Centre for International Governance Innovation

Digital Policy Hub

Digital Policy Hub – Working Paper

Buying Defence in the Digital Age

Mark Robbins

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The Digital Policy Hub at CIGI is a collaborative space for emerging scholars and innovative thinkers from the social, natural and applied sciences. It provides opportunities for undergraduate and graduate students and post-doctoral and visiting fellows to share and develop research on the rapid evolution and governance of transformative technologies. The Hub is founded on transdisciplinary approaches that seek to increase understanding of the socio-economic and technological impacts of digitalization and improve the quality and relevance of related research. Core research areas include data, economy and society; artificial intelligence; outer space; digitalization, security and democracy; and the environment and natural resources.

The Digital Policy Hub working papers are the product of research related to the Hub's identified themes prepared by participants during their fellowship.

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The Centre for International Governance Innovation (CIGI) is an independent, non-partisan think tank whose peer-reviewed research and trusted analysis influence policy makers to innovate. Our global network of multidisciplinary researchers and strategic partnerships provide policy solutions for the digital era with one goal: to improve people's lives everywhere. Headquartered in Waterloo, Canada, CIGI has received support from the Government of Canada, the Government of Ontario and founder Jim Balsillie.

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Policy Memo

CIGI | Digital Policy Hub

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Bottom Line Up Front

Defence supply is highly tuned to the industrial age. While this has serviced the needs of large-scale production and long-term capacity to produce materials and equipment, there are signs that this structure of defence production is beginning to crumble under the strain of technological progress, accelerated adaptation on the modern battlefield and exigent demand for scale. This working paper investigates how digital technologies and new market dynamics are bypassing traditional defence intermediaries, examining the shift from research and development (R&D) lead by legacy defence contractors to smaller, agile firms and non-traditional players leveraging emerging technologies, and how tangled national defence value chains are being challenged micro-production. The paper argues that the defence industry is at a moment of sea change in the digital revolution, and yet the defence procurement system is still designed around the assumptions of a defence supply ecosystem that is long past.

Key Points

- Defence production is built on industrial-era assumptions and the procurement system supporting it likewise is based on industrial-era assumptions of innovation and firm dynamics. These are proving increasingly outdated for the digital age.
- As digital-era technologies break apart assumptions of firm size and composition, asymmetric actors and militaries that bypass traditional procurement structures have achieved remarkable success in generating military effect through disintermediated production.
- Generating a new format, not just with niche programs at the margins of defence procurement but at the centre, which embraces digital innovation principles as a default, will be essential to generating relevant military effect and sustainable innovation and production practices.

Recommendations

- **Procedural recognition that innovation increasingly follows small scale:** Government procurement has historically assumed that R&D is the purview of large, siloed, industrial-era companies. The current wave of digital innovation, by contrast, is generally small-scale, open and radically accessible. Recognize this new character of innovation as ordinary and normal, rather than an exception to be accommodated, is essential, and this new reality needs to be reflected in how day-to-day procurement is conducted and procurement opportunities are designed.
- **Service standards and assessment criteria that match the pace and character of innovation:** Traditional defence supply has followed a certain pattern of assumptions about timeliness, scale, opportunities for synergy, and direct collaboration/experimentation between users and suppliers, but these are appearing vastly out of date considering recent conflicts, such as in Ukraine. There must be a practical recognition that speed, sandboxing and synergy are lodestars to the successes that other countries are having in their procurement of defence innovation.
- **Scale to match the importance and urgency of the defence innovation need:** The nature of interstate competition is changing. Success or failure will increasingly depend on the ability to leverage all the instruments of national power in interstate competitions which are marked more by the ability to systematically innovate across all domains. Canada's level of initiative, in whatever form(s) it takes, will need to be grand enough to match this.

Introduction

Supplying the military with its material and technological needs is not a normal business. The military has exceedingly diverse needs ranging from arms to radios, clothing, housing, medicine, food, satellites and so on seemingly to infinity, which must all be produced to unique requirements at a mass scale. With the martial imperative generating unique requirements, military supply has required variation from commercially available equivalents of nearly everything that can be produced. The direct consequence is that supply and provision of the defence establishment has traditionally been focused on bespoke solutions designed according to military specifications and at irregular volumes. These needs have been provisioned by a small network of suppliers who specialize in servicing monopsony requirements stemming from unique tradecraft and secrecy, rather than being what would normally be considered as open to free competition from civilian commercial products.

Taken as a whole, the supply of military organizations is among the biggest logistical and administrative undertakings that humanity has ever invented. The military's needs have created a unique ecosystem of suppliers to the defence industry and one which has its own distinct relationship with the concept of digital innovation. For one, defence suppliers tend to specialize in working with militaries and defence organizations at the expense of other digital or innovation companies who might rightly be good peers to cross pollinate ideas with. While concepts such as "dual use" and "military spin-outs" are popular and attractive, they are a relative rarity in the real world. Whether it be the individual craftsman specializing in the best ironwork for medieval knights, or present-day aerospace engineers developing and deploying stealth technology on fighter jets, the business of innovative military supply has tended to be insular and stovepiped to those working directly in the defence establishment.

This is easy to critique in the digital age where all innovation is highly networked, but the reality is that there are a multiplicity of structural reasons for why the defence innovation ecosystem is the way it is including:

- the necessity of secrecy and tradecraft to prevent the diffusion of defence innovations to potential adversaries;
- the security and reliability of supply;
- the technical importance of hyper specialization in the development of a martial advantage;
- the improbability of meaningfully compatible dual-uses for defence technologies; and
- the impracticality of running a profitable business with such dramatic ebbs and flows of demand.

While there is always great interest in the exceptions to the rule — namely, cases in which defence suppliers have created military products that meet a military requirement effectively while also servicing a commercial civilian need at a competitive

market rate — the fact remains that the needs of the defence establishment tend to create a special class of suppliers that are unique in form and function.[1]

These defence suppliers tend to be large complex organizations organized according to traditional bureaucratic corporate structures. BAE Systems (107,000 employees), General Dynamics (117,000 employees), Lockheed Martin (121,000 employees), Northrop Grumman (97,000 employees) and RTX Technologies/Raytheon (189,000 employees) — all commonly referred to as defence prime contractors — are companies that individually represent a personnel count larger than most countries' militaries. They are large, publicly traded companies with significant presence globally and their own internal bureaucratic processes to match the enormity of their tasks and workflow. These are quintessential industrial-age organizations that reliably and effectively produce industrial-age products for defence and tend to be preferred by governments seeking to purchase defence supply, even while this approach is increasingly looking out of step with the innovations driving and leading the digital revolution. While there are several reasons that could explain this trend, this paper specifically focuses on one of them: namely, the issue of government procurement.

Procuring Innovation

At its core, government procurement is the system of formalized procedures and structures that exist to manifest supply and purchase outcomes that are repeatable, defensible, and compliant with a myriad of overlapping requirements, regulations and legal authorities. This includes rules from national governments as well as those stemming from supranational trade agreements that ultimately define much of the minutiae of the procurement process. Procurement policies, frequently maligned, in fact exist for good reasons, namely to make government acquisition open, fair, transparent and honest using a competitive process to advance government objectives. Taken as a whole (in theory at least), the comprehensiveness of the procurement process routinely produces the best results for the best price. This is generally true when the subject of procurement is industrial-age goods such as chairs, cubicles, stationary and the like, but the same structure hinders the effective acquisition of innovative digital-age defence equipment and technology (Clarke 2019).

In the industrial age, it was normal and natural for innovation and research and development (R&D) to be stovepiped to large organizations that possessed the capital density and clustering of expertise required to support innovation. As a result, large corporate structures routinely proved most effective for generating innovative (defence) products. This also aligned well with the structure of government that was uniquely designed to accumulate unique expertise and decision-making ability to manage supply and make procurement decisions. Such a system has the potential to be mutually reinforcing since the two organization types understand each other well and are optimized for speaking with one another. In the information age, many of the

1 It is difficult to imagine another form of business that by design must be able to supply, say, anywhere between 100 and one million units of artillery shells at any given time with no prospects of alternative sales channels since, naturally, it is illegal for these items to be sold to private citizens, most civilians and all but a select few foreign governments with the correct geopolitical alignment.

innovation advantages ascribed to large organizational structures are much more widely and transparently accessible across organization types. This has encouraged “open innovation,” or the pattern whereby innovative ideas are sourced and enriched from outside one’s own organizational structure rather than solely from within it. This pattern — in combination with the tendency for small organizations to be administratively more rapid, nimble and agile — has meant that in the present era, innovation is concentrated in start-ups and scale-ups more than in in-house corporate or government labs.

The failure of the industrial age defence procurement approach to capture the technological zeitgeist of the present is especially pronounced with respect to the small, nimble and upstart companies that lead much of the twenty-first century’s innovation process. This failure is ultimately because the requirements for government procurement tend to bloat from risk mitigation efforts into omnibus contracts that few but the largest companies can successfully bid to complete (Clarke 2024). Noteworthy examples might include well-intentioned requirements for a 10-year work history (disqualifying start-ups); prior awards of defence contracts (disqualifying start-ups and horizontal market entrants); scale production (disqualifying small businesses) and the like. This tendency becomes especially worrying as the innovative technologies of the digital age frequently emerge from companies that are smaller, younger and faster than the traditional industrial-era companies that typify defence suppliers. While all these requirements respond to a real defence need as markers of quality and reliability in defence supply, they risk functionally insulating the defence sector from innovation occurring in wider industry when taken as a whole (Borger 2025).

Indeed, large companies increasingly focus on using start-ups for their own innovation, either by creating supportive environments for spin-outs, and/or by supporting and ultimately acquiring innovative firms, rather than fully in-sourcing their own innovation (Robbins and Crelinsten 2018). And yet, even in cases where the requirements of defence can be easily met by upstart firms, often the administrative requirements of government contracting prove prohibitive to participation. A request for proposal (RFP) is the normal interaction point for prospective suppliers, a document that will routinely exceed 100 pages and require a bid submission of a similar length by way of reply. While this administrative burden of government contracting may be small for a company with 10,000-plus employees, it is prohibitive for the small (under 100 employees) and micro (under five employees) firms that typify much of the digital age’s cutting-edge innovation. While the reality is that innovation is concentrated in smaller firms and start-ups, the system for sourcing defence innovation has not reflected this in the way its interactions are designed.

Natural Experiments

As a natural experiment to prove this case, the success that asymmetric actors, including violent extremist groups, have had in their ability to source equipment for generating military effect can be examined. Though much smaller in scale than conventional militaries, these groups have routinely proven their ability to access and leverage digitally forward emerging technologies such as artificial intelligence, 3D printing and drones at comparable, and sometimes faster, pace than traditional military actors (Ahmad 2025). This is in no small measure due to the fact that digital-age technologies support

small organization sizes in a way that the complexity of say, fighter jets, do not. It is also perhaps not unrelated to note that violent extremists and terror organizations tend to be none too preoccupied with their compliance obligations under procurement procedures or international trade law, all but eliminating their administrative barriers to entry.

The war in Ukraine (2022 to present) provides another interesting case in point since the urgency of the material needs in the conflict led, at least initially, to a jettisoning of procurement procedures and a downstream flourishing of small and micro-defence suppliers offering highly innovative defence products. Specifically, a Ukrainian cabinet directive allowed the military to forgo the regular procurement process under the auspices of martial law (Cabinet of Ministers of Ukraine 2022). As a result, the number of Ukrainian defence start-ups went from roughly 50 before the start of the war in 2022 to roughly 300 in 2023 and as many as 1,000 in 2024. Naturally, the size of Ukraine's defence spending increased during this period as well — from roughly three percent of GDP in 2022 to around 30 percent of GDP in 2025 — but the Ukrainian government also claims that the proportion of defence spending going to domestic suppliers has steadily increased as well due to its support of defence start-up culture, with as much as 70 percent of its defence needs being supplied by Ukrainian companies in 2025 versus 45 percent in 2024 (Prots 2025).

Given that it was employed as an emergency measure and not as a viable policy for peacetime circumstances under multilateral rules, the removal of procurement rules is not particularly important. More significant to note, however, are the activity types that subsequently flourished in the absence of formal procurement structures, which included the emergence of short feedback loops between developers of military goods and military users, creating fast development cycles and constant product iteration. The lessening of formal structures comes with negative trade-offs as well, such as poor standardization, more variability in quality assurance and questionable (if not corrupt) pricing by suppliers; all things that the procurement system is designed to protect against. As the war entered its second year and Ukraine began to systematize some of its early lessons into formalized structures — as with the launch of the Brave1 defence accelerator in 2023 — the institutionalization of rapid development cycles was front and centre of positive procurement innovations that were to be preserved.

Indeed, much of Brave1's mandate is precisely to facilitate these interactions and rapid feedback loops between innovators and the military user base. This constructive connectivity between small nimble suppliers and the Ukrainian military is generally regarded as more important to Brave1's success than the modest financial support to innovators. In fact, it is remarkable to note the consistency with which this natural experiment reproduced some of the best practices of digital innovation and technology start-ups in a military environment. Defence products typically undergo multi-year, if not multi-decade, design, test and iteration cycles. This is generally understood to be a necessary and unavoidable function that is specific to defence equipment and fundamentally unchangeable. With many Ukrainian defence products originating from within a digitally native start-up culture, marked by rapid iteration and condensed development periods, it is worth questioning if this is the natural state of innovation in defence as well, albeit one hitherto suppressed by the industrial-era defence procurement system.

It is also worth noting the extent to which the examples above have leveraged, to the surprise of many, Commercial Off-The-Shelf (COTs) technologies. Some of the most impressive military innovations from Ukraine and asymmetric actors has been their ability to adapt commercial products off the shelf into militarily relevant products, the most eye-catching of which has been drone warfare. This is a controversial subject which will receive full treatment in an upcoming CIGI working paper, but it is worth noting here that COTs in defence follow the most radical paradigm for defence supply, opening up large segments of the defence enterprise to fully open innovation and integration to the R&D landscape for commercial products. Several observers have noted that the use of COTs, while making some sacrifices in the specificity and customization of the products for military use, have the added advantage of leveraging the global commercial R&D sector instead of just national defence R&D sectors (Baldwin 2024).

One of the dynamics at play in this is the observation that the global R&D budget for commercial goods and services is significantly higher than any national R&D budget for defence budgets, with global R&D for commercial goods in 2025 representing $1.3 trillion USD. By comparison, the single largest country for defence expenditure on R&D, the United States, spends approximately 10 percent of that at $1.43 billion USD per year on defence R&D (Blevins et al. 2025). If there is the ability for commercial cross over into military applications, not only does this bridge access to a much larger R&D budget but also one which is fed by a blend of public and private dollars. All and all, there is a growing awareness of the importance of commercial and dual use-innovation to the wider defence ecosystem, punctuated by the 2025 Hague Declaration that future North Atlantic Treaty Organization defence spending targets would include 1.5 percent of GDP that could be more flexibility allocated to arenas not represented in the traditional defence budget (Murphy, Forrest and Samson 2025).

Injecting Digital Innovation

In a peacetime environment and (happily) absent a catastrophic military emergency, there is unlikely to be a radical break with the existing procurement system whose trajectory is steered by the weight of history, procedure, international law and the network effect of global trade agreements. While organizations such as the Defense Advanced Research Projects Agency (DARPA) may conjure up an aura of mystic and innovation success, it is important to recall that these kinds of organizations are bolted on to existing procurement mechanisms, existing only because normal processes alone were not sufficient in creating the desired innovation pipeline. This observation may be a tired one, but it is no less true from repetition. The limitations of injecting digital innovation into defence are well known and have persisted through multiple generations of initiatives which all sought to add the appropriate features that would offset the defence establishment's allergy to digital innovation.

It is possible to characterize these procurement innovation initiatives into four broad categories:

- **Small business tenders:** Government procurement opportunities are designed specifically with R&D-intensive small businesses in mind, minimizing administrative burden, reducing corporate history requirements and increasing accessibility to small firms.

Example: Innovative Solutions Canada challenge procurement, Innovation for Defence Excellence and Security (IDEaS) contests, DARPA challenges

- **Set asides:** A mandated proportion of procurement activity must be done in an innovative way. This could be government-wide (one percent of procurement activity must be through a start-up) or within a wider contract (10 percent of all contract value must be subcontracted to a Canadian start-up).

Example: The Innovative Solutions Canada program, IDEaS program competitive projects, Industrial Technological Benefits credits

- **Chaperone services:** A dedicated office to help innovative entities to navigate the complexity of government and benefit fully from the opportunities of supplying to government.

Example: The Accelerated Growth Service, IDEaS Counter-Uncrewed Aerial Systems Sandbox, GCXpo, Brave1

- **Micro-contracting:** A service or interface to disintermediate between contributors and the large purchaser, allowing small organizations or even individuals to win microcontracts for individual pieces of work.

Example: Bountysource, Topcoder, the National Aeronautics and Space Administration's Open Innovation program

These programs and initiatives serve to improve the posture of the defence procurement ecosystem and are largely successful. This is not to say that they have individually transformed defence innovation and digital defence procurement and that this work is done, but rather that within their defined scopes of action, these programs tend to accomplish their objectives and hit their programmatic targets. The question is whether these types of defence innovation add-ons are sufficient for responding to the emerging character of war in the 2020s and beyond. While it would seem quite clear that more needs to be done, it is unclear how far reform in defence innovation and defence digital procurement can and should go. This may be especially germane as the nature of war itself is changing.

The Ukraine conflict shows routine evidence that the development cycles for new military innovations have increased to a pace previously assumed impossible. In drone warfare specifically, the standard development cycle for new generations of the technology is generally noted at four to six weeks between iterations, compared to the more standard practice in routine defence procurement of four to six years (Pusztaszeri and Harding 2025). For this to take place, there has been a complete teardown and reconstruction of the basic assumptions of defence supply and innovation, with many describing the essence of victory being about which military can innovate and successfully adopt innovations faster. While defence procurement has always been viewed as a question of supplying the needs that the military has defined for itself, what happens when innovation in defence has become sufficiently rapid that military requirements are defined in battle, with new militarily relevant technologies being invented before the military can ask for them?

The defence procurement system is increasingly face to face with this problem, whether this is widely understood or not. While these kinds of policy and programmatic

interventions are necessary in buoying the innovative capacity of the defence procurement system, none of them represent a silver bullet which has "solved" the requirement for injecting innovation into defence, much less so in the present threat environment. These interventions represent at best some form of progress along a pathway to a future state for defence innovation, a new state that is not yet known. While it is difficult to go full speed to an unknown destination, it is nonetheless possible to progress even if only the general direction is known. Whatever the future iteration of defence innovation procurement looks like in Canada, it will be marked by and measured against five essential criteria that will ultimately go hand in hand with both in-sourcing innovation and using procurement to spur innovation.

- **Speedy**

Government procurement timelines are extremely slow by today's standards, both for supplying the needs of the defence establishment as well as for meeting the basic requirements of innovative firms to move quickly. The speed for evaluating proposals, awarding contracts and executing on financial transfers needs to match at minimum the speed of relevance that in many cases is an order of magnitude faster than common practice.

- **Small**

Procurement needs to be accessible to small- and medium-sized businesses by default and design. This means reducing bidder requirements that functionally exclude small suppliers, reducing the complexity and size of (omnibus) contracts to improve competitors, and minimizing the administrative burden of application by making RFPs and RFP proposal requirements as streamlined as possible.

- **Sandbox**

Continue the successful emphasis on experimentation intrinsic to existing innovation programs and increase their frequency and scale. Develop more opportunities for sandboxing military innovations particularly with regard to giving innovators opportunities to connect with military users and use-cases. Evidence suggests that frequent contact with the user-base makes for more rapid development cycles and more effective user-driven innovation. Sandboxing should also apply to innovation procurement as well, with increasing efforts to experiment in the "how" of innovation procurement.

- **Scaled**

Successful initiatives need to be scaled for a continuous innovation flywheel to work. This means scaling successful innovations both in terms of how the defence innovation system works, taking models such as IDEaS and encouraging them to grow, and in the individual innovation collaborations. A successful defence innovation collaboration that remains limited as an experiment, rather than as a scaled production, is insufficient to address the challenges of the day or effectively support an innovation ecosystem.

- **Synergy**

The challenges of the defence sector are too large to be addressed by defence R&D budgets alone. Any improvements in defence innovation must break down the silos between all instruments of national power both to help generate greater military effect

and also to ensure that the benefits of public R&D funding through the defence sector have the widest possibility of supporting downstream commercialization.

These five criteria, with some minor variation, will define the success of military procurement in generating and sourcing innovation. While lumbering organizations and long timelines may have defined the industrial age, success in present-day military innovation will be defined by the character of the digital age, and our defence procurement systems must adapt to this reality. While this is going to mean a lot more defence start-ups, hackathons, "grass shoots" and creative destruction than is common in government procurement, innovation will never be an exclusive purview of nimble start-ups. The successful ventures and products of the industrial age will remain essential to the future of conflict as well. While history may remember the Blitzkrieg for the German Panzer tank — the era-defining land warfare innovation of the time — all told the German military used 46,000 Panzers in the Second World War side by side with 2.7 million horses, the technology of the proceeding age. Today's requirement is not supplanting incumbent firms and technologies, but rather ensuring that all elements of the defence supply chain are able to meet the spirit of the time.

Concluding Observations

While a subject of continuous evolution, war has been generally defined as a distinct arena for interstate competition used to decide matters of national interest. These interstate competitions represent the best technology, material, manpower and training that each side can muster to gain a geopolitical high ground, from which other issues can be decided. At its core this is unlikely to change, but the role of technology and innovation in this contest is increasingly becoming centre stage, particularly as the nature of interstate competition bleeds out from a specific and siloed arena of competition into a more general competition between all the instruments of national power. The lines between conflict and stasis and between war and peace have indeed blurred with increasing pace since the end of the Cold War era, with the emergence of terms such as "conditions less than peace," "hybrid warfare," "gray conflict" and "unrestricted warfare" being increasingly common in describing contemporary conflict.

Often referenced as the keystone text in the evolution of war in the twenty-first century, *Unrestricted Warfare*, written by then colonels Liang and Xiangsui of the People's Liberation Army of China, references the changing nature of warfare:

> Ever since early man went from hunting animals to slaughtering his own kind, people have been equipping the giant beast for action…with soldiers, weapons and a battlefield. The problem comes when people discover that all of these basic elements, which seemingly were hard and fast, have changed so that it is impossible to get a firm grip on them. When that day comes, is the war god's face still distinct?…Does a single hacker attack count as a hostile act or not? Can using financial instruments to destroy a country's economy be seen as a battle?…[All the boundaries lying between the two worlds of war and non-war, of military and non-military (are) totally destroyed. (Liang and Xiangsui 1999, 34–36, 50–55)

In the 2020s, Liang and Xiangsui's predictions regarding the shifting boundaries of war and non-war are proving prophetic. In Ukraine, for example, both sides are engaging in intelligence crowdfunding, cyberwarfare, independent financial attacks and innovation bootstrapping in defence production, with both private citizens and soldier-developers creating their own defence products iteratively and under time lines and innovation processes previously deemed to be impossible. The future of war and of peace will be increasingly defined by the ability of militaries to out-innovate one another according to the principles of digital-age innovation, which is increasingly occupying the high ground for other instruments of national power as it drives economic, military and social variables.

As evidence continues to mount that these traditional boundaries between war and peace have been surpassed, the question becomes not whether existing initiatives for bringing digital innovation into defence procurement have met their stated objectives, but instead whether their stated objectives are sufficiently ambitious to meet the evolving character of war and interstate competition. Being able to ensure that procurement is a steady force for innovation, commensurate with all the best practices of the digital age, will be increasingly a foundational requirement for success in our world.

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