Orchestrating Norway's Defense Ecosystem for Improved Utilization of its Innovation Capabilities

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This is a pre-copyedited version of a contribution published in 2026 21th Annual System of Systems Engineering Conference (SoSE) published by IEEE. The definitive authenticated version is available online at IEEE Explore: 10.1109/SoSE69681.2026.11622387

***Abstract* – As the global defense landscape continues to evolve, Norway's ability to orchestrate an ecosystem that takes advantage of its innovation capabilities will be essential in addressing both traditional and emerging security threats − startups and Small and Medium Enterprises operating in the technological trajectory plays an important role in achieving that goal. The defense landscape cannot thrive on public investments alone, as consequence, we need a deeper understanding of how to orchestrate the ecosystem.**

Due to the complexity of the issue at hand, a qualitative approach was taken, in form of in-depth interviews with relevant actors within the ecosystem, to get a better understanding of the current situation. The findings indicate that the Norwegian defense ecosystem could benefit from improving its ability to identify and take advantage of disruptive technologies developed outside the traditional defense boundaries and there seems to be challenges related to scalability for unconventional technologies which makes this difficult and should be investigated further, in addition to trust barriers, rigid procurement structures, and the need for better interaction between organizations within the ecosystem.

Keywords – Defense, Ecosystem, Innovation, Technology, Investments, Complex Systems, System of Systems

I. Introduction

According to NATO, 90 percent of all technology used for military purposes is produced and financed by the private sector alone. [1] But in Norway we see a reluctance from investors to invest their money in defense related technology businesses. The Norwegian defense sector is perceived as closed off and very complex with long and unpredictable decision processes. They describe the market as binary – meaning that there are few customers operating with long procurement processes – which increases the risk. Many of the investors also have little knowledge about the sector, and in addition to formal requirements, such as SDG standards, alongside informal barriers such as personal convictions there is little willingness to invest. To attract more venture capital from private investors the Norwegian Defense Research Establishment (FFI) suggest more openness around the needs in the sector and how the procurement processes are being handled, in addition to achieving better communication processes with potential suppliers early on, and introducing mechanisms for early testing, validation and qualification of new technology. [2]

The findings presented in this paper form part of a broader investigation into product innovation and strategies for reducing time-to-market for defense equipment for the Norwegian defense sector, and within this broader inquiry, the orchestration of the Norwegian defense ecosystem emerged as a critical factor in fully leveraging the nation's innovation capabilities. Because of the complexity of this challenge, a transdisciplinary approach was adopted, bringing together diverse stakeholder perspectives to enhance understanding and generate more holistic insights into the issue at hand.

The research questions highlighted in this paper are:

1. How is the current Norwegian defense ecosystem orchestrated?
2. What factors might explain the underutilization of technologies developed by startups and Small and Medium Enterprises (SMEs) by the Norwegian defense ecosystem?

The objective of this paper is not to offer definitive solutions, but rather to propose options that may positively influence or accelerate transitions toward greater technical excellence for Norwegian defense products and orchestrating an ecosystem that takes better advantage of its innovation capabilities. A more comprehensive examination of the ecosystem may give additional insights into strengthening technical superiority for Norwegian defense equipment. Therefore, additional research is strongly recommended.

II. Background

Norway faces its most serious security situation since World War II. Russia is rearming faster than expected, becoming more unpredictable and militarily strengthened, while great-power rivalry between the United States and China is intensifying. Security, economic, and technological dynamics are increasingly intertwined, and the growing partnership between China and Russia has significant implications for Norwegian and European security. [3]

Norway's National Security Strategy (2025) [4] calls for greater societal resilience and stronger economic security. Russia's war against Ukraine demands substantial resources and creates uncertainty, making support for Ukraine a high priority. [5] At the same time, transatlantic relations have become less predictable, and there is broad agreement within NATO that Europe must assume greater responsibility for its own security. Fairer burden-sharing and strengthened collective defense require higher European contributions. In response, Norway has an interest in reinforcing Europe's threats preventions by expanding defense production capacity, reducing delivery times, and promoting greater standardization of military equipment. [3]

To increase production capacity within the defense sector, the Norwegian government is planning to increase defense spending with approximately 600 billion NOK from 2025-2036. [6] By increasing the public spending, the Norwegian government is hoping to stimulate private investment. While increased demand in other sectors stimulate increased supply, the defense sector differs from other industries in a way where private investors are unsure about the future 'need' of defense equipment and the risk of overcapacity before collecting a yield on investments. The government alone cannot bear the cost of ensuring preparedness, and are relying on accelerated investments from private actors, to deliver according to plan. While the Norwegian armed forces could potentially operate sufficiently on equipment produced outside of Norway, there are certain areas that are crucial to Norway to maintain technological expertise and operating capacity in today's security situation. [7] The most important technological areas of expertise to Norway today are; Missile technology, Ammunition, propulsion technologies and military explosives, Command, control, information, communications and combat management systems, and Systems integration. [8]

According to NATO's Secretary General, approximately 90 percent of the technology used for military purposes is developed and financed by the private sector, particularly through venture capital. However, in Norway, there remains a noticeable reluctance among investors and companies to engage in defense-related businesses. Technological SMEs are important in the pursuit of technological advancements within the Norwegian defense sector, and for these businesses to accelerate and prosper, venture capital play's essential role. [2] The 'EU Defence Industry Transformation Roadmap: Unleashing Disruptive Innovation for Defence Readiness' also highlights the importance of startups operating in the same trajectory. It is no longer enough to have a solid military platform to be competitive and protect a nation's sovereignty. The defense equipment produced needs to take full advantage of the latest disruptive innovations that exist, where testing and embedding are essential to that process. Complex systems need to be combined with low costs and off-the-shelf products. [9]

In 2024, private founding of startups reached an all-time high for European countries, and more than 230 defense startups were founded. These companies are directly contributing to the acceleration and disruption of technological innovations and are bringing new forces into an already established defense industry. Agile and new adaptive approaches are essential to reduce response time of products to market and produce technologically superior products, in addition to maintain low cost in production. [9]

Even though we see that private investment in defense companies reached an all-time high in European countries, the reluctance to invest in defense companies in Norway is still a major concern. Olsen et al. (2025) asked the question why Norwegian investors are so hesitant to invest in defense related technology and they quickly realized that the answer is more complex that they first anticipated. The investors find it hard to access the end users and their needs because of security reasons. The acquisition process is perceived to be long (from demo to sales), there is limited transparency and the requirements for financial solvency and different certifications are high, in addition to limited places between investors and the actors operating in the defense sector. Strict ESG-requirements, (businesses environmental, social and governance impact [10]), have been cited as obstacles to innovation, with ESG-related issues often impeding progress. [2] The Norwegian Defense Pledge (2024) aim to simplify the formal requirement for public tenders, allowing for SMEs and startups to participate more easily, which could lower the barriers. [6]

Guntram Wolff, the economic defense expert and senior fellow at the Brussels think tank Bruegel and professor at the Université Libre de Bruxelles, highlights the importance of European countries to take full advantage of technological startups, especially startups specializing in IT, to compete in today's rapidly changing geopolitical environment. Today, most of the software used for military equipment are produced in the United States, making European countries entirely reliant on the United States and their software innovations. [11]

To understand innovation processes within the Norwegian defense sector, we often refer to the *Trekantmodellen* (the Triangle Model). This model describes the structured collaboration between the Norwegian Armed Forces, Norwegian Defense Research Establishment (FFI), and the defense industry. Together, these three actors form the foundation of defense-related innovation in Norway. Although materiel procurements carried out within this triangular framework vary significantly in scope and complexity, they share several common characteristics. Over time, the defense sector and Norwegian industry have developed a systematic approach to creating advanced, high-technology solutions in a highly cost-effective manner. Close user involvement, long-term cooperation, and shared risk between stakeholders have been key success factors. Compared to how research and development, industrial growth, and market introduction typically function in the civilian sector, the Triangle Model stands out with several distinctive features – particularly its integrated collaboration between end-user, research institution, and industry from an early stage. [12]

When we now are further strengthening the innovation capacity of the Armed Forces due to the current geopolitical environment [3], it is essential to understand what has contributed to this success. [12] Key elements that have been highlighted are the ability to mobilize civilian innovation and technology environments in the development of smart, cost-effective solutions for the Armed Forces. This requires broader collaboration with SMEs, startups, and entrepreneurial ecosystems, which often contribute significantly to rapid technological advancement. Dedicated arenas should be established where industry, operational users, and researchers can come together to collaborate on innovation, experimentation, and concept development – whether to mature new ideas or to address clearly defined operational challenges. The industry should have access to facilities that enable systematic experimentation, both in laboratory settings and in operational environments, which is essential. Such facilities can ensure that new solutions are tested for practical utility and interoperability with existing material and systems. Experience shows that early exposure of emerging solutions to user environments – combined with structured feedback loops to development teams – significantly accelerates iterative innovation and increases the likelihood of operational relevance and success. To fully realize these benefits, innovation efforts must be supported by more flexible procurement processes and tools. These should enable rapid acquisition, incremental upgrades, and the swift implementation of solutions that meet the evolving needs of the Armed Forces. [13]

III. RESEARCH DESIGN, METHODOLOGY AND METHODS

A. *Research design.*

The findings presented in this paper is part of a larger study where an exploratory case study design was applied to enable in-depth, contextual, and holistic analysis of the Norwegian defense ecosystem. The ecosystem's boundaries for the study were predefined based on the Norwegian defense own definition of the ecosystem. [14]

Within this broader frame of research, the orchestration of the Norwegian defense ecosystem with a particular emphasize on SMEs and startups to strengthening Norway's defense ecosystem emerged as a critical factor in fully leveraging Norway's innovation capabilities.

B. *Methodology.*

Given the "wicked" and systemic nature of the challenge, a transdisciplinary research methodology was adopted. This approach aims to integrate perspectives from various disciplines, such as academia, practitioners, and stakeholders to address complex societal problems that cannot be understood through a single disciplinary lens. It emphasizes stakeholder involvement, shared problem framing, and the co-creation of actionable knowledge, making it particularly suitable for analyzing innovation within a defense ecosystem operating in a dynamic geopolitical environment. [15]

To structure learning and intervention in this complex system, Soft Systems Methodology (SSM) was applied for the main study. SSM supports holistic analysis by incorporating multiple worldviews, social complexity, and systemic interdependencies. [16] It facilitates structured reflection and identification of feasible improvements within human activity systems [17] such as defense acquisition and innovation processes.

C. *Methods.*

The study is based on qualitative methods, primarily semi-structured in-depth interviews with stakeholders across different organizational levels within the ecosystem, as recommended by Bunkar et al. (2024). [15] Interviews were conducted digitally, recorded, and transcribed. Observation and ongoing contextual analysis complemented the interviews. Method triangulation and cross-level sampling were used to enhance validity. [18]

Data was analyzed using thematic analysis following Braun and Clarke's (2024) structured framework. [19] This flexible yet systematic approach enabled identification of recurring patterns and themes, forming the basis for the study's findings and recommendations for improving the current ecosystem structure and innovation capacity for the Norwegian defense sector.

IV. CONCEPTUAL MODEL OF THE DEFENSE ECOSYSTEM

Muller presented in the keynote presentation at the TNO-ESI symposium [20] in October 2025 a layer model of ecosystems, see Fig. 1. Higher layers are using and paying lower layers for products and services they deliver. The highest layer is society with consumer and government, "operators" serve them; in case of defense these are the military forces, like the army and navy. An acquisition and maintenance organization provides infrastructure and equipment and manages the assets that operators need, in Norway NDMA. Defense contractors execute development programs to supply the providers with procured solutions, often in the form of systems-of-systems. These contractors buy systems and components from suppliers and sub suppliers. Lower layers typically have more technical concerns, while higher layers have more operational, political and social concerns.

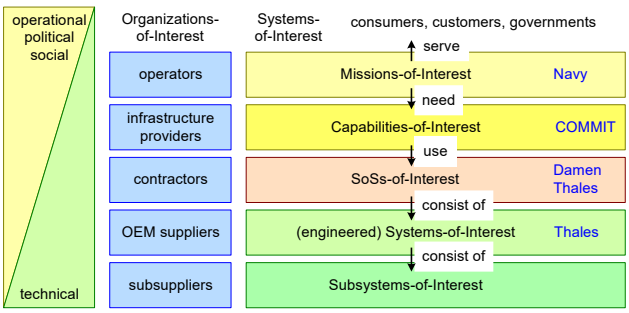

Fig. 1. Ecosystem layer model by Muller [19]

Fig. 2 shows a highly simplified representation of a national defense ecosystem. At the top there is the government and the politicians that govern the Ministry of Defense (MoD). The MoD defines the policies, regulates, and determines the funding for the navy, army, and air force. These forces operate based on the doctrines and standards. Most of the time during peace, the majority of military personnel are training to ensure that they can deliver their capabilities. The material agency procures equipment, materials, and services. For updated or new capabilities, they run programs to obtain the desired capability from the ecosystem. A significant part of the assets has lifetimes of decades, requiring long-term life cycle support. This difference is causing a trust barrier, since the organizations have different drivers and value systems. Defense organizations deploy a few governmental organizations to offer consultancy, e.g. during the acquisition process. In Norway, FFI supports defense with consultancy and research. Contractors, OEM-companies, sub suppliers and start-ups are commercial organizations.

There is a fundamental boundary between governmental and commercial organizations. Governmental organizations operate strictly within the ministry's governance, where decisions and spending need justification from politicians and the public. Commercial organizations tend to sell to multiple countries, where they primarily will satisfy the shareholders.

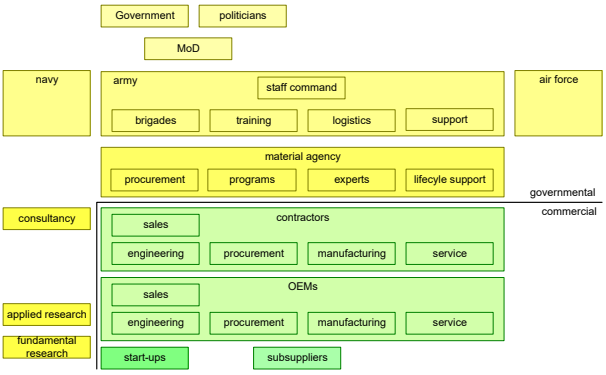

Fig. 2. Highly simplified presentation of a national defense ecosystem from Muller [21]

V. ORCHESTRATION

Developing, delivering, and sustaining updated and new capabilities, require the cooperation of all these organizations, across organizational boundaries. This requires active orchestration within and across layers, as Fig 3. is showing. Orchestrators will typically be part of one of the organizations themselves without any formal mandate over other

organizations. A major challenge of the defense ecosystem is its size and number of organizational boundaries, causing many information boundaries and handovers. Bøe [22] found 7 handover moments from actual user to engineer in the supplying organization. Each handover increases the risk of deformation and loss, like the whisper game. Muller [20] proposes a network of orchestrators that together must orchestrate the ecosystem to deliver the desired capabilities.

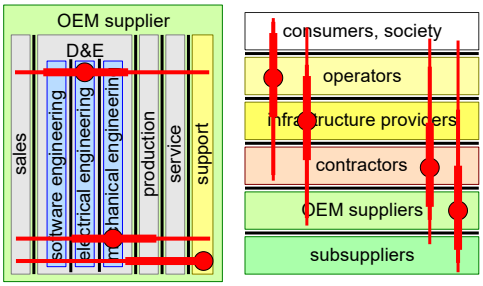

Fig. 3. Orchestrators within and across layers from Muller [19]

Fig. 4. shows what Muller [20] proposes as orchestration in terms of personal competency and organizational capability. The goal of orchestration is to ensure that the parties together deliver a fitting solution. This requires from orchestrators that they can work with a wide variety of stakeholders, e.g. understanding their interests and concerns, connecting them in a way that the orchestrators can influence the stakeholders. A challenge is to cope with ecosystem complexity, uncertainties, and unknowns themselves, as well as helping the stakeholders to navigate them. Necessary attitudes are seeing the big picture, while having eye for the devilish details, taking ownership of problems, needs, and solutions, to be pro-active, and to be genuinely interested in stakeholders.

- **Orchestrating** is the competence to **proactively nudge** involved **parties** towards a **fitting solution**.
- Orchestrating requires the abilities:
  - to relate with a wide **variety of stakeholders**, to understand their **interests** and **concerns**, to **connect** with them such that they can **influence** them
  - to **understand** the **problem and solution space** sufficiently
  - coping with **ecosystem complexity**, **uncertainties** and **unknowns**, and helping stakeholders to navigate them
- Orchestrating requires the attitudes:
  - to see the **big picture**, while still have an eye for the devilish details
  - to **own**
  - to be **pro-active**
  - to be **genuinely interested** in stakeholders

Fig. 4. Orchestration as personal competency and organizational capability from Muller [20]

VI. Findings

Question 1. As illustrated in Figure 2, the Norwegian defense ecosystem is largely structured as a hierarchical governance model. At the top, the Norwegian Government determines the allocation of public resources. The Ministry of Defense (MoD) holds overall responsibility for defense policy and exercises its authority primarily through the 'Norwegian Defence Materiel Agency' (NDMA), which is responsible for defense-related acquisitions.

Operational needs are articulated by the Norwegian Armed Forces, including the Army, and communicated to NDMA. Based on these inputs, NDMA translates capability needs into formal system requirements and manages the procurement process with its main suppliers. These suppliers, in turn, develop and deliver defense materiel in accordance with the specifications defined by NDMA.

Within this structure, communication flows predominantly in a top-down manner. Interaction between main contractors and sub suppliers is limited in the early phases of requirement definition, and prime contractors largely depend on the formal requirements issued by NDMA. As a result, the production of Norwegian defense products is primarily requirement-driven, with limited horizontal integration across industrial tiers during the initial stages of capability development.

Question 2. The findings indicate a general reluctance among investors to engage in defense-related industries. Several structural barriers contribute to this hesitation. Investors report difficulty accessing end users and understanding operational needs due to security constraints. The acquisition process is perceived as lengthy – from demonstration to confirmed sales – with limited transparency throughout the process. In addition, high requirements for financial solidity, compliance certifications, and regulatory approvals create significant entry barriers. There are also few structured arenas where investors can regularly interact with defense-sector actors. Strict ESG-requirements are frequently cited as an additional obstacle, with defense-related investments often falling outside prevailing sustainability criteria.

Main contractors tend to rely on established partnerships and proven suppliers, often prioritizing predictability over exploration of new actors. Often, startups and smaller SMEs lack the production capacity, financial robustness, and infrastructure required to scale up in line with the demands of major defense contracts.

The findings also point to a degree of mistrust between public and private actors. Rigid requirement systems reinforce this presumption. Even though this system is in place to reinsure for ESG-requirements are being followed, this may contribute to misunderstandings, excessive caution, and protective behavior that limit effective knowledge sharing and the optimal utilization of available human and technological resources. Several stakeholders note that traditionally hierarchical defense structures – common across parts of Europe – may constrain the participation of smaller actors in early-phase development processes. Large financial commitments and the high consequences of failure also appear to reinforce a risk-averse culture. A traditionally hierarchical professional background among many actors within the ecosystem seems to further strengthen this tendency. In addition, a broader societal hesitation toward defense-related investments may contribute to the underutilization of startup technologies due to limited access to capital.

The study highlights a continued need for structured meeting arenas where investors, startups, and defense stakeholders can interact. Initiatives similar to Brave1 in Ukraine – designed to connect defense innovators with funding and operational stakeholders – illustrate how dedicated platforms can reduce barriers, build trust, and increase investment in advanced technological solutions.

VII. Discussions

Due to current geopolitical environment, rapid technological advancements and new ways of doing warfare, orchestration of defense ecosystems can be lifechanging. More agile and adaptive frameworks are required – both in innovation processes and procurement structures. Such approaches are essential to shorten time-to-market, deliver technologically superior solutions, and maintain cost-efficient production in an increasingly complex and fast-moving security environment. In 2024, private funding for start-ups

reached a record level across Europe, with more than 230 new defense-oriented companies established. These emerging firms are actively accelerating technological development and introducing disruptive innovations into a traditionally established defense industry. By bringing new capabilities, business models, and development approaches, they are reshaping competitive dynamics within the sector. [9]

Although private investment in defense companies reached record levels across Europe in 2024, investor reluctance remains a significant challenge in Norway. Olsen et al. (2025) examined why Norwegian investors appear hesitant to engage in defense-related technologies and found that the explanation is more complex than initially assumed. Investors report limited access to end users and operational needs, largely due to security restrictions. The acquisition process is perceived as lengthy – from demonstration to commercial contract – with low transparency throughout. High requirements for financial robustness, compliance certifications, and formal approvals further raise the threshold for entry. In addition, there are relatively few structured arenas where investors can interact directly with defense-sector actors, in addition to strict ESG-requirements. [2]

In 2025 Muller presented a layered ecosystem model that would be useful in the effort of orchestrating the Norwegian defense ecosystem for improved utilization of its innovation capabilities. To develop, deliver, and sustain defense capabilities, coordinated action across all layers is required. A fundamental boundary exists between governmental and commercial organizations, as they operate under different governance structures, incentives, and value systems. This structural divide, combined with long asset life cycles, can create trust barriers. Muller therefore emphasizes the need for active orchestration within and between layers. Orchestrators – often without formal authority – must align stakeholders across numerous organizational and informational boundaries. [20] The ecosystem's size and complexity increase the risk of information distortion, particularly during handovers; research has identified multiple critical transfer points from end user to engineer. [22] Muller proposes a network of orchestrators who collectively ensure that the ecosystem delivers coherent and effective capabilities. Effective orchestration demands both individual competencies and organizational capabilities. Orchestrators must understand diverse stakeholder interests, manage complexity and uncertainty, bridge boundaries, and maintain a balance between strategic overview and attention to detail. Above all, they must take proactive ownership and foster trust to ensure that the ecosystem delivers fit-for-purpose solutions. [19]

Additional findings indicate that main contractors predominantly rely on established partnerships and familiar suppliers, favoring predictability and reduced risk over engagement with new or emerging actors. At the same time, startups and smaller SMEs often lack production capacity, financial resilience, and organizational infrastructure required to scale up in accordance with the demands of large defense contracts. This structural mismatch limits their participation in major programs. A perceived closed market combined with high financial stakes and the significant consequences of failure appear to contribute to a risk-averse culture. A broader societal hesitance toward defense-related investments may also contribute to the underutilization of startup technologies, particularly through limited access to capital. Rigid system requirements and little room for product innovation from suppliers' side is also highlighted as a hindrance of optimal utilization of the ecosystem's innovation capabilities. The findings underscore the importance of establishing structured arenas where investors, startups, and defense stakeholders can interact more systematically. Initiatives such as Brave1 in Ukraine – created to connect defense innovators with funding sources and operational users – demonstrate how dedicated platforms can lower barriers, strengthen trust, and stimulate investment in advanced technological solutions.

VIII. Conclusion

The aim for this paper was to take a closer look at the Norwegian defense ecosystem and possibly highlight factors to improve utilizations of its innovation capabilities. First, we wanted to look at how the ecosystem is currently structured and secondly what factors might explain the underutilization of technologies developed by startups and SMEs. The research shows that to remain operationally relevant, Norway must adopt more agile and adaptive innovation and procurement frameworks capable of shortening time-to-market, delivering technologically superior capabilities, and maintaining cost efficiency in a complex and fast-moving security environment. While Europe has witnessed record levels of private investment in technological startups Norway continues to face structural barriers that constrain capital flow and innovation uptake. Limited transparency in acquisition processes, restricted access to end users, high entry requirements, ESG-constraints, and insufficient interaction arenas between investors and defense actors, in addition limited scalability for startups and SMEs collectively could reduce the attractiveness of the Norwegian defense market. The findings suggest that cultural factors – such as risk aversion, hierarchical traditions, and societal ambivalence toward defense investments – contribute to underutilization of emerging technologies. Rigid requirement structures and limited flexibility for supplier-driven innovation further constrain the ecosystem's adaptive capacity. To unlock Norway's full innovation potential, structured arenas that facilitate systematic interaction between investors, startups, established industry actors, and defense stakeholders are crucial. Initiatives such as Brave1 illustrate how dedicated platforms can lower barriers, build trust, and accelerate the integration of advanced technologies into operational capabilities. Ultimately, strengthening Norway's ability to orchestrate its defense ecosystem – across institutional, industrial, and financial boundaries – would be beneficial for enhancing innovation performance, reducing response time, and ensuring future-ready defense capabilities.

Acknowledgment

We would like to give a special thanks to all stakeholders who contributed to this research.

ChatGPT (GPT-4) was used to assist with text formatting, language refinement, and translation support. All findings, analyses, discussions, and conclusions presented in this paper are solely the authors own work.

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