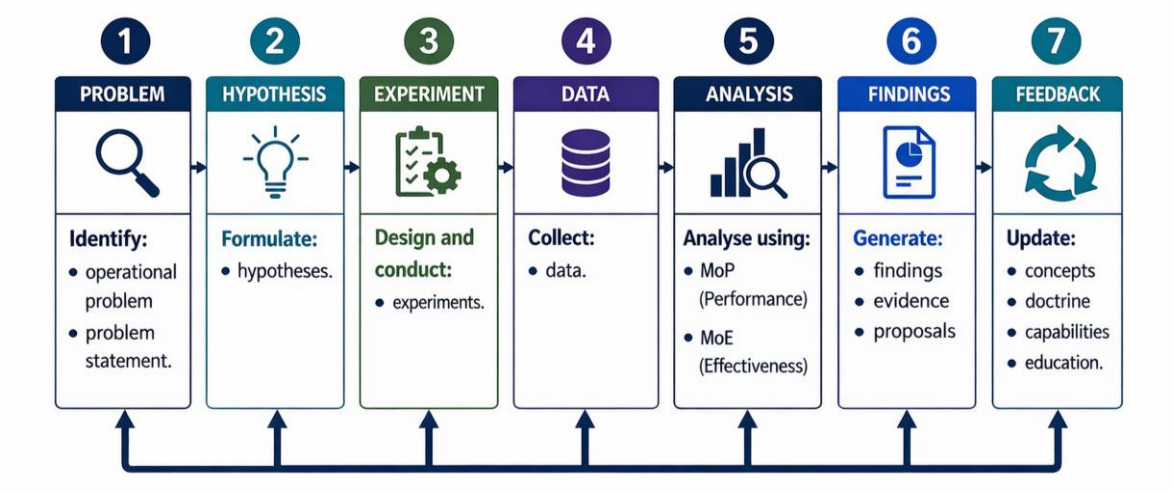

Fig. 3. Concept Development and Experimentation (CD&E) Process.

These hypotheses are addressed through individual use cases that mature through successive iterations (e.g., v0.1 to v1.0). Each iteration explicitly links hypotheses with supporting evidence and documents resulting in doctrinal or capability implications.

Subsequently, experiment design and execution are conducted using M&S tools, wargaming, and operational analysis. For each case, formal Experiment Design Documents and Data Collection and Analysis Plans (EDD/DCAP) are developed. These specify objectives, experimental venues, data requirements, measurement approaches, and analytical tools.

The data collection and analysis phase evaluate experimental outcomes using Measures of Performance and Measures of Effectiveness (MoP/MoE). These indicators assess operational suitability and effectiveness while also accounting for confidence levels and use case limitations.

Each completed use case results in a Final Experiment Report (FER), which constitutes The experimental workflow one of the primary MDCC outputs. FERs consolidate findings, identify DOTMLPFI implications, assess risks, and outline alternative courses of action. In addition, MDCC outputs include structured knowledge packages comprising scenarios, datasets, model libraries, and teaching cases prepared for reuse in PME and exercises.

MDCC effectiveness should be assessed at the programme level using Key Performance Indicators (KPIs) aligned with national MDO horizons and the Centre's iterative cadence. Representative milestones may include a validated catalogue of use cases with associated EDD/DCAPs (M+6), initial FERs (M+12), an operational MDCC knowledge portal (M+18), curriculum and exercise updates (M+24), interoperability audits (M+30), and a capability uptake review (M+36). These indicators measure not only experimental throughput but also institutional adoption, which represents the true value of a concept development centre.

Priority use cases should reflect near-term national requirements. For the Czech Republic, relevant areas may include kill web orchestration, data-centric common operational picture development, targeting in anti-access/area denial (A2/AD) environments, convergence of ground-based air defence and Suppression of Enemy Air Defence (SEAD), resilience of space-enabled PNT/ISR/SATCOM, and integration of cyber and electromagnetic operations. Each use case should define appropriate MoP/MoE, such as F2T2EA timelines, sensor-to-effector latency, COP refresh rates, FMN compliance metrics, or mission success under cyber and jamming stress, to ensure auditability and decision relevance.

3.2. Governance and Workshare

The proposed MDCC governance model combines an industry-delivered standing experimentation infrastructure (including model federations, gateways, and toolchains) with an academically led use case pipeline focused on problem structuring, metrics definition, operational analysis, and validation.

STAKEHOLDER	ROLE IN MDCC	CORE CONTRIBUTIONS	OUTCOMES FOR THE ECOSYSTEM
NATO / ALLIES	Ensures alignment with NATO-conformant processes and standards.	• NATO-conformant processes and standards	• Evidence-based insights • Validated outputs • Interoperability by design • Institutional learning
MINISTRY OF DEFENCE	Provides strategic guidance, defines capability requirements, and sets defence policy.	• Strategic guidance • Capability requirements • Defence policy	
UNIVERSITY OF DEFENCE	Provides conceptual, methodological, analytical, and educational leadership.	• Conceptual leadership • Methodological governance • Operational analysis and M&S competence • Education and knowledge management	• Evidence-based insights • Validated outputs • Interoperability by design
INDUSTRY & TECHNOLOGY PARTNERS	Provides technologies, integration, and the standing experimentation infrastructure.	• Technical integration • System engineering • Experimentation infrastructure (model federations, gateways, toolchains)	• Evidence-based insights • Interoperability by design
MILITARY USERS	Ensures operational relevance and uses validated outputs for adoption and implementation.	• Subject matter expertise • Operational relevance • Testing in realistic context • Adoption and implementation of validated outputs	• Evidence-based insights • Testing in realistic context • Institutional learning

Fig. 4. MDCC Stakeholder Roles, Core Contributions, and Expected Outcomes.

Industry partners leverage their strengths in technical integration and system engineering, while the University of Defence provides methodological supervision, peer review, red teaming, and data governance. End users, primarily the General Staff and individual services, contribute subject matter expertise, ensure operational relevance, and ultimately receive validated outputs for adoption and implementation.

A key challenge remains controlled access to products containing non-public or sensitive data. For a small state, this requires pragmatic handling of classification and data rights constraints. Measures such as anonymisation, tiered access controls, selective use of synthetic datasets, and portal-based audit trails offer a balanced approach that preserves scientific transparency while meeting security and contractual requirements. As MDCC matures, an expanding library of security-cleared scenarios and datasets is expected to reduce costs and accelerate subsequent experimentation cycles.

4. Discussion

This article has articulated the role of the University of Defence (UoD) as the academic engine of the Multi-Domain Concept Centre and framed a Concept Development and Experimentation (CD&E), driven pathway for implementing the Czech Multi-Domain Operations Concept. Building on the methodological framework (Section 2) and the identified MDCC products and governance arrangements (Section 3), this discussion interprets how UoD's institutional functions enable doctrinal coherence, analytical rigor, and long-term capability uptake. These findings are consistent with other international studies in the fields of intelligence [8], alliance concepts [9], system integration [10], and historical research [11].

4.1. University of Defence as the Academic Engine of the MDCC

While the primary industrial integrator retains responsibility for technical integration, system implementation, and operation of dedicated experimentation infrastructure, the University of Defence (UoD) is uniquely positioned to ensure that the MDCC remains a concept-driven and learning-oriented institution rather than a technology-centred project. Its value lies not in ownership of tools, but in ownership of meaning, method, and continuity across experimentation cycles.

The UoD contributes as an external expert partner providing subject-matter expertise, specialized analytical personnel, and academic legitimacy. This role anchors the MDCC within NATO-aligned conceptual logic and prevents fragmentation of experimental activities into isolated technical demonstrations. By operating at the intersection of doctrine, operational analysis, and education, the UoD ensures traceability from strategic guidance to validated knowledge and institutional learning.

Four mutually reinforcing functions define UoD's role as the academic engine of the MDCC: conceptual leadership, methodological governance, operational analysis and M&S competence, and education and knowledge management. Together, these functions operationalize the CD&E logic outlined in Sections 2 and 3 and translate it into an enduring national capability.

4.2. Conceptual Leadership and CD&E Problem Structuring

UoD's primary contribution lies in translating NATO and national guidance into operationally testable problem statements. This includes structuring doctrinal challenges, such as mission command in data-centric C2, cross-domain

targeting, integration of cyber and electromagnetic operations, or resilience of space-enabled services, into hypotheses suitable for experimentation.

By maintaining conceptual continuity across use cases, the UoD ensures coherence of the MDCC portfolio and alignment with Czech MDO objectives, NATO ACT CD&E principles, and coalition interoperability requirements. This function directly supports the CD&E-driven pathway articulated in the article, where experimentation is subordinated to doctrinal purpose rather than driven by tool availability.

4.3. Methodological Governance and Evidence-Based Validation

As the academic engine, the UoD provides methodological governance of the experimentation process. This includes leadership in Experiment Design Documents (EDD), Data Collection and Analysis Plans (DCAP), and the definition of MoP/MoE.

Through peer review and red-teaming, the UoD safeguards analytical rigor, reproducibility, and transparency of results. This role is critical for ensuring that outputs captured in FERs represent evidence-based insights rather than anecdotal findings. Methodological stewardship thus forms the backbone of the CD&E cycle and underpins the credibility of MDCC outputs for doctrinal adoption and capability development.

4.4. Operational Analysis, M&S, and the Use Case Portfolio

UoD's analytical workforce enables the decomposition of Multi-Domain missions into composable mission threads and scenario vignettes suitable for experimentation. Analysts and M&S specialists quantify cross-domain bottlenecks, such as sensor-to-shooter latency, data fusion constraints, or resilience under cyber and electromagnetic stress, bridging the gap between conceptual ambition and parameterized experimental design.

In shaping the use case portfolio, the UoD ensures that experimentation priorities reflect national needs rather than short-term industrial or technological drivers. Near-term Czech priorities, such as kill web orchestration, GBAD/SEAD convergence, or targeting under A2/AD constraints, thus become vehicles for progressive implementation of the Czech MDO Concept through iterative CD&E cycles.

4.5. Education, Knowledge Management, and the Learning Force

The long-term value of the MDCC is realized only when validated insights are absorbed by the institution. UoD's education and knowledge management function closes this loop by integrating MDCC outputs into professional military education, training, exercises, and research.

Operation of the MDCC digital portal by the UoD provides institutional memory, scenario reuse, version control, and auditability. This transforms experimental artefacts into reusable knowledge assets and enables cumulative learning over successive CD&E cycles. Embedding these outputs into PME curricula contributes to the development of a "learning force" capable of operating under the cognitive and organizational demands of MDO.

4.6. Limitations, Risks, and Boundary Conditions

Several limitations shape the scope of UoD's contribution. The analysis relies on currently available doctrinal material, expert input, and open sources; requirements related to MDO are still evolving. Access to classified data remains constrained, requiring reliance on synthetic or sanitized datasets and tiered-access solutions. Furthermore, implementation depth is contingent on the technical capabilities of the industrial integrator, placing natural boundaries on academic analysis of system-level integration.

These constraints do not diminish the central argument of the article: namely that the effectiveness of an MDCC in a small-state context depends less on ownership of infrastructure and more on sustained conceptual leadership, methodological discipline, and institutional learning, functions best delivered by an academic partner.

4.7. Implications for Implementing the Czech MDO Concept

The CD&E-driven pathway outlined in this article positions the UoD as a catalyst for progressive implementation of the Czech MDO Concept. By structuring doctrinal problems, governing experimentation, validating outcomes, and embedding lessons into education, the UoD enables incremental yet durable capability evolution.

This approach mitigates the risk of premature technological lock-in and ensures that MDO implementation remains adaptive, evidence-based, and human-centred. In this sense, the MDCC, powered by an academic engine, becomes not merely a test environment, but a national mechanism for sustained Multi-Domain learning and capability convergence.

4.8. Limitations

The presented work is subject to several limitations that affect the scope and precision of its conclusions. First, the analysis is based on currently available strategic and doctrinal documents, some of which remain under development or revision; as a result, requirements related to MDO may evolve over time. Second, the study relies on expert inputs and workshops outcomes that represent selected stakeholder perspectives and may not fully capture the entire spectrum of institutional expectations. Third, the technical aspects of the project, such as implementation tools and integration

capabilities, remain dependent on the primary industrial integrator, which limits the depth of analysis regarding specific implementation details. Fourth, the project cannot make use of classified or otherwise restricted data (although the subsequent classified use of finished MDCC solutions, after submitted, is feasible and dependent on the needs of the respective classified user), whether originating from the Czech Ministry of Defence or from collaborating companies; therefore, the work draws exclusively on open sources, publishable materials, and data shared in accordance with contractual and security requirements, including access-control and anonymization measures where applicable. Finally, the proposed use cases and data-sharing mechanisms through the MDCC portal remain conceptual in nature and will require further refinement, testing, and validation under real operational and technical conditions.

5. Conclusions

Grounded in facts mentioned above, the argument consolidates around a simple thesis: the MDCC is a vehicle for institutional learning in MDO environment, and the UoD is its engine. By coupling doctrinal intent to experimentally validated concepts and then folding those concepts back into adjusted capability planning and PME syllabi, the Czech defense ecosystem can accelerate the transition from a politically declared level of ambition to functional operational deployment while remaining interoperable with NATO standards and processes.

Leveraging its academic, research, and methodological capabilities, the UoD is positioned to serve as an integrating element linking scientific inquiry, education, and operational practice within the Czech Ministry of Defence and the Armed Forces of the Czech Republic. The establishment of the MDCC represents a necessary step for modern armed forces facing increasing operational complexity and the imperative to integrate all operational domains into a coherent framework. The UoD possesses unique academic, research, and conceptual capabilities that position it as the natural core of this initiative and as a key partner in the long-term development of multi-domain competencies. By implementing the MDCC, the Armed Forces of the Czech Republic will significantly enhance their ability to operate effectively in a Multi-Domain environment, accelerate doctrinal development, strengthen interoperability, and improve the integration of scientific knowledge with operational practice.

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