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Policy Paper

Baltic Collaboration in Defence-Related Research and Technology: How to achieve lift-off without a stand-down?

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Executive summary

S1. In 2010, the ministers of defence of Estonia, Latvia and Lithuania signed a Letter of Intent (LoI), stating their wish to extend trilateral Baltic collaboration to the field of defence-related research and technology (R&T). They resolved to pursue collaborative R&T projects and programmes in order to support the development of military capabilities and organisations and the conduct of military operations. This intent to build synergies between the three national defence-related R&T programmes was entirely congruent with the context of broader trends within the EU and NATO such as the desire for more 'pooling and sharing' between member states and for stronger regional defence cooperation, including in R&T. However, the ministerial will has to be translated into more specific policies and actions to launch and sustain trilateral collaboration in this field.

S2. This ICDS Policy Paper seeks to generate ideas on how the Baltic states could advance their collaboration in defence-related R&T. It explores and compares the current state of affairs in their national defence-related R&T sectors and identifies various obstacles and opportunities. These, in turn, define what is possible, feasible and necessary in fostering close collaboration and what levels of ambition, directions and 'business models' the Baltic states can realistically pursue. In doing so, the paper adopts a broad definition of R&T, which encompasses not only natural sciences and engineering but also social sciences and humanities, i.e. in addition to armaments and equipment R&T also pertains to organisational, doctrinal and human aspects of defence-related knowledge and innovation.

S3. The paper outlines the broadly similar experiences of all three countries in their national defence-related R&T efforts over the last decade or so. The Baltic states conducted projects of similar nature and have a limited number of 'success stories' to boast with. Estonia is slightly ahead of Latvia and Lithuania in the development of its R&T strategy for its defence organisation and its implementation mechanisms. The same applies to funding, although none of the three countries have been able to meet the target of spending 2% of their defence budgets on R&T. All three countries largely rely on the civilian science and technology (S&T) sector as suppliers, with Latvia having the most advanced understanding of how its defence efforts can benefit from the civilian S&T. However, the defence industrial base in all three countries is virtually non-existent and mutual awareness of civilian S&T and military organisations is very limited. Furthermore, in-house R&T capacities and competences of the three defence organisations are very thin, thus hampering effective understanding of emerging technologies and capabilities, transactions with civilian S&T suppliers and successful utilisation of R&T outcomes.

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S4. The paper demonstrates that the Baltic states eagerly participate in the activities of the NATO Research and Technology Organisation (RTO, soon to be renamed as Science and Technology Organisation, STO) because its 'business model' and the scale and nature of its projects are more attractive than those of the European Defence Agency (EDA), given the limited resources and ambitions of the Baltic states. The RTO area of human factors and medicine appears to be the field in which interests and involvement of all three countries are the most aligned. Trilateral collaboration in defence-related R&T is mostly confined to this field in the form of a trilateral 'community of practice' of military medics, although regularly meeting military 'communities of practice' in other fields could at least generate common requirements for R&T inputs. The Baltic Defence College (BALTDEFCOL) has occasionally served as a regional hub for knowledge exchange and as a meeting place for such communities, just like the now discontinued Baltic Defence R&T Conference, which the ministries of defence organised in the past.

S5. The Baltic states must understand that there is a number of obstacles to their collaboration in defence-related R&T and that the obstacles need to be managed. The following obstacles were identified: (1) conceptual – there is a prevailing concept that R&T must be focused on technical issues and that its desired outcomes are field armaments and equipment; (2) cultural – there is no habit of drawing on S&T expertise in improving defence organisations and thus its relevance is often dismissed; (3) planning – advanced military capabilities are often poorly understood and there is a degree of instability of capability plans and requirements, which should form the basis for R&T requirements; (4) organisational – the Baltic states lack 'knowledge brokering' hubs (or centres of competence) and their defence structures do not have sufficient numbers of various specialists who could act as mediators between military end-users and civilian S&T suppliers; (5) legal – the application of public procurement laws could create problems if pan-Baltic suppliers of R&T products and services received preferential treatment; (6) political – there is a lack of enthusiasm for large trilateral collaboration initiatives plus a tendency towards more bilateral ties within the region; (7) human resources – the skills and qualities of those involved in defence-related R&T often do not command respect of important stakeholders; (8) financial – financial austerity and pressures on defence budgets make the acceptance of ambitious and expensive R&T collaboration programmes very unlikely.

S6. At the same time, conversations with members of the three defence organisations and with representatives of the civilian S&T sector revealed a number of opportunities for trilateral collaboration. The opportunities present themselves, inter alia, in the following forms: an emerging interest in S&T foresight; the need to better understand new military capabilities pursued by NATO and the EU; an overlapping interest in how to improve the management of human resources in the military; a growing understanding at various levels of the dismal state of knowledge and technology management competences in the three defence organisations; and the eagerness of specialist military 'communities of practice' to develop their competences with the help of R&T. The high cost of some robotic solutions to specific military problems available on the international market and the need to manage legacy armaments and equipment were also seen as opportunities for joint R&T activities in at least two of the countries. Last but not least, the existing trilateral collaboration projects and organisations could generate some common 'pull' for R&T efforts to support their development and functioning (e.g. research in maritime mine countermeasures to support further evolution of BALTRON).

S7. Subsequently, the paper suggests to limit the ambitions of trilateral defence collaboration in R&T and, first and foremost, to focus its agenda on the issues central to the military profession and military organisations such as theory, history, strategy,

operations, tactics, doctrine, leadership, etc. The paper argues that this focus could be supported by carefully chosen interdisciplinary themes that branch out into civilian S&T, with human factors and medicine, organisational management and modelling and simulation being the prime contenders, followed by such areas as C4ISR, information assurance, autonomous vehicle technology and electromagnetic spectrum technologies. Even in these areas, however, the paper cautions against too ambitious, risky and expensive pursuit of new products and services based on R&T, which would lead to the creation of new capabilities. The paper recommends that the Baltic states should rather collaborate in defence-related R&T with the purpose of building their capacities for S&T awareness, transactions with the civilian S&T sector and better absorption of R&T results.

S8. The paper suggests that the most suitable 'business model' for the implementation of this approach, which would also reflect the very limited administrative capacities of the three defence organisations, would be to advance trilateral R&T collaboration by means of a BALTDEFCOL-led research consortium of national defence academies, mentored by a non-Baltic NATO/EU nation with significant experience in defence R&T. As the principal forum and the main channel for sharing the outputs of the consortium and for linking civilian S&T and military 'communities of practice' and end-users for collaboration purposes, the paper recommends the re-launch of the Baltic Defence Research and Technology Conference as a biennial event, which should each time be preceded by a series of workshops and seminars run by thematic research task groups. It is also proposed to create a common database for sharing the results of the consortium and the information about national projects and R&T competences.

S9. The paper concludes that although this approach does not directly correspond to the desires of the ministers to develop new military capabilities through R&T collaboration, it is far better suited to the present realities of the Baltic states. The approach is flexible and relatively low-cost. Over time, it will help to induce a culture of learning, experimentation and innovation in the three defence organisations and to build their technological competences, which are the prerequisites for intelligent acquisition, maintenance and use of military capabilities.

Introduction

1. This policy paper was conceived as part of the on-going effort by the Baltic states to give substance to the idea of closer trilateral collaboration in the defence-related research and technology (R&T) area. In May 2010, the ministers of defence of Estonia, Latvia and Lithuania signed a Letter of Intent (LoI) concerning such collaboration, which is up for review in 2012. This LoI followed in the footsteps of a trilateral commitment of 2009 to establish a legal framework for R&T collaboration. It outlined several principles upon which trilateral (or bilateral) collaboration had to be based chiefly by setting a firm focus on capability development and by pursuing improvements in operational, logistical, organisational and other aspects of their defence organisations. The R&T coordinators of the defence ministries and the armed forces have been tasked to develop a set of more specific proposals regarding the areas in which synergies between the defence-related R&T agendas of the three countries could be achieved or where their interests in advancing this field in the future are shared.

2. Attempts to find grounds for Baltic collaboration in defence-related R&T are being made in the context of several broader trends, one of which is the effort to rejuvenate Baltic defence cooperation, which has been stagnating since accession to NATO, and to link it with Nordic defence cooperation (NORDEFCO) in the Nordic-Baltic framework. In the Baltic format, a few initiatives such as sharing training infrastructure, conducting joint procurements, carrying out joint maintenance and the generation of a common contribution to the NATO Response Force have recently been launched or are picking their way through various bureaucratic and political complexities. In the Nordic-Baltic framework, discussions are focusing on the inclusion of the Baltic states in NORDEFCO, on bringing them all under the same EU Battle Group and on the enhancement of cooperation in cyber defence. Thus the intent to cooperate in defence-related R&T adds to the overall impetus to enhance Baltic defence cooperation and potentially provides an additional linkage with the Nordic defence cooperation agenda.

3. The second major trend is that NATO and EU member states and partners are increasingly exploring the possibilities to team up in bilateral and multilateral R&T projects in order to reduce costs, to share risks, to achieve critical mass, to expand their scientific and technological knowledge base, to facilitate innovation and to promote interoperability of their forces. An illustration of this trend is the Anglo-French defence agreement of 2010, which included cooperation on the development of their defence technological bases and centres of excellence in key technology areas (FCO, 2010: 5). At the same time, there is a long-standing tradition of collaboration in defence R&T between various nations of NATO and the EU, often bringing together complementary competences. The drive to pursue more multilateral or bilateral R&T projects builds on this tradition and mutual trust generated by the well-established knowledge networks. NATO's and the EU's efforts to promote more common R&T and to eliminate the duplication of national defence acquisition programmes in the spirit of 'smart defence' and 'pooling and sharing' are also gaining traction, albeit with modest results so far (see Giegerich & Nicoll, 2012: 70). In any case, at the level of ideas, Baltic collaboration in defence-related R&T fits into this general trend very well.

4. The aim of this paper is to identify the areas of R&T in which collaboration between the Baltic states makes most sense, to determine the level of ambition they should aspire to and to propose a suitable 'business model' for such collaboration. It tries to take into account the experiences, current status, needs and future plans for R&T of each individual country, together with various contextual factors which may facilitate or, to the contrary, inhibit development of a collaborative R&T agenda. Defence policy and planning documents, national and defence sector R&T strategies and

interviews with defence planners, military leaders, military specialists and researchers in the three countries served as sources to develop insights and ideas on the subject.[1] In-depth research conducted by ICDS on the subject of defence R&D/R&T in some small NATO allies and in Estonia also informed and shaped assessments and proposals put forward in this paper. The paper does not seek to provide a detailed list of technologies which the Baltic states can develop together, but rather stays on the level of strategy by trying to define the ends, means and ways of Baltic collaboration in defence-related R&T.

Approach

5. Before further elaboration of any ideas regarding Baltic collaboration in defence-related R&T, it is necessary to explain the principles and assumptions which guided the efforts to harness those ideas from the Baltic defence and scientific establishments. First, in relation to the central concept of 'research and technology', it is assumed that:

5.1 research, or search for new knowledge, in defence is not confined to the disciplines of natural sciences or engineering, but also includes social sciences and humanities;

5.2 technology should be understood broadly, not only as military hardware (armaments and equipment). Systems, processes, methods, arrangements – including those not directly related to military hardware but pertaining to organisational and human aspects of armed forces – all can be considered as technology in a broad sense;

5.3 as a field of activity, R&T does not necessarily lead to a new product on the defence market. Its aim is to generate new knowledge to be used in the development, improvement, sustaining and use of military force (e.g. in the management of human, financial and material resources, in the conduction of operations, in the acquisition of new capabilities, in the organisation of defence, etc.). In technical areas, this means R&T ends somewhere between the technology (or system) readiness levels (TRL/SRL) 4 and 5 (see Mankins, 1995) and thus encompasses basic and applied research and the initial stages of experimental development at most.

6. Consequently, the above departure points widen the scope of national and trilateral defence-related R&T agendas beyond technical areas. Thus the circle of potential R&T stakeholders in the three defence organisations is extended beyond national armament directors and the structures supervised by them. In terms of its level of ambition (expected outcomes), the approach adopted in this paper towards R&T also mitigates the impact of such factors as the virtually non-existent defence industrial base and the modest testing and evaluation (T&E) infrastructure of the defence organisations in the Baltic states, all of which would be necessary if R&T were defined in a narrow techno-centric (or hardware-focused) way and were seen as extending all the way to TRL/SRL 9.

7. The second set of considerations kept in mind throughout the research process for this paper concerns the nature and purposes of collaboration in defence-related R&T. Collaboration would normally mean the conduction of common R&T projects with researchers from the three countries submitting joint proposals (collaborative supply

[1] I am enormously grateful to all the people (at the Estonian Ministry of Defence, the Estonian Defence Forces, the Latvian Ministry of Defence, the Latvian National Armed Forces, the Lithuanian Ministry of National Defence, the Lithuanian Armed Forces, the Baltic Defence College and civilian research establishments in Estonia) who kindly agreed to share their experiences, views and opinions, supplied me with valuable information and acted as a 'sounding board' for my ideas.

'push') to the three defence organisations or the joining of forces to fulfil a common requirement articulated by the three defence organisations (collaborative demand 'pull'). The purpose of such collaboration would be to share the costs and results, to exploit the complementarities of national scientific and technological competencies and to achieve a critical mass which each country lacks individually. However, collaboration in defence-related R&T between the Baltic states:

7.1 could be sought to develop the knowledge and technology management competences and the science and technology awareness capacities of the defence organisations. This does not necessarily require the launch of formal research projects;

7.2 could be bilateral rather than trilateral (as pointed out in the ministerial LoI);

7.3 could be pursued to assure the quality or to enhance the multidisciplinary aspects of the ongoing national projects, based on the requirements of a single country (e.g. by one country which sub-contracts researchers from one or two other Baltic states to conduct independent peer reviews of the national project or to add missing segments of competence to it);

7.4 could exist on the demand side (i.e. the formulation of common requirements and the provision of common funding) but not on the supply side (an R&T provider may be contracted from outside the region) and vice versa (i.e. R&T suppliers in the three countries may team up to provide services to defence contractors outside the Baltic states);

7.5 could be launched in specific cases by merging similar ongoing projects, by initiating new projects in the areas where agendas for future R&T are aligned or both;

7.6 could be conducted as part of the already existing (or planned) trilateral Baltic defence cooperation projects in order to bring new knowledge to these projects.

8. The above considerations allow for a diversity of 'business models' in the framework of the Baltic collaborative R&T agenda, not just for a single-minded focus on trilateral demand leading to trilateral R&T projects (trilateral supply) or vice versa. (However, this paper does not involve cases of R&T suppliers from the three countries collaborating to undertake projects for customers other than the Baltic defence organisations.) This also means that the search for viable ideas could be conducted from different angles and perspectives and not only by exploring and comparing the needs that stem from separate military capability plans of the three nations or by comparing national defence-related R&T programmes.

9. However, as a final note in explaining the approach adopted in this policy paper, it is essential to point out that defence-related R&T and respective collaboration efforts – no matter how defined and understood or from which perspective looked at – are only one input (among many) to various defence processes. The key question, which remains outside the purview of this paper, is whether the Baltic states truly have those processes in place and are able to benefit from the R&T inputs.

Current status in defence-related R&T

10. Defence-related R&T in the Baltic states has played a marginal role in the development of defence strategies, capabilities and organisations due to modest levels of investments and organisational capacities. The experiences and learning curves of the three states are broadly similar, with Estonia and to a certain degree Latvia being ahead

of Lithuania in the identification and specification of knowledge and technology areas of interest to defence.

10.1 Although this was not set out in the existing defence research and development strategy of 2008, in practice Estonia seeks to focus its investments primarily in the areas of (1) situational awareness, systems, systems' integration and decision-making; (2) force protection and sustainment; and (3) human factors and medicine, each of which is comprised of more specific technologies and competencies (see Jermalavičius, 2011: 25). The strategy will be reviewed and renewed in 2012.

10.2 In Latvia, the sector is steered by the ministerial guidelines of 2006, which stated that the science, research and technology development policy of the Latvian Ministry of Defence should encompass the areas of (1) national and international security; (2) military operations (including doctrines, command and control, intelligence, communications, logistics, defence against weapons of mass destruction and defence against terrorism); (3) resources for defence needs (including military industry, human resources, environmental protection, logistics and procurement, infrastructure); and (4) military science and technology (Grinpauks, 2010).[2] (A new R&T programme for 2012–2015 is currently being drafted, using a recently approved capability development plan until 2032 as a basis.)

10.3 Lithuania, on the other hand, does not have a clear and formalised strategy concerning its defence-related R&T investments. The development of such a strategy is now a task facing a newly established defence R&T coordination group in the Ministry of National Defence.

11. Moreover, each country has undertaken projects similar to those in the portfolios of the other two (see Figure 1), although their mutual awareness about such projects has been relatively limited and mostly confined to information exchanges at the meetings of national R&T coordinators. All three countries struggle to increase the significance of defence-related R&T for the defence organisations, but the number of 'success stories' – projects leading to significant and visible improvements in defence which can convincingly be communicated to all stakeholders – is very limited.

12. On the other hand, it can be confidently asserted that as a result of past programmes and projects all three nations have established a certain base in defence-related knowledge and technology which they are at risk of losing if minimum levels of investments are not maintained. In this regard, the size of their current defence-related R&T portfolios is not encouraging: Lithuania is funding only two projects from its R&T budget (in the areas of robotics, medical sensors and information management); Estonia – also two (in the areas of military psychology and bionics) with further seven (in the fields of military personnel health management, military medicine, the performance of armoured vehicles, materials, counter IED, radio-electronics for electronic warfare, textiles, modelling, simulation and military history) approved and to be launched in 2012;[3] Latvia has no projects, but it plans to re-start its programme in about 2014 and expects to benefit from some national (civilian) R&T programmes.

[2] The scope of Estonia's defence-related R&T policy does not extend to the area of international security research, although such research is actually conducted and funded by the Estonian MOD (e.g. projects carried out by ICDS). On the other hand, Latvia seems to consider 'military science and technology' as a distinct subset of its MOD's science, research and technology development policy, but does not identify specific technologies of interest within it, which raises some legitimate questions about, for example, the difference between research in military operations (and specific sub-areas such as communications) and military science. These variations in the definitions of the R&T policy area in general and its specific sub-areas make direct comparisons between the two countries rather difficult.

[3] This does not include projects funded by the MOD and conducted by ICDS.

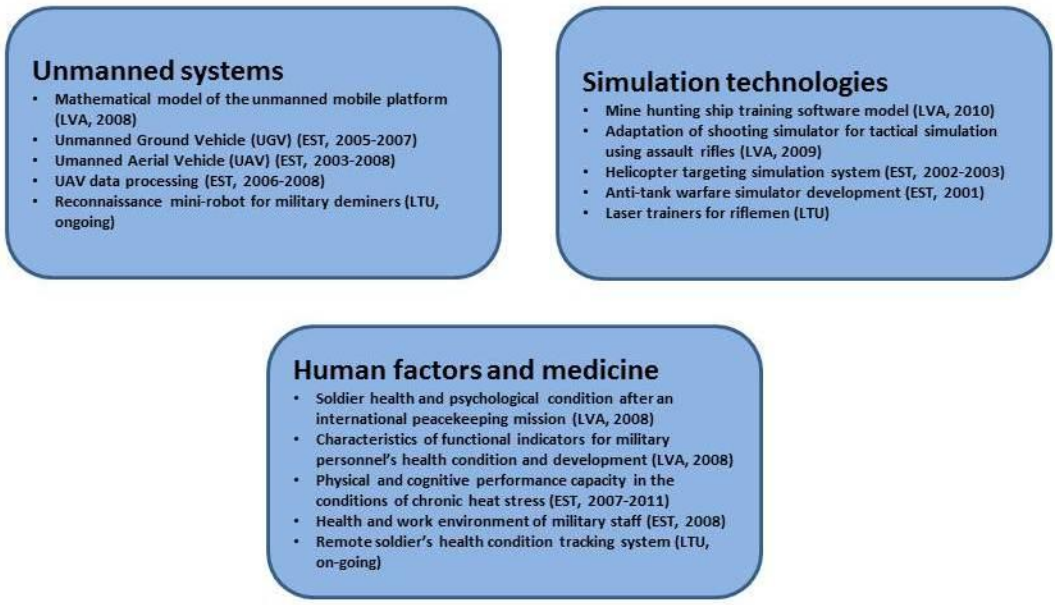

Figure 1: Selected national defence-related R&T projects in Estonia, Latvia and Lithuania clustered into knowledge and technology areas.

13. The funding allocated to R&T from the defence budgets – although Estonia's share is larger than those of Latvia's and Lithuania's combined – relegates all three countries to the bottom league in the broader context of NATO and the EU. None of them come anywhere close to dedicating 2% of their defence budgets to this area, which is a benchmark agreed upon by the members of these organisations: according to the information obtained from the ministries of defence, Estonia plans to spend about 0.18% of its defence budget on R&T in 2012 (or approximately 650,000 euros),[4] Lithuania – about 0.04% (approximately 102,000 euros) and Latvia has not earmarked any funding for the MOD-sponsored R&T projects at all.[5] The funding shrank significantly and project portfolios were trimmed drastically in all three nations as a result of the financial crisis of 2008–2009.

14. Despite that, all three nations eagerly participate in the activities of the NATO Research and Technology Organisation, RTO (soon to become NATO Science and Technology Organisation, STO), which serves as a good indicator of the areas where their interests overlap (see Table 1). Participation in the R&T programmes of the European Defence Agency (EDA), however, is less developed and less informative about coinciding interests: essentially, Lithuania is just an observer of the EDA's R&T activities; Latvia and Estonia have assigned experts to some Category B activities (CapTechs), but Latvia so far does not participate in any projects, while Estonia is planning to launch its contribution to IN4STARS 2.0[6] project in 2012; Estonia has also expressed its readiness to participate in, and has even earmarked funds for contributing to, a planned Category A activity – Joint Investment Programme on Situational Awareness – which is, however, struggling to get the necessary endorsement from some key EU member states and has not been launched yet. In all three countries, the NATO RTO and its 'business model' obviously have much greater appeal than the EDA and its programmes.

[4] This does not include research funded by the Estonian MOD from other budget lines than defence procurement (e.g. defence policy and infrastructure). Thus, if R&T is defined broadly as it is done in this paper, Estonia understates its full scale of investments in defence-related R&T.

[5] The Latvian MOD intends to resume funding R&T projects from its budget in 2013. However, some defence-related research is funded from the budget of the Latvian National Defence Academy and via national science programmes, so it does invest something in R&T. However, just as in the case of Estonia (see the above footnote), the fact that these expenditures are not recorded under defence-related R&T funding obscures the overall picture of how much the country actually invests in defence-related R&T (according to the broad definition).

[6] IN4STARS – Information Interoperability and Intelligence Interoperability by Statistics, Agents, Reasoning and Semantics.

Table 1: Participation of the Baltic states in the NATO RTO.

	AVT	HFM	IST	SAS	SCI	SET	NMSG	NURC
EST		●	●	●	●	○	●	●
LVA	●	●	○	○		○	○	
LTU	○	●	◌		•	●		

● – full-fledged participation (both in the governing body and research projects)
• – participation in the research projects but no representative in the governing body
○ – representative(s) in the governing body
◌ – representative(s) in the governing body temporarily absent

AVT – Applied Vehicle Technology; HFM – Human Factors & Medicine; IST – Information Systems Technology; SAS – System Analysis & Studies; SCI – Systems Concepts & Integration; SET – Sensors & Electronics Technology; NMSG – NATO Modelling & Simulation Group; NURC – NATO Undersea Research Centre.

15. All three nations mostly rely on the science and technology capabilities of the civilian sector for the development of defence-related applications. So far, at the policy level, only Latvia has established a clear link between its defence interests and a broader strategic agenda of national R&T as well as, in more practical terms, has mapped the national supply base for dual-use (civilian and military) solutions. Four areas in its national S&T investments programme for 2010–2013 were identified as being of interest to defence (an interview with an official at the Latvian MOD):

15.1 Energy research as it allows Latvia to increase energy efficiency and the autonomy of its military systems;

15.2 New materials and nanotechnology research as it provides new solutions to force protection, IED detection and countering;

15.3 Health research as it generates knowledge for addressing the issues of stress impact on military personnel, for monitoring their wellbeing and for the assessment of the impact of military installations on public health;

15.4 Society and demography research as it extends the necessary understanding of the trends relevant to defence recruitment and retention policies and strategies.

16. In Estonia, some tentative efforts have recently been made to synchronise defence-related R&T with the national research, development and innovation strategy and to propose areas of investment in dual-use (military and civilian) R&T, but without any visible outcomes so far. In Lithuania, no discussion has been undertaken in the defence organisation at all on whether and how to link R&T with its national strategy for science and technology. Defence officials in both countries admit that they are only dimly aware of what is being done in the civilian sector and of what could be captured for defence purposes.

17. Conversely, the civilian research sector in all three countries also has a very limited understanding of the defence organisations and of how to work with them, often treating defence as if it lacked real opportunities and resources in order to engage with it. The civilian S&T sector in the Baltic states does not have much to offer in terms of specialised defence-related R&T centres that are dedicated to serve the knowledge needs of the defence organisations and possess an effective understanding of the military. The Institute of Defence Technologies at Kaunas University of Technology, focused primarily on the modelling and integration of certain systems, and the International Centre for Defence Studies in Tallinn, concentrating mostly on regional

security, defence policy, military strategy and defence management issues, come close to being such centres, but they lack researchers with military experience and background.

18. None of the Baltic defence organisations have an in-house R&T centre of competence, which would serve as a knowledge brokering hub between them and the wider science and technology community (national and international). According to the interviews conducted for this paper, the current thinking in Lithuania and in Latvia is that the research centres of their national military academies – the Institute of Military Science at the Lithuanian Military Academy (and its centres for military technology, strategic research and military history) and the Defence Science and Research Centre at the Latvian National Defence Academy – will become such knowledge brokering hubs in the future. The latter centre, however, is still very rudimentary in its capacity. Both countries fall short of a coherent vision and strategy regarding such centres, while Estonia has made a decision to reorganise the Applied Research Centre of the Estonian National Defence College into a training and doctrine command altogether.

19. Judging from the interviews, the defence organisations of the Baltic states lack in many fields the critical mass of skilled and experienced subject matter experts (specialists), especially those with advanced degrees. There are some knowledge and technology areas in which each organisation has no more than a few experts, who are often totally preoccupied with their routine functions and duties. Thus the ability of the organisations to conduct and sustain in-house research and to interact competently with the broader science and technology community is very constrained. In academic terms, their resultant 'absorptive capacity' or 'institutions, incentives and processes for effective technology learning' (Wylie et al., 2006: 271) are very modest.

20. This is compounded by similarly modest project management and administrative capacities allocated to R&T and the lack of concept development, experimentation and doctrine development practices, which often serve as a stimulant of demand for R&T inputs. Some tentative steps are being made to bolster the technological competences of the armed forces (e.g. the intention of the Lithuanian Military Academy to run a degree programme in technology management), but it will take time before they can get started and make any visible impact.

21. Baltic trilateral cooperation in defence-related R&T has so far been most pronounced in one trilateral 'community of practice', which brings together military specialists from one particular field. Namely, Estonian, Latvian and Lithuanian military psychologists collaborate through their BaltMilPsy Forum to conduct research, to share their research results and to adapt the BATTLEMIND training programme of the U.S. Walter Reed Army Institute of Research to the needs of the armed forces of the Baltic states. In the past, there have been collaboration projects where one country included R&T providers from another (e.g. Latvia's project on bioremediation strategies for contaminated sites, partly funded by the MOD, also involved some Estonian researchers from the University of Tartu) and projects pending approval within a multi-national framework such as the NATO RTO have had participants from two countries (e.g. a project on microelectromechanical systems technology for vehicle tracking applications was submitted for funding from the RTO support programme by a team from Kaunas University of Technology in Lithuania and Riga Technical University in Latvia).

22. However, research collaboration within pan-Baltic military 'communities of practice' or through project teams of civilian universities have remained the exception rather than the rule. So far, regular trilateral meetings between various military 'communities of practice' (e.g. military cartographers, military engineers, medical, C3I, strategic communication, environmental management, modelling and simulation experts, etc.) have not led to any sustained collaboration in R&T neither as a source of

commonly articulated demand for research inputs from external providers nor as a framework for collaborative R&T projects by military experts themselves (as in the case of military psychologists).

23. The Baltic Defence College (BALTDEFCOL) occasionally serves as a hub for knowledge-sharing among individual specialists and researchers in such areas as leadership, ethics, military history and various aspects of military operations, but it has not been used as an incubator for sustained trilateral defence-related R&T collaboration, the more so as it has very limited resources to serve as such. It does provide some opportunities in the form of seminars, workshops, conferences and publications to enhance mutual awareness about research activities in each country and beyond, but those opportunities are not systematically utilised by the three countries in their national defence-related R&T programmes. A trilateral R&T awareness-building, knowledge-sharing and networking initiative – the annual Baltic Defence Research and Technology Conference, launched in 2008 – has also been abandoned due to financial pressures and the lack of an effective vision behind it.

Main obstacles to collaboration

24. There are several sets of issues which shape the possibilities of Baltic collaboration in defence-related R&T. On the one hand, the resolution of some issues is potentially a good starting point for collaboration. On the other hand, other issues are going to remain and will have an impact on the collaboration models and agendas, so they will have to be managed carefully. It is essential that the stakeholders map and appreciate these issues if collaboration is going to be more than just a one-off undertaking and is not intended for show-off purposes. In the course of research for this paper, the following sets of issues have been identified.

24.1 *Conceptual.* Large sections of all three defence organisations define R&T very narrowly as only related to armaments, equipment and systems. A corresponding expectation is that projects should deliver visible, tangible products rather than just new knowledge. Even when the merits of new knowledge generated by applied research are acknowledged, it is argued that it is often very difficult to justify financial expenditures to auditors or the general public if there are no visible deliverables (i.e. a piece of equipment) or if a negative result is achieved (which, in science, is also a result – a point well made by one Latvian defence official). Since the defence industrial base for the use of R&T outcomes to produce such deliverables (or bring technology to the highest TRL and to the market) is extremely thin in all three countries, investments in R&T are often perceived as ineffectual and unjustifiable.

24.2 *Cultural.* As a logical extension of the above conceptual view on R&T, many members of the defence organisations dismiss the relevance of R&T to defence organisations and adopt a 'buy-off-the-shelf' attitude. The culture of ignorance towards R&T means that there is even little understanding of how it can support an 'intelligent buyer' posture when buying something 'off-the-shelf' or help develop different aspects of the defence organisations and their capabilities. Not one of the three defence organisations exhibits a strong tradition of using scientific advice in its work as they rely mostly on experiential learning. At lower organisational levels, there is a lot of knowledge about specific military problem solving to which R&T could make a valuable contribution, but this knowledge often does not make it to higher decision-making levels and thus does not lead to user-driven R&T projects. The absence of coherent and effective knowledge, technology and innovation strategies, their management competences and the requisite organisational cultures in the

three defence organisations forces R&T to languish 'out in the cold' and whatever number of collaborative trilateral projects will not help overcome this problem.

24.3 *Planning.* On the surface, all three countries run well-established and formal defence planning and capability development processes in the long, medium and short term. However, many plans never get implemented due to constant shifts in political and military priorities, urgent operational requirements, financial constraints, the lack of 'business continuity' and underestimated challenges. The requirements based on the capability needs are unstable, whereas stability is essential for R&T to make a meaningful input. Furthermore, many advanced military capabilities, which each of the Baltic states aspires to possess, are often understood by their defence organisations in a shallow and superficial way, while efforts to develop a deeper understanding are hampered by the lack of subject matter experts. In this context, all three nations struggle to derive effective requirements for R&T from their capability plans. This greatly complicates the implementation of the vision to base such collaboration mainly on capability needs in accordance with the ministerial LoI on defence-related R&T collaboration.

24.4 *Organisational.* As pointed out above in the description of the current situation in the defence-related R&T sector, the three defence organisations lack centres of competence and knowledge brokering hubs in their structures, even in 'core competence' areas such as land warfare. Moreover, their doctrine development is not linked with research (although, at least theoretically, Latvia has an organisational arrangement for very effective coordination between the execution of research, concept development, doctrine, training and education: the commanding officer of its Training and Doctrine Command, TRADOC, is also in charge of the entire military education system and the rudimentary in-house research centre).

i. Notably, there are differences in where each country allocates its policy coordination responsibility for R&T: the Latvian MOD places it with its personnel department because this sector is perceived as being closely aligned with knowledge, competences and human resources; more in tune with their procurement-centric and armament/equipment-focused perspectives, the Estonian ministry has assigned the responsibility to its procurement department and the Lithuanian ministry to its armaments and systems department.[7]

24.5 *Legal.* In Latvia and, although less strictly, also in Lithuania, the contracting of R&T services is subject to public procurement laws, which forbid the expression of preference for a fixed configuration of suppliers. This makes it difficult, if not outright impossible, to always show preference for pan-Baltic R&T consortia (e.g. by following the principle 'common proposals get common funding'). Any bidder from just one of the three countries, or entirely from outside of the region, would be able to challenge trilateral decisions to disqualify it for not being 'Baltic' enough (i.e. having suppliers from all three Baltic states) in a court of law. However, this does not prevent the defence organisations in the Baltic states from teaming up to undertake common procurement of R&T

[7] This also complicates common decision-making at a higher level: Lithuania's and Estonia's National Armament Directors (NADs) can discuss R&T issues and agree on common courses of action, but their Latvian colleague cannot contribute because R&T matters are not under his/her authority. At the same time, defence-related R&T investments that do not pertain to armaments and equipment but rather to human resources, doctrines and organisations do not fall within the remit of NADs at all, even though their subordinates in Lithuania and Estonia – national R&T coordinators – have to deal with such investments simply because there is no one else to do so.

services and from drawing up joint contracts with their chosen suppliers if their requirements coincide. On the other hand, the dearth of joint armament and equipment procurement efforts by the Baltic states could indicate that joint procurement of R&T services might be an equally fraught matter.

24.6 *Political.* The ambition to launch trilateral collaboration in defence-related R&T should be treated in the context of complicated defence relations between the three Baltic states. On the one hand, the ministers have a strong political will to push ahead to deepen and broaden the trilateral cooperation agenda. Military-to-military cooperation (e.g. in training and exercises) is often close and intensive. However, the Baltic defence establishments also exhibit competitive instincts vis-à-vis each other, a lack of mutual trust and respect, together with divergent preferences for collaboration partners (e.g. Estonia often pursues closer ties with Finland and Sweden than with Latvia and Lithuania; Lithuania seeks to build closer defence relations with Poland). The Baltic states increasingly tend to give bilateral configurations (e.g. Lithuania-Latvia, Estonia-Latvia) precedence over trilateral solutions and to seek expanded regional collaboration in the Nordic-Baltic format. Little progress is made on new, and not so new, trilateral cooperation initiatives, such as joint procurement, which could serve as sources of common demand for R&T inputs. There is little enthusiasm for establishing new common organisations with physical bases (as opposed to 'virtual' and *ad hoc* arrangements) in addition to the already existing ones or for embedding people within each other's structures to facilitate networking, to build trust and to increase integration between the three defence organisations.

24.7 *Human resources.* A set of problems is associated with the quality of human resources involved in national defence-related R&T programmes. This is the 'elephant in the room' as it is obvious to everyone and referred to in many conversations, but never recognised and addressed properly. A certain number of players congregate in this field in each country – researchers, engineers, administrators and policymakers – whose deficiencies in 'transferrable' skills (e.g. networking, management or foreign languages), professional competence, reputation, past record and even character and attitudes draw derision from various stakeholders in their own defence systems and beyond. They often manage to alienate key decision-makers and foreign partners, thus undermining the credibility of their initiatives and efforts, no matter how beneficial those efforts may prove to be in the long-term perspective if viewed objectively. Those few active, competent and enthusiastic players who are the driving force behind the existing programmes can go only as far with the advancement of national and trilateral R&T agendas as the quality of human resources concentrated in this field (and the respect it commands in various quarters) permits.

24.8 *Financial.* All three defence organisations came under severe financial pressure during the financial crisis of 2008–2010 and had to make cuts in their defence budgets. Estonia's defence spending has already rebounded and is expected to constitute 2% of GDP in 2012, while Latvia's and especially Lithuania's remain low, roughly at about half of this level or even less. This means that more urgent or, in the eyes of the defence decision-makers in Latvia and Lithuania, more essential priorities must receive greater attention and financing, making any substantial increases in the funding allocated to R&T very unlikely in the medium or even long term. Although international collaboration in R&T (and in other areas) yields better results and offers savings in the long-term perspective, it often requires additional financial inputs compared to purely national programmes. In addition, the costs of R&T projects – national or

international – are usually evident early on (and, if it is decided to move projects beyond R&T to higher TRLs, they multiply exponentially in technical areas), while the benefits of such investments often remain uncertain and become visible only after years of sustained spending. Given the current and the foreseeable financial climate, it is unlikely that the defence decision-makers of the Baltic states will approve any ambitious R&T projects, whether national or collaborative.

Main opportunities

25. There is a range of opportunities for collaboration in defence-related R&T between the Baltic states. If exploited and built upon skilfully, they could provide a sustainable basis for expanding this collaboration in the future and even enable cooperation in certain areas where it is currently struggling to advance beyond political declarations (e.g. joint procurement, common capabilities and joint maintenance). The following opportunities were identified in the course of the interviews.

25.1 Defence policymakers are becoming increasingly interested in science and technology and S&T foresight in order to understand major S&T trends and their implications to defence policy, military strategy and current and future capabilities. They are also ardent users of research into various aspects of global, regional and national security issues.

25.2 All three countries have broadly similar experiences from international operations and realise the need to better understand political, military (strategic, operational and tactical), socio-cultural and physical environments in which their armed forces may have to operate in the future and the potential implications of those environments for the development of their capabilities.

25.3 Due to the direction in which the Alliance's capabilities are evolving, there is also an overlapping interest to gain a better understanding of the technical, doctrinal, operational, organisational and other aspects of some currently existing, or emerging, highly advanced capabilities and technologies, together with their implications for the development of national defence. In particular, the study of the concept of Networked Enabled Capabilities (NEC) and its associated domains (e.g. command, control, communications, computers, intelligence, surveillance and reconnaissance – C4ISR; unmanned platforms; human-machine interfaces; systems integration; cyber defence, etc.) were mentioned during the interviews in all three countries.

25.4 Due to Latvia's and Lithuania's transition to the all-volunteer force format, they are increasingly interested in the improvement of human resources management to stay competitive in the labour market, in the implications of broader societal changes (e.g. migration trends) for the armed forces and in military sociology. Estonia is also considering whether to expand research into various aspects of human resources management. The financial crisis seems to have imbued all three defence organisations with a new sense of urgency to better manage their small (and, in some cases, still shrinking) workforce.

25.5 Some senior and mid-level defence officials in the Baltic states are becoming more aware of the dismal state of the knowledge and technology management competence both at the level of individuals (both generalists and specialists) and throughout the defence organisations.

25.6 Various specialist 'communities of practice', sparse as they are within the three defence organisations, are very eager to learn and advance their

specialist competences not only on the basis of experiential learning but also by using inputs from research and technology projects. Interaction with R&T, just as with the Baltic and other NATO/EU counterparts, is accepted as an important contributor to the professional growth of such 'communities of practice'.

25.7 Two countries – Latvia and Lithuania – have aspirations to add research arms to their national military academies and to acquire at least some research capacity in the fields of military technology, concepts and doctrines.

25.8 Latvia and Lithuania have areas of overlapping interest in the development of products based on R&T results and national S&T competences because some of the products available on the market are too expensive, complex or not easily adaptable to specific requirements (e.g. there is some interest in the development of cheap, simple, easy-to-assemble and dispensable small robots for military engineers – Lithuania even runs a formal project in this area – and small dispensable UAVs to train air defence troops).

25.9 A major challenge lies in the management of the so-called 'legacy' armaments, equipment and systems in the inventory of the armed forces, acquired in the past as donations from supporting nations or as purchases of 'second-hand' military hardware. In some cases, applied research is needed (e.g. in materials, mechanics, electronics) to understand the possibilities for extending the life-time of such hardware and/or for enhancing related capabilities. (For example, Lithuania has considered conducting research into the materials required to produce pods for Soviet machine guns still in its arsenal.)

25.10 All three countries periodically renew the field uniforms of their military personnel, often starting with a rather comprehensive process of analysis necessary to draft operational and technical requirements. Research into textiles is something all three would be able to utilise to support this process.

25.11 Some R&T projects get stalled because one Baltic state lacks proper testing and evaluation (T&E) infrastructure or civilian or military capabilities domestically, while such capabilities may actually exist in one of the other two Baltic states. Greater awareness of the T&E services provided by civilian and military organisations in each of the Baltic states would open up possibilities to pool and share those T&E resources for the benefit of national, bilateral and trilateral R&T projects.

25.12 Some of the current trilateral cooperation organisations and projects have a potential, which is in reality exploited too, to generate by definition a common demand for R&T inputs (e.g. the development of a maritime mine countermeasures – MMCM – capability was pointed out as a possible direction for further research into how to support BALTRON's functioning in the future; the Baltic Defence College constantly requires research inputs in the areas covered by its programmes such as international relations and international security; laws of armed conflict; society and the military; military history, theory, strategy and operations; leadership; management; military technology, etc.).

Starting with capacity building

26. Given the above assessment, it appears that the attempt of the ministerial LoI to steer defence-related R&T collaboration directly towards capability development is too ambitious under present conditions. The number of national and trilateral supporting mechanisms, structures, capacities and resources is not adequate to enable such a focus. Each country struggles with its own national defence-related R&T programme –

its legitimacy, strategy, financing, processes and impact on capability development. In a trilateral framework with its own complications, there is a significant risk that those problems may be pooled, shared and amplified rather than deliver smart solutions to capability needs and gaps. This would inevitably damage the credibility of trilateral Baltic cooperation initiatives and the already struggling area of defence-related R&T.

27. The capability-focused approach is certainly appropriate as a long-term vision of what collaborative efforts should seek. However, movement towards that vision requires certain capacities which are currently not in place in the defence organisations of the Baltic states. To start with, there is a need to strengthen the prospects, impetus and impact of defence-related R&T in each of the Baltic states. A large part of this effort could be undertaken trilaterally. (Indeed, it is highly advisable to do so because more diverse inputs into the exploration of ideas and the analysis of needs tend to lead to better outcomes.) The Baltic states could collaborate and achieve critical mass and synergy in the following areas.

27.1 Awareness building in their defence organisations about S&T, its impact on security and defence; about emerging strategic and/or disruptive technologies; and about future capabilities. None of them has individually been able to achieve this prerequisite for a long-term perspective, intelligent defence investments and risk management. A collaborative research effort into S&T monitoring, analysis, foresight and future capabilities could address this gap and serve as a catalyst for further collaborative work in more specific knowledge and technology areas where the defence planners of the Baltic states would come to recognise particular challenges as a result of such research.

27.2 The provision of a common platform for their defence organisations and national S&T communities to interact, to exchange information about national policies and programmes, to understand the perspectives of various stakeholders, to cross-fertilise their ideas and to learn about on-going work and potential opportunities for defence-related R&T. The organisation of a rigorously structured biennial regional conference, accompanied by more specialised seminars of particular ‘communities of practice’ and supported by a common database of national projects and S&T competences, would be a key measure in this regard. This would create a forum for the generation of ‘bottom up’ ideas relevant to defence needs and would also facilitate the commissioning of peer reviews for R&T projects individually conducted in each country without sufficient international exposure and independent domestic expertise.

27.3 The building of their capacities for in-house applied research, concept development and experimentation in the areas of military ‘core competences’ (e.g. military theory, operations, tactics, doctrine, education and training; military technology; logistics; military personnel management, leadership and command, etc.). It would be necessary to harmonise the build-up, mission and work programmes of the research centres of the national defence academies (or their research capacities if no such centres exist). Ideally, representatives of the existing (and often cooperating) military ‘communities of practice’ would be included in these research centres. Collaboration between in-house centres would also make it possible to avoid legal issues stemming from public procurement laws because public tenders are not required for it.

28. The above three closely interwoven strands, which could be labelled as ‘capacity building’ (see Figure 2), need to be developed as a coherent whole and to be linked up with the best practices of more experienced allies and partners. This requires a fourth strand of effort – coordinated guidance and oversight from the three national R&T

authorities in the defence ministries and close coordination between the executive organisations (e.g. national defence academies) with sufficient administrative resources.

29. It would be particularly helpful if a key organisation had a strong sense of stake in this three-pronged effort with (a) a firm commitment to Baltic defence cooperation and to intellectual and professional growth of all three defence organisations; and (b) strong international links. (As it happens, such an organisation already exists: a pan-Baltic identity, the pursuit of multinational solutions and 'best practices', and the utilisation of knowledge relevant to military organisations are the cornerstones of the Baltic Defence College, BALTDEFCOL.[8])

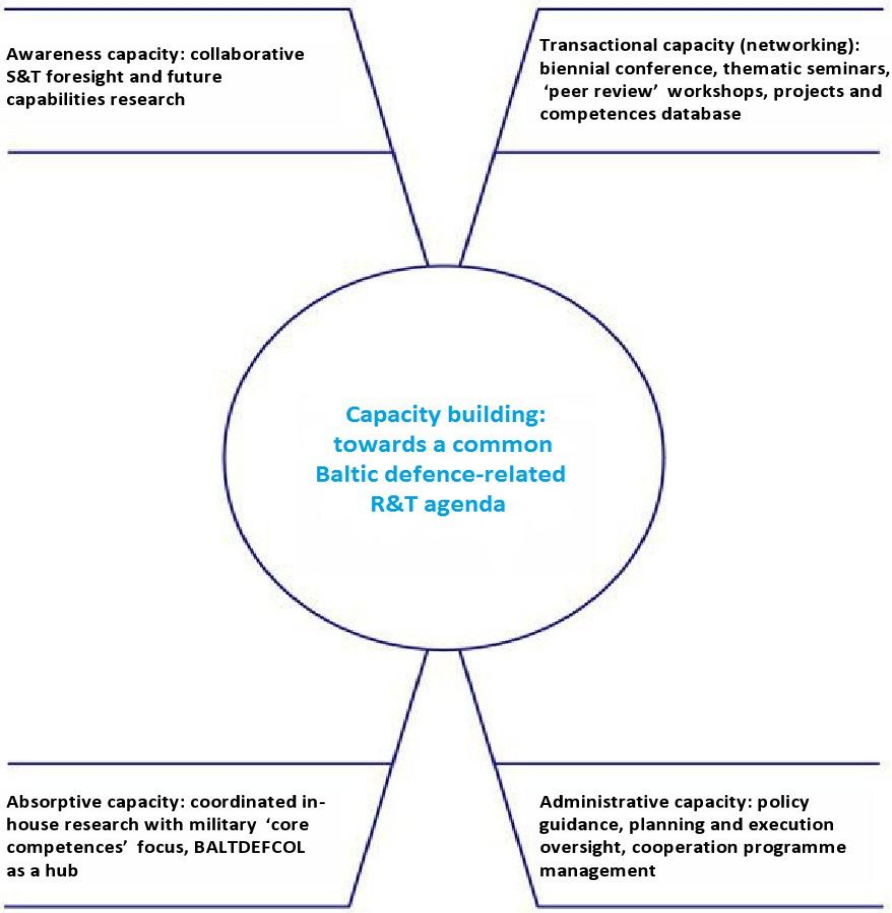

Figure 2: Collaborative capacity building for pan-Baltic defence-related R&T.[9]

30. All these factors (research into S&T monitoring, analysis, foresight and future capabilities, a regional defence-related R&T forum, the development of internal capacities to conduct R&T and their co-ordination mechanisms) are crucial, but they are still only 'enablers' that set the stage for further collaboration in a longer term perspective. Some key questions remain: (a) which areas represent common interests and (b) what should be the level of ambition in terms of deliverables in those areas?

31. Of course, these shared interests would eventually mostly be generated by joint research into foresight and future capabilities and by collaboration in the areas of military 'core competences': they would point to the directions where the Baltic states

[8] BALTDEFCOL also has experience in leading the harmonisation process of national policies in a field critical to its mission success – the continuous professional development of military officers. Such experience would be valuable and relevant in the harmonisation of the strategies and agendas of the research arms of the national defence academies.

[9] Awareness capacity is defined as a 'means of effective technology searching to identify opportunities for R&D investments', absorptive capacity as 'institutions, incentives and processes for effective technology learning' and transactional capacity as a 'trusted transactional environment to facilitate knowledge formation and exchanges' (Wylie et al., 2006: 271).

need to invest in and accumulate knowledge in the long term, so that the acquisition of new capabilities would be based on competent scientific and technological advice.

32. However, since they would not be starting as a clean slate in defence-related R&T and since research into military affairs necessarily branches out into broader domains of S&T, it is possible to put forward several areas of overlapping interest, which could serve as the initial thematic repertoire of collaboration. They are elaborated in the order of coinciding interests and feasibility in Table 2 below, drawing upon a general assessment of the area's potential, the interviews conducted for this paper and an analysis of the present and past activities in R&T by the three defence organisations.

Table 2: Knowledge and technology domains with the most potential for Baltic collaboration.

Domain	Rationale
Human factors, medicine, sociological research	Psychological and physical wellbeing of defence personnel; their behaviour and performance in various situations; values and norms; decision-making, communication and learning patterns; interfaces with technology and society – these and similar topics are constant issues in defence organisations, no matter in which direction their military capabilities evolve or what national defence planning documents stipulate. Concentrating on them makes it possible to generate new knowledge and to develop solutions which can always be tied in with many other areas of R&T (e.g. materials for uniforms, soldier monitoring and protection systems, individual training simulators, personnel management, etc.). All three Baltic states have some 'cutting edge' knowledge in this area in their S&T communities and contribute to the activities of the NATO RTO HFM panel. Military psychologists – one particular 'community of practice' – also cooperate between themselves, conducting collaborative research in the three defence organisations. All three countries have also been conducting individual research on various aspects of human factors, military sociology and medicine. The results can often be utilised without significant capital investments but by simply adjusting the policies and procedures in human resources management, which makes it an attractive and potentially 'low cost-high impact' direction for national R&T and trilateral collaboration.
International security	Defence organisations always operate in a broader security landscape which shapes their missions, strategies and capability needs. Many non-military (economic, societal, environmental, energy and cyber) dimensions of security have military implications which have to be studied and understood as part of strategic planning in defence. Ministries of defence of the Baltic states have a track record of commissioning and using research into various aspects of international security. Civilian research establishments in the Baltic states – universities and think-tanks – have acquired substantial expertise in various fields of international security research and have also often successfully cooperated between themselves. In many regards, it would be very beneficial if more effort – both on the demand side and on the supply side – was put into pooling research competence in such areas of common interest as regional security in the Baltic Sea region; Russia's foreign, security and defence policies; the EU's Eastern Partnership; and transatlantic security. It would help raise the profile of the Baltic states internationally; support their defence diplomacy efforts; create opportunities to cooperate with the Nordic countries; avoid the duplication of programmes; and build critical mass in what is still a very fragmented area of knowledge production in our region.
Management and administration	Similarly to the previous domain, defence also relies on some form of organisation, which is continuously evolving. Many military successes depend on a superior organisation of military efforts (both in peacetime and during conflict), so the issues of organisational culture, organisational behaviour, organisational learning, performance management, command and control arrangements remain pertinent at all times. This rationale is further strengthened by the fact that defence organisations have to continuously change and adapt to new strategic, operational and tactical environments, technologies and societal and economic realities. Research and development of new organisational concepts will be key to the implementation of NATO's ideas concerning 'smart defence'. Each Baltic state has been building its individual awareness of 'best practices' in this field and reflecting on its own defence reforms and on broader security sector reforms, but this has not involved much original research so far. However, this area will require greater attention from the Baltic defence policymakers as the pressure to improve organisational performance, to reduce inefficiencies and to derive better value from defence investments will not go away.

Domain	Rationale
Modelling and simulation (M&S) and training simulation technology	Modelling and simulation has long established itself as a pivotal area in the development and sustaining of military force. Enhanced use of M&S and training simulation technologies makes it possible both to reduce costs and to increase opportunities for military innovation. Estonia and Lithuania have their own capabilities in this area, with centres at the ENDC and the TRADOC respectively. Although the levels of development of the two centres are different, both countries take a keen interest in M&S technologies and know-how which can be accessed through the NMSG and bilateral ties with NATO allies. Latvia's defence authorities also show an interest in expanding the application of M&S. All three countries have been conducting R&T projects in M&S (e.g. to enable modelling and simulation of cyber attacks) and developing training simulators for various purposes (e.g. a rifle shooting simulator, a maritime mine countermeasures simulator). Trilateral collaboration between the three defence organisations to advance their expertise in this field of technology, especially taking into account the extent of their common military training activities, would bring immense practical benefits.
C4ISR	The ability to collect, transmit, fuse, analyse, share, store, use and protect information is central to defence organisations and ever more so to the concept of Network Enabled Capabilities with many of these processes getting better integrated and more automated. Defence organisations are operating in a data-rich environment and military advantage will increasingly be conferred upon those who are more adroit at exploiting it. Furthermore, various C4ISR systems have to be made interoperable with the 'legacy systems' in defence organisations and with the systems of the allies, which always renders R&T efforts in this area pertinent and useful. The field also combines a variety of technologies (sensors, data links, software, etc.) which require very diverse inputs and a broad knowledge base. The Baltic states have been contributing to the NATO RTO SCI and SET panels and possess some 'cutting edge' R&T competences in computing, electronics and information technology. Their defence organisations persistently list investments in ISR, C3I and related fields as their priority and they would benefit greatly from pooling their R&T expertise to support this priority with new knowledge.
Information assurance: cyber security and cyber defence	Cyber defence is currently one of the most popular subjects in security and military affairs. It is also one of the most dynamically developing areas, with NATO, the EU and their individual members increasing their resources to counter the growing range and intensity of threats in cyber space. As defence organisations are highly dependent on situational awareness and command and control systems, the protection of their systems is critical to mission success. Estonia hosts the NATO Cooperative Cyber Defence Centre of Excellence (CCDCOE), which also has Latvia and Lithuania as its sponsoring nations (even though their national attention to cyber issues at the policymaking and policy execution levels is not matching that of Estonia's). It would be very useful to pool S&T expertise on projects in cyber security and defence in order to support national strategies and to enable cooperation with Nordic countries, although so far only Estonia has carried out defence-funded R&T projects in this field. In political terms, trilateral collaboration in this domain might not make much sense and add much value, given that the three countries can simply concentrate more efforts on CCDCOE, instead of developing a parallel trilateral programme.
Unmanned platforms and systems	The trend towards automating warfare in all its dimensions is accelerating and autonomous vehicle technology is critical to that. The numbers of unmanned platforms and systems, especially UAVs, deployed in operations are growing. Key military powers plus NATO are investing more resources to advance this technology and to increase their reliance on it. (Civilian security organisations are also exploring how to make more extensive use of such technology, thus opening opportunities for interagency collaboration and synergy.) Even though human supervisors will remain 'in the loop' in the near future, in the long-term advanced autonomous systems will be granted ever greater degrees of decision-making authority, which will raise multiple challenges not only of technical, but also of moral, legal, political and doctrinal nature. This requires multi-disciplinary research inputs in this field to develop a thorough understanding of the emerging capability and the possible risks and opportunities related to its deployment. All three Baltic states have invested in R&T in this area and have participated in the NATO RTO AVT panel, which means there is a certain knowledge base in place. Each Baltic state also pursues the acquisition of unmanned platforms and systems (e.g. tactical reconnaissance UAVs, underwater demining robots, contribution to NATO's common UAV acquisition project), which makes it necessary to properly understand the technology, its management challenges and its future evolution.

Domain	Rationale
Electromagnetic spectrum technologies	Various applications derived from scientific research on different parts of the electromagnetic spectrum constitute the bedrock of many essential military capabilities from radar surveillance and communications to counter-IED and electronic warfare capabilities. Military planners and defence acquisition managers will always be interested in understanding scientific and technological developments in this field, their implications for military capabilities and methods for protecting personnel, equipment and systems from disruption or neutralisation using EMS-based technologies. This field may also attract those in charge of critical civilian infrastructure protection. Estonia's and Lithuania's defence organisations have a track record of R&T investments in this domain and Estonia has even achieved some success in equipment development both for military and civilian security organisations. At lower levels of ambition, both countries may find it useful to combine their knowledge and experience to support knowledge needs of their defence and national security organisations.

33. The above list is not finite; it could be extended. (The areas mentioned come in addition to research required to develop the 'core competences' of the military plus S&T foresight and the awareness of future capabilities.) However, it would be wise to start with one or two areas and gradually expand the scope of activities, with the most important criterion being whether experts in those fields – primarily members of the defence organisations but also MoD-funded researchers from civilian research establishments – see any benefits in collaboration and have a national knowledge base to draw on. Combined with the four-pronged approach suggested earlier, a focus on these areas would allow bottom-up initiatives to spring up and get underway in a guided fashion. If the three defence organisations simply expected the top-down requirements (demand 'pull') to materialise from the defence planners, followed by bilateral or trilateral harmonisation and resourcing, it would mean a long wait for them before growing up in intellectual and managerial aspects. In addition, as one interviewed defence official underlined, it was pointless to enforce artificially construed bilateral or trilateral projects top-down if there was no enthusiasm or capacity to implement them by the S&T communities in the Baltic states.

34. There is another important consideration which has to be kept in mind: as it was stated in the beginning, R&T collaboration should not be pushed too far in terms of its level of ambition (expressed in TRLs/SRLs – R&T ends between levels 4 and 5). Many stakeholders in the three organisations have an inherent temptation to seek projects which produce 'hardware' and/or lead to new products for the defence market (and represent something to be shown to the public for the money spent). Such ambitions are expensive, risky and unrealistic, given the resources, prevailing attitudes, S&T and defence market awareness, the competences and capacities of the three defence organisations and the size of the national S&T and defence industrial bases. By concentrating collaborative defence R&T investments mainly on applied research, the Baltic states would avoid many wasteful failures which usually mark these ambitions (even in much better resourced and more experienced nations) and which would also discredit the idea of trilateral cooperation. The level of ambition, just as it was recommended in the ICDS report on Estonia's defence R&D (see Jermalavičius, 2011), should be fixed at the production of new knowledge through applied research (and, in some cases, experimental development) and at ensuring its proper utilisation for the development of various aspects of the Baltic defence organisations (e.g. intelligent procurement processes, better management of human resources, improvements in training and education, the enhancement of interoperability with the allies, increased visibility in *quid pro quo* knowledge exchanges with the allies, etc.).

35. Large programmes leading from basic research to new products have to be supported by a proper organisational framework, usually in the form of a dedicated agency with sufficient expertise and capacity (e.g. staffed with certified project

managers) to manage complex requirements, risks, processes and contracts with suppliers. None of the Baltic states has such a national agency nor plans to create one. There is also no willingness to set up a common trilateral defence research, technology and capability development agency with associated overhead costs and the usual tussles for influence over it. However, if the level of ambition remains modest, as suggested above, no such agency would be needed. Instead, a 'virtual' organisation somewhat analogous to the NATO RTO could be constructed, with a similar 'business model' and a corresponding decision-making structure, but without a permanent administrative support and coordination unit. This model would best support the recommended aims and forms of trilateral collaboration and would offer a middle-course solution between a full-fledged (unnecessary and unrealistic) agency and a random set of (usually short-lived and ineffectual) cooperation initiatives.

36. The scheme below (see Figure 3) depicts the basic architecture of this trilateral collaboration effort (which could also be bilateral, should one of the states decide it has not much to contribute to a particular theme or has little interest in it), provisionally named as BaltSmartMil. The architecture is centred around a consortium of defence academies led by BALTDEFCOL, working to strengthen research in the 'core competence' areas of the military and linking it with research in selected technology areas where specialised 'communities of practice' (including representatives of academia and industry) constitute key contributors. It includes the following components.

36.1 The existing trilateral committees (a ministerial committee; a military committee) issue general policy guidelines and approve resources and activities, planned by R&T directors and national coordinators, with inputs from military end-users and providers. National R&T directors and coordinators oversee their implementation and the utilisation of the results.

36.2 Military end-users (most likely established specialist 'communities of practice' in particular fields) provide their expert feedback to (or fully participate in) the research projects run by the consortium of research centres of national defence academies and use project results.

36.3 The consortium implements a policy of collaboration by running common projects, coordinating the work of thematic panels, arranging their seminars and workshops and organising a biennial defence-related R&T conference.

36.4 Civilian academia and industry contribute (subject to interest and need) to thematic panels. They are also key participants in the biennial conference and in thematic seminars.

36.5 The Baltic Defence Research and Technology Conference serves as a focal point of the collaboration efforts, providing a forum for knowledge sharing, networking, the identification of opportunities and the development of understanding of end-user needs. It will lead to the publishing of a regular publication on applied research studies conducted under the auspices of BaltSmartMil.

36.6 All publications resulting from the collaboration efforts and the information concerning national projects of defence-related R&T and national experts in various S&T fields are stored in a shared and continuously updated database.

36.7 Individual nations and BaltSmartMil may draw upon a common pool of peer reviewers to assess the scientific quality of R&T projects at their various stages.

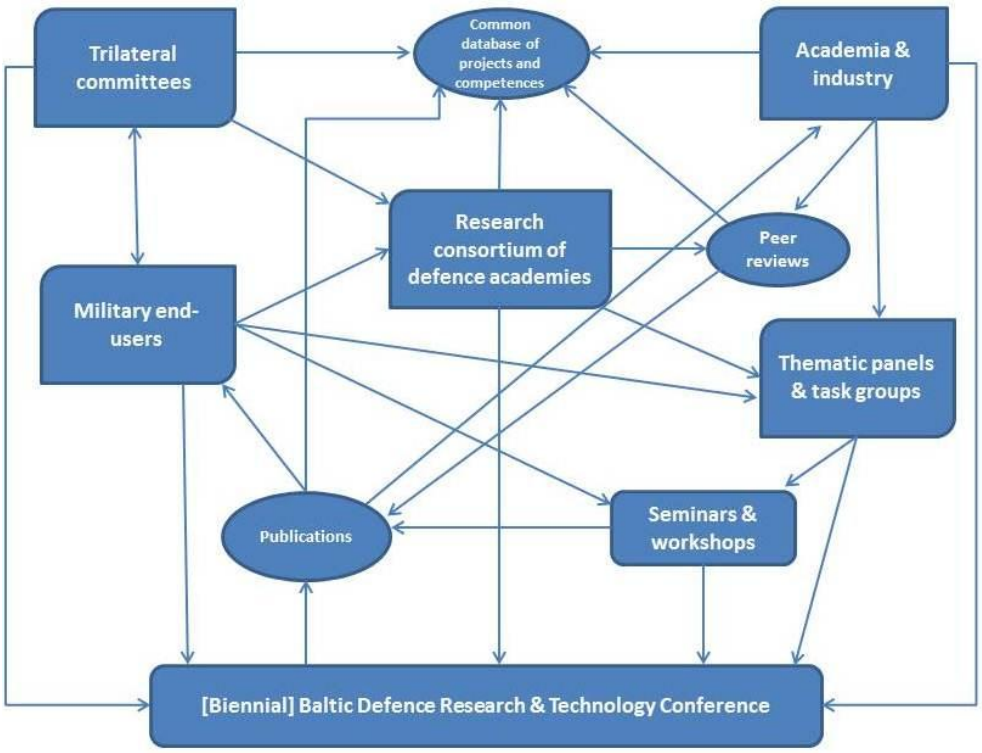

Figure 3: A possible architecture of BaltSmartMil.

37. While being very much centred on the consortium of defence academies and the conference, which form the cornerstones of its activities, BaltSmartMil provides a highly flexible mechanism for collaboration. It allows to attract researchers from outside the defence organisations and from military 'communities of practice' that are not part of the defence academies. Moreover, it does not commit only to trilateral configurations: projects conducted under its auspices could be bilateral or even unilateral, while the results could still be shared with others. Finally, networking and the exchange of ideas within this forum could lead to the definition of common trilateral (or bilateral) requirements by military end-users for R&T inputs, which could serve as the basis for inviting tenders and seeking suppliers entirely from outside this framework.

Conclusions

38. This policy paper attempted to explore the areas in which the Baltic states could cooperate in defence-related R&T and the 'business model' which could be applied to sustain this collaboration. The current status of national defence-related R&T in the Baltic states, their trilateral R&T cooperation record and some broader contextual aspects were analysed to identify the existing obstacles and possible opportunities for trilateral (or bilateral) collaboration between the Baltic states. The paper also sought to define the level of ambition which the Baltic states could aspire to in their cooperation efforts in this field and how to achieve it.

39. Interviews with defence officials (defence policymakers, capability planners, procurement managers, educators, R&T coordinators, researchers and military subject matter experts in various fields) and the data, views, insights and experiences provided by them all point to one simple conclusion: the Baltic states are not ready for and not capable of collaboration in defence-related R&T in order to deliver specific new capabilities to their armed forces. The conceptual, political, strategic, financial, economic and organisational prerequisites, especially those necessary for the generation and management of effective common requirements, are insufficient for the

fulfilment of this ambition. In addition to very weak conditions on the demand 'pull' side, there are also some legal obstacles to showing a preference for trilateral projects by R&T suppliers if they are not owned by the national defence organisations.

40. The defence organisations lack the required awareness, absorptive, transactional and administrative capacities to conduct effective defence-related R&T programmes even nationally, let alone on a multinational basis. On the other hand, a growing recognition among various defence stakeholders of those multiple weaknesses in the management of knowledge, technology and innovation in the defence organisations represents an opportunity for collaboration. This opportunity could be exploited if the Baltic states set capacity building for better knowledge, technology and innovation management in defence as their key objective and work at it together as much as possible. It would certainly contribute to the development of new products and capabilities if unreasonable expectations were dropped, if the states limited themselves to applied research in several key domains of R&T and if a clear focus were directed towards building in-house research in military affairs (strategy, operations, tactics, history, theory, sociology, leadership, technology, etc.).

41. Research capabilities of the national defence academies in the Baltic states are of utmost importance to any ambitions to enhance internal research in the three defence organisations and to acquire proper knowledge-brokering hubs, necessary for collaboration with the civilian S&T sector and foreign partners. This will require sustained investments in the form of human and financial resources, together with the formulation of right policies and leadership guidance by the national defence authorities in each Baltic state. Trilateral coordination, harmonisation and eventual linking of the development of the internal research capabilities of the three defence organisations could constitute the main thrust of Baltic collaboration in defence-related R&T in the medium term, with BALTDEFCOL playing an active – perhaps leading – role in this effort. It would have a beneficial effect if a NATO ally with considerable experience in the development of in-house defence research capacities and, preferably, with involvement in BALTDEFCOL were recruited as a mentor for collaboration.

42. Over time, common efforts devoted to increasing the 'organisational brainpower' in defence will create a demand for more practical novel solutions to improve military capabilities, consequently leading to joint undertakings for the achievement of these solutions. These undertakings will not be pursued on an *ad hoc* basis or be subject to short-termist whims of specific defence policies and plans; rather they will be rooted in and stemming from a broader culture of critical thinking, learning, experimentation and innovation in military affairs – something at which all three Baltic defence organisations are still woefully deficient.

Recommendations

43. Discard the aspiration to develop new products and entire capabilities as a level of ambition for trilateral R&T collaboration. Set the generation of S&T awareness and new knowledge of military relevance, the enhancement of technology management competences in defence organisations and the promotion of doctrinal and organisational innovativeness as the main objectives of trilateral (or bilateral) R&T collaboration.

44. Invest in R&T capabilities of the national defence academies and link them through a BALTDEFCOL-led research consortium (BaltSmartMil).

45. Direct the consortium:

45.1 to conduct research in the areas closest to central issues for the military profession (history, theory, doctrine, strategy, operations, tactics, organisation, sociology, etc.);

45.2 to develop research into collaborative S&T monitoring, foresight and future capabilities;

45.3 to facilitate research collaboration, based on military 'communities of practice', within a few R&T domains where the national excellence, interests and past activities of the three countries are the most aligned (at this point, human factors and medicine stand out as the most suitable area for trilateral collaboration; other fields listed in Table 2 constitute areas of potential bilateral cooperation);

45.4 to resume the Baltic Defence Research and Technology Conference in a biennial format as the consortium's main forum where various R&T stakeholders meet to share their plans, ideas, knowledge and the results of R&T activities.

46. Create a shared database for storing information about national projects, S&T competencies, T&E capabilities and the activities and results produced under the auspices of BaltSmartMil.

47. Consider asking a NATO ally/an EU partner represented at BALTDEFCOL and with experience in the development of in-house defence R&T capacities of national academies to serve as a mentor for BaltSmartMil.

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