Conference Report

Advanced Technology and Economic Resilience

Joseph Jarnecki
Advanced Technology and Economic Resilience

Joseph Jarnecki

RUSI Conference Report, February 2023

Royal United Services Institute for Defence and Security Studies
192 years of independent thinking on defence and security

The Royal United Services Institute (RUSI) is the world’s oldest and the UK’s leading defence and security think tank. Its mission is to inform, influence and enhance public debate on a safer and more stable world. RUSI is a research-led institute, producing independent, practical and innovative analysis to address today’s complex challenges.

Since its foundation in 1831, RUSI has relied on its members to support its activities. Together with revenue from research, publications and conferences, RUSI has sustained its political independence for 192 years.

The views expressed in this publication are those of the author, and do not reflect the views of RUSI or any other institution.

Published in 2023 by the Royal United Services Institute for Defence and Security Studies.

This work is licensed under a Creative Commons Attribution – Non-Commercial – No-Derivatives 4.0 International Licence. For more information, see <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Advanced Technology and Economic Resilience

Introduction

This report was produced and the ATER event series occurred prior to the creation of the Department for Science, Innovation and Technology (DSIT). Many of the topics covered have substantial relevance to DSIT and RUSI will continue to assess them as part of the Technology and National Security programme.

Advanced technologies are increasingly important to strengthening national security and prosperity. The development and use of technologies including AI, synthetic biology and quantum represent a growing share of GDP and have societal impacts across productivity, safety and security, and international influence, among other areas.

Recent geopolitical events have seen global approaches and attitudes to advanced technology shift markedly. The invasion of Ukraine has led to a raft of sanctions against Russia by the US, the UK and partners, specifically targeting the supply of advanced technologies. However, in certain areas, exports have continued covertly, casting doubt over government control of domestic producers. Meanwhile, US trade restrictions on China targeting advanced semiconductors demonstrate the geostrategic importance of technology supply chains in interstate competition.

Strengthening the UK’s advanced technology ecosystem is part of the current government’s ambition to ‘[secure] our status as a Science and Tech Superpower by 2030’ and will be crucial to meeting other objectives for national security and prosperity. Although some positive initiatives have been launched, including a Cabinet coordinating committee and several digital and tech strategies, outstanding issues remain, including:

• Where to focus government efforts.
• How to prioritise international engagement and partnerships.
• How to improve internal horizon-scanning capabilities.
• How to support research commercialisation.

To address these gaps and deliver its science and technology (S&T) objectives, the government should strategically connect and consolidate its ongoing activities within the public sector and take greater steps to engage partners across industry and civil society.

Purpose and Scope

This conference report summarises discussions from the RUSI Cyber research team’s 2022 event series entitled ‘Advanced Technology and Economic Resilience’ (ATER). Events included speakers from government, the private sector and civil society, and focused on sovereign capability, partnerships and competition, and geostrategic instability. The ATER series is part of RUSI’s ongoing Technology and National Security programme, which focuses on the transformative role of technologies at the centre of the global security landscape.

The events focused on distinct themes that impact the UK’s advanced technology horizons.

Advanced Technologies and Geostrategic Instability: A Conversation with Ian Levy, 3 May 2022

To launch the ATER series the first event outlined the relationship between advanced technologies, economic resilience and geostrategic instability. The keynote address was given by Ian Levy, then Technical Director of the UK National Cyber Security Centre. The chair was Conrad Prince, RUSI Distinguished Fellow. Levy raised issues including approaches to trust in cyber security, the importance of engaging in international standards bodies and the global fragmentation of technology.

Advanced Technology: International Partnerships and Geostrategic Competition, 9 June 2022

The second event explored the dynamics of global technology partnership and competition, and how these affect international security and prosperity. The keynote address was given by Ambassador Sylvie Bermann, RUSI Trustee and former French Ambassador to China, Russia and the UK, and the chair was Seth Centre, Senior Advisor for the Special Competitive Studies Project. Panellists were Agathe Demarais, Global Forecasting Director for the Economist Intelligence Unit, Chris Jones, Director of Technology and Analysis at the Foreign, Commonwealth and Development Office, and John Lee, Director of East-West Futures. Participants outlined divisions and interdependencies in the international technology landscape, arguing that it forms the central issue in global competition today. Additionally, they emphasised the need
for the UK, alongside likeminded countries, to think more proactively about technology in the medium to long term.

**Advanced Technology: Made in Britain or Made Insecure?, 16 December 2022**

The final event assessed the UK’s S&T ecosystem and proposed a systems-based framework to understand the intersection of geopolitics and international trade. The keynote address was given by Anthony Finkelstein, President of City, University of London, and former UK Chief Scientific Advisor for National Security, and the chair was Madeline Carr, RUSI Senior Associate Fellow and Professor of Global Politics and Cybersecurity at University College London. Discussions focused on the need for new systems design approaches to tackle supply chain challenges, more effective national capacities for technological foresight, and clearer foreign policy stances to inform downstream policy issues.

**Report Outline**

This report synthesises discussions from across these events, aggregates and thematically presents their key points. The first section assesses the challenges of relying on UK sovereign capabilities to mitigate risks to supply chain resilience. Next, the report addresses the importance of diverse international engagements to existing and future UK advanced technology priorities. And last, it discusses the expanding government capacity to gather and analyse anticipatory intelligence related to advanced technology.

This report is relevant to several strategic documents expected over 2023, namely the China and Semiconductor Strategies as well as the Integrated Review refresh. It also relates to the work of the newly established National Science and Technology Council (NSTC) and the development of the Procurement Bill.

**Sovereign Capability Is Not a Fix-All Solution to Supply Chain Resilience, Nor Is it Always Desirable**

**Supply Chain Resilience**

Advanced technologies almost invariably rely on components sourced through globalised supply chains. For example, the iPhone (designed in California) is likely to be assembled in factories in China using components from suppliers across roughly 43 countries. Those suppliers will, in turn, rely on diverse inputs, including scarce rare earth materials. Nonetheless there are hundreds of millions of iPhone users – while just-in-time global supply chains are complex, they largely work.

---

A consensus across ATER series speakers was that when global supply chains fail it is more likely a symptom of external issues, rather than a problem with supply chain processes. Examples demonstrating this point include recent disruptions to food and fuel supplies following Russia’s invasion of Ukraine, problems for advanced technology manufacturers in China in the wake of US sanctions on advanced microchip technology, and issues procuring medical supplies during the Covid-19 pandemic. Each disruption was experienced through supply chains but was caused by global events.

Problems with advanced technology supply chains are particularly acute when dependency on given technologies is high and there are few suppliers. Taking the example of UK access to advanced telecommunications: there are high levels of dependency, as internet speeds affect economic growth, and suppliers are highly concentrated, with Ericsson, Huawei, Nokia, Samsung and ZTE dominating the global market. Consequently, the UK is necessarily dependent on select foreign suppliers for its telecommunications infrastructure, thereby creating supply chain risks. This raises questions including: will the UK miss out on early access to cutting edge tech; are adequate cyber security provisions taken across the supply chain; and can the UK can effectively assure supply chain resilience?

To mitigate risks from global supply chains one option is to build sovereign capabilities.⁶ The difficulty with this, in the context of advanced technologies, is the spectrum of capabilities needed for complete sovereign self-sufficiency. Truly sovereign capabilities for something such as telecommunications infrastructure would require capacities ranging from mineral extraction, refining and R&D to coding, assembly and installation. In sum, developing the capabilities is a massive and prohibitively expensive endeavour, especially when existing supply chains provide relatively simple and cheap access. It is unsurprising therefore that Anthony Finkelstein expressed that he is ‘not clear that many of our critical national systems or capabilities to respond to national risks require sovereign supply’.⁷

Given total sovereign capability across advanced technologies is neither possible nor preferable for the UK, some level of dependency on global supply chains is inevitable. This, however, does not mean planning or preparedness should be disregarded; rather it emphasises their importance. Therefore, to avoid threats associated with advanced technologies, many ATER participants advocated for risks, including those to supply chains, to be systematically mitigated.

---

⁶ Lance Worrall et al., *Australian Sovereign Capability and Supply Chain Resilience: Perspectives and Options* (Adelaide: Australian Industrial Transformation Institute, Flinders University of South Australia, 2021). Sovereign capabilities relate to diverse capacities – industries, logistical networks and research infrastructures, among others – required by a country to achieve specific objectives, such as safety, health and wellbeing, infrastructure security, and so on. For the UK, in the context of advanced technology, they are those elements or processes that create self-sufficiency across access, production and consumption of advanced technologies.

⁷ RUSI, ‘Advanced Technology: Made in Britain or Made Insecure?’, online event, 16 December 2022.
A Systems Approach

In the face of uncertain, complex and novel challenges, governments require new approaches to problem-solving. To tackle particularly ‘complex’ or ‘wicked’ challenges, systems approaches have been developed. A systems approach ‘refers to a set of processes, methods and practices that aim to effect systems change’. This means adjusting the way governments think about problems. Systems approaches move away from traditional linear procedures, static strategic planning and reform as an isolated intervention. Instead, systems approaches are holistic and outcome-oriented.

At the final ATER event, Anthony Finkelstein advocated for the UK government to adopt a systems approach to advanced technology. Stating that ‘national security, including societal resilience and economic security, is bound up with the design of complex systems and their associated supply chains’. He argued that a systems approach would better secure the UK against key dependencies, manage supply chain complexities, and anticipate future challenges and opportunities. However, it will require improvement in cross-government processes and an expansion of anticipatory capacities. Recent reforms in governance and research could provide good foundations for a systems approach if properly run.

Multiple participants mentioned the establishment in 2022 of the NSTC, a Cabinet Committee focused on S&T, which could be the focal point to organise whole-of-government efforts. Moreover, its supporting secretariat – the Office for Science and Technology Strategy (OSTS) – was praised by several participants as a promising unit to conduct cross-government measurement and analysis. While the NSTC was fortunately not lost amid the recent turbulence in government, there has been little effort to signal its continued role – currently its gov.uk webpage still lists its chair as the former Chancellor of the Exchequer, Kwasi Kwarteng. More effort should be put into explaining how the NSTC is guiding the government’s approach to S&T.

Finkelstein also highlighted that reforms to the funding of S&T could support a systems approach to leverage the best of UK R&D. Recent initiatives launching UK Research and Innovation (UKRI) and legislating for the Advanced Research and Invention Agency (ARIA) – a high-risk investment vehicle based on the US Defense Advanced Research Projects Agency (DARPA) – are welcome in this regard. Additionally, funding to the UK Telecoms lab and support to expert committees such as the AI Council demonstrates that diverse actors are being considered. An issue that

9. Ibid.
10. RUSI, ‘Advanced Technology: Made in Britain or Made Insecure?’.
was raised by one audience question, however, was whether the UK is behind its peers. UK R&D funding by share of GDP continues to be persistently below the OECD average and the government, until the recent creation of DSIT, has failed to prioritise certain technologies, instead assuming the UK can be ‘world-leading’ without exception.

Each of these foundations therefore, across governance and research funding, present opportunities for systems thinking but will require long term buy-in to ensure their success.

International Engagement Is Crucial to Reassert and Build on Existing UK Advanced Technology Strengths

Countering China in International Standards Bodies

In 2020 Beijing launched China Standards 2035, a plan to put China at the centre of advanced technology standard-setting. Thus far, the plan is going well. Chinese officials sit at the head of four international standards bodies, including the International Telecommunications Union and the International Electrotechnical Commission, and Chinese companies are leading standards setters, especially across 5G telecommunications. Beijing has supported these successes by pursuing core standards-setting influence activities across:

- **Innovation.** Significant R&D investment has created first-mover advantage across key technologies, including 5G telecommunications. Consequently, Chinese companies can set standards as foreign firms catch up.
- **Market domination.** China’s large-scale production activities open the door to standardisation through scale.
- **Consensus.** China has pursued influence in international standards bodies through direct engagement, and supporting the participation of its national companies, both financially and politically.
- **Investment and provision.** Through the Digital Silk Road, a key part of the Belt and Road Initiative (BRI), China builds technology infrastructure in other countries. These infrastructures use Chinese standards, meaning recipient countries must adhere to these standards to ensure they can continue to use the technology.

In comparison, as Chris Jones, Director of Technology and Analysis at the Foreign Commonwealth & Development Office described in the second ATER event, ‘over the past 10 years the West has been caught napping on technology’. Unlike China’s primarily state-driven model, the UK, the US and most European countries take an expert-led multistakeholder approach to standards. In theory this allows the private sector, academics and other experts to reach open and free consensus in international standards bodies with minor intervention from governments. The issue with this approach, however, has been an excessively light touch from Western governments against a contrastingly heavy hand from Beijing. To prevent this extreme level of Chinese influence over international standards, UK and likeminded governments should step up to provide a counterbalance. Central to this is increasing engagement in international standards bodies, both through direct government activities and providing support – financial or advice-based – to national companies to do the same.

Putting aside international standards bodies as a forum for geostrategic competition with China, there are significant positive reasons for increased engagement. Among those mentioned by ATER participants were:

- **Values.** Standards encode technology with values. Increased engagement by the UK should be motivated by embedding free, open and democratic values in advanced technologies. The risk otherwise is contrary values prevailing. For example, Huawei’s proposal for New Internet Protocols (New IP) – supposedly to support next-generation connectivity – has been widely criticised, including by Levy, as seeking to further ‘surveillance and control’.
- **Interoperability.** Common standards create interoperability for components and products across different jurisdictions. If standards are siloed, by companies or countries, technology is not easily interoperable. Concurrently there is less interaction and engagement, thereby driving down coordination and cooperation and reducing economic opportunities. Continued interoperability creates the most chances for economic growth and reduces costs on production and development by preventing near-identical products with siloed supply chains. Interoperability is also fundamental to global Sustainable Development Goals (SDGs) as it provides the greatest access to the least costly green technologies.
- **Highlight UK strengths.** The UK has substantial research strengths, especially across the university sector. Supporting academic and other UK experts to contribute to international standards bodies creates opportunities to increase their impact while putting a spotlight on UK research excellence.

---

To achieve these objectives several participants across the events advocated for the government to take a multistakeholder approach by supporting – financially or otherwise – UK private sector and civil society experts to engage with international standards bodies. With 809 technical committees and sub-committees in just the International Organisation for Standardisation (ISO), government cannot adequately resource engagement across them all, not to mention other international standards bodies. Instead, civil society and private sector actors, guided and supported by the government and the British Standards Institute, are best equipped to represent UK interests and values.

A Values-Led Approach

A consensus across the ATER event series was that current geostrategic competition is an ideological opposition between autocratic states and democracies. Advanced technologies are a key area of this competition, with each side vying for access to greater capabilities and market share. The amount of users technologies have is important as it influences their impact: their likelihood of creating standards; the scope of their operations; and their revenue generation. User attraction hinges on factors including cost and supply but also values. Advanced technologies are often either stifled or encouraged in national markets based on whether governments think they align with their values. It is important therefore that the UK and likeminded countries set out and actively promote a clear values agenda for advanced technology.

While requiring full elaboration in a strategy document, the core of the UK advanced technology values proposition advocated for by event participants places freedom and democracy, a multistakeholder approach, responsible use, security and resilience, and the rule of law at the forefront. In practice this should include initiatives that support inclusive, responsible and sustainable technological and digital transformation, for example, by establishing multistakeholder partnerships to assure the cyber security of green energy infrastructures.

To promote these values, participants across the ATER series put forward two main strategies for the UK. First, it should consistently and clearly state its values through multistakeholder forums and strategy documents, and second, it should undertake targeted engagement with countries experiencing rapid growth in digital use and development. The latter is necessary as these countries are the fastest-growing markets and will set future values and standards. Moreover, China is actively pushing its values proposition to these countries – largely through the BRI – therefore it is necessary to counteract this influence.

To effectively promote its values proposition ATER participants recommended the UK be:

- **Responsive.** There should be sensitivity about the needs and priorities of those the UK aims to influence. Countries considering their approach to advanced technology are

---

focused on issues relevant to them; understanding these and relating them to the UK values proposition is crucial.

- **Consistent.** Values should inform actions and actions should not undermine values. In promoting a values proposition it is important to stick to stated values and to emphasise that doing so leads to desirable outcomes.

- **Positive.** Criticism of other countries’ approaches is not a sufficient argument for the adoption of the UK values proposition. Narratives should instead emphasise how freedom, openness, the rule of law and so on are positive in themselves, and be accompanied with effective technological solutions.

- **Clear.** Risks associated with the procurement of technologies from certain countries should be highlighted, especially where the UK has unique intelligence. This should build the case for risk sensitive values-led procurement.

### Avoiding ‘Balkanisation’

A central motivation for strong UK international engagement on advanced technology, including across standards and values, should be the prevention of what is often called ‘balkanisation’.\(^{21}\)

Across the ATER events, participants disagreed to what extent advanced technologies were already balkanised. The argument in favour pointed to diverse Chinese activities creating a de-facto balkanised internet. While the argument against stressed that though there is divergence in progress, for example CIPS (Cross-Border Interbank Payment System) the Chinese alternative to the SWIFT payment system, there is still strong interoperability.\(^{22}\) Overall, fragmentation is certainly happening, but not yet to the point of balkanisation.

Fragmentation, and the balkanisation it may lead to, was argued by participants across ATER events as presenting a negative outcome as it creates:

- **Wastage.** The siloed development and production of advanced technologies generates duplication as groupings acquire distinct versions of similar devices and systems.

- **Cost.** Separate, insulated supply chains reduce international economies of scale, increasing costs of production and limiting supplies, resulting in increasing prices for users and reducing standards of living. Balkanised advanced technology production would also have knock-on costs, especially in reaching SDGs. For example, if China, the primary producer of clean energy technology, isolates or is isolated from global supply chains, the rollout of green energy will slow significantly, threatening both global climate objectives and non-carbon energy security.

\(^{21}\) ‘Fragmentation’ of advanced technology is the process by which distinct ecosystems – whose digital products and services are not interoperable – emerge. ‘Balkanisation’ of advanced technology refers to a global division of technology users and producers into groups and sub-groups who are unfriendly to one another.

\(^{22}\) Huileng Tan, ‘China and Russia Are Working on Homegrown Alternatives to the SWIFT Payment System. Here’s What They Would Mean for the US Dollar’, *Business Insider*, 29 April 2022.
• **Tension.** Reduced interoperability can cloud understandings of adversary capabilities and provides fewer opportunities for cooperation and coordination.

• **Weaker resilience.** Sole reliance on siloed advanced technologies damages resilience in two ways. First, technologies used only among likeminded countries are ideal targets for adversaries who have alternative supply chains: which insulates them from impacts. Second, if those advanced technologies break there are no back-ups, and capabilities from other silos cannot be easily swapped in.

International engagement serving to prevent or minimise fragmentation, and eventual balkanisation, is therefore a central priority.

**UK Government Understanding of Advanced Technology Is Not Improving Fast Enough**

**Anticipatory Capacities**

As part of the ‘Science and Tech Superpower’ agenda, the UK government has expanded its monitoring, analysis and anticipation capabilities for advanced technology that are relevant to national security. Capacities have been created across strategy and policy through the OSTS and NSTC, research via the UKRI and its partners, and funding for business and innovation with ARIA and the National Security Technology and Innovation Exchange (NSTIx). It does not reflect well on government’s long-term approach to advanced technology, however, that ATER participants consistently called for further efforts to be launched. Members of the panel for the second event also raised the difficulty in assessing efforts to date as the precise remits of the organisations have not been communicated publicly. Given each is concerned with future advanced technology, presumably all have horizon-scanning responsibilities. But how do these coexist? What are the mechanisms to coordinate and deconflict? Which, for instance, would lead on developing a supply chain mapping and monitoring capability, or on mainstreaming supply chain resilience in advanced technology procurement cross-government? And how do their activities relate to other diverse initiatives, such as the own-collaborate-access framework for S&T power detailed in the Integrated Review? Overall, there is too much uncertainty.

Given their newness, it is too early to determine the performance of these capabilities, especially before more information is released publicly. Nonetheless, the assertion by the former UK Chief Scientific Advisor for National Security that, despite these initiatives, a ‘vastly better science, technology and innovation intelligence’ is needed is not a promising sign.

Alongside improved anticipatory intelligence, ATER participants pointed to the need for measurement capabilities to assess the impact of advanced technologies across the UK and particularly in government. Measurement, like anticipatory intelligence, will require cross-government coordination to ensure standardisation, minimise duplication and mainstream

---


24. RUSI, ‘Advanced Technology: Made in Britain or Made Insecure?’, online event, 16 December 2022.
successful initiatives. The OSTS is well placed to work towards this objective. However, this will require NSTC direction and efficient cross-government working.

**Strategic Clarity**

To support its S&T objectives, the government should address holes in the UK strategic posture. Among the gaps identified throughout the ATER series were:

- **First-order international policy issues.** Outstanding questions about the UK’s international relationships are complicating progress across a range of areas.
  - The tepid UK–EU post-Brexit relationship has prevented further UK participation in Horizon Europe,25 the EU’s €95.5-billion research programme, and created new trade barriers. The former threatens the access for UK researchers to grants, and the latter has damaged UK exports and made it a less attractive regional hub for technology. Advanced battery production highlights this precarity, with 111 industrial battery projects under development across EU countries versus just one operational in the UK and a recent start-up, Britishvolt, entering administration.26 Lacking domestic production and potentially isolated from European battery autonomy the government’s ambition for the electric vehicle industry is at risk.
  - The UK–China relationship is profoundly complex and has seen extensive change over the past decade. Both countries have common stakes across investment, market access, the avoidance of conflict, and climate change, but tensions persist over geostrategic, national values and other issues. While clarity would be useful for policymakers and industry, it is both undesirable and unrealistic to look for a binary position on China. The UK cannot be simply ‘for’ or ‘against’. It is necessary therefore for the government to be agile where activities relate to China. To inform this agility government should prioritise strong horizon-scanning capabilities and strategic flexibility to best seize future opportunities and minimise the impact on downstream policy by recognising as early as possible when changes are necessary.

---


• **Supply chains.** Certain pressing issues across advanced technology supply chains remain unaddressed. Notably the promised semiconductor strategy remains unpublished despite a strong recommendation in 2022 by the Business, Energy and Industrial Strategy Select Committee that it be released immediately.\(^{27}\) Greater coherence in UK policy towards semiconductors is urgently needed. While the UK has some capacity, it cannot achieve end-to-end self-reliance; therefore, it will remain to some extent dependent on complete imports alongside raw inputs and components. Risk-managing this process will be crucial, as will working with key allies. It could prove difficult to find a mechanism that works with traditional allies, however, given UK–EU relations remain frosty and the UK is not part of the EU–US Trade and Technology Council.

• **Scale-up.** The UK has a strong research base. In 2020, it was third globally as measured by the number of scientific publications and their citation share – a proxy indicator for impact and quality.\(^{28}\) It also outperforms its level of investment, spending less than the OECD average on R&D and far below both the US and China. This research excellence is unfortunately not matched by the success of the UK tech business ecosystem. Rates of research commercialisation have improved but remain poor, as indicated by the low levels of UK patent registry and, more importantly, existing start-ups and small and medium-sized enterprises struggle to grow.\(^{29}\) According to the Digital Strategy, this is a priority for the government and it has attempted to free up capital and encourage investment through various mechanisms.\(^{30}\) The problem, however, is that many of the levers of change do not sit within government. To fundamentally tackle the diverse cultural issues in the UK research commercialisation landscape, financial incentives and other problems need to be addressed. The government therefore will need to participate in and encourage a whole-of-society approach to holistically reform approaches and attitudes to research commercialisation. Tech companies’ growth also relies on attracting talent. Launching the Office for Talent,\(^{31}\) establishing a Global Talent Visa and opening new routes for graduate jobs are positive measures, but it is uncertain whether they will sufficiently mitigate the reputational impacts of Brexit, the loss of easy access to the EU labour pool, and the high costs of living in the UK.

### Areas of Future Research

Throughout the ATER series, participants pointed repeatedly to areas that would be important in the medium to long term but about which they felt there was insufficient research. These included:

---


30. Ibid., p. 8; Department for Digital, Culture, Media and Sport, ‘UK Digital Strategy’.

Technology-Enabled Threats

- **Security for AI rather than AI for security.** Most security-focused AI research concentrates on the use cases of AI, rather than how AI itself is vulnerable. Further research on this topic should explore technical measures needed to assure and monitor AI security, as well as interdisciplinary and policy questions such as how to build in economically feasible redundancy.

Impact of Technology on Geopolitics

- **State-controlled digital currencies.** The widespread adoption of state-controlled digital currencies, notably the digital renminbi, represent efforts to de-dollarise, thus undermining the US dollar as the world’s reserve currency. Additional research can be conducted into how the EU is already responding to these efforts and what impacts state-controlled digital currencies may have.
- **Extent of balkanisation and speed of fragmentation.** ATER participants held differing views on the extent to which advanced technology is already balkanised and the current pace of fragmentation. Research to thematically group advanced technologies and assess their current balkanisation and fragmentation trajectories would be useful to inform wider analyses of the technology landscape and geostrategic competition.

Governance of Technology

- **Trust in cyber security.** In the near term, trust in back-end code and processes may break down as supply chains continue to be compromised to insert vulnerabilities. As a result, the development of digital products may become more expensive as companies seek greater end-to-end control and visibility. The speed and extent of this process will be influenced by domestic and international governance as requirements or responsibilities are outlined and enforced on companies. To best anticipate and prepare for these changes, multistakeholder research that examines the risks and opportunities associated with changing perceptions of trust is needed.
- **Digital-identity primacy.** Currently, physical identities are the primary form of identity. As more services are digitalised and people increasingly conduct interactions online, this may shift to digital-identity primacy. This could have impacts across access, exclusion, security, affordability and so on. Due to the wide-ranging outcomes that could follow such a shift, research in the near term should convene interdisciplinary perspectives to assess current trajectories and international comparisons, and begin to map future threats, risks and opportunities. Such research should consider how governance can best support security-sensitive innovation.

Technology-Driven Intelligence and Military Innovation

- **Anticipatory intelligence and monitoring.** Advanced technologies present a challenge for government to continually monitor and adapt. One area of research, therefore, is
how government can most efficiently do this given its limited resources – this could mean engaging industry, streamlining cross-government cooperation, working with international partners and so on. Another area is how can anticipatory intelligence processes themselves incorporate advanced technologies to facilitate monitoring. This could include leveraging AI or machine-learning tools to prioritise what human analysts focus on and using complex tracking systems to project and manage supply chain risk.

Joseph Jarnecki is a Research Analyst in cyber threats and cyber security within the Cyber team at RUSI. Joseph’s experience covers cyber capacity building, threats and opportunities from advanced and emerging technology, ransomware and multistakeholder approaches to cyber strategy. Currently his primary research is on the experience of cybercrime, the role of technology companies in national cyber defence and commercial hacking tools. He has a particular interest in the role responsibility plays in a whole-of-society approach to cyber security.