Feasibility Study:
Establishment of a Research, Technology & Innovation Capability for the Irish Defence Organisation

An Roinn Cosanta
Department of Defence

Óglaigh na hÉireann
IRISH DEFENCE FORCES

VEDETTE

Final Report

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FOREWORD

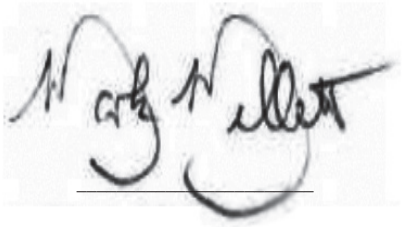
We are delighted to support the completion of this feasibility study and fully endorse the proposals in support of a Defence Research, Technology and Innovation capability. We also would like to acknowledge the productive and cooperative joint working relationship between the Defence Forces and Department of Defence and the rapid progress that was made by the team, despite the constraints that the Covid-19 restrictions have placed upon them. Deploying complementary perspectives of military and civilian staff and their unique skillsets has led to a product which has garnered universal support from the senior management teams in the Department and the Defence Forces.

The security environment globally is changing dynamically and the Defence Organisation, through the Department and the Defence Forces, need to be able to adapt to that change and become more agile in addressing new security challenges and integrating technology to support capability development to address new and emerging threats. This requires a combined Department and Defence Forces approach that is linked into the latest thinking and research on new and emerging technologies and their potential application in support of Defence Forces operations at home and overseas. It also requires systems, structures and processes that are connected to the wider public sector innovation programme under One Public Service and which benefits from and contributes to the knowledge economy.

Developments at EU level are also placing defence capability development on a new footing with significant funding now available for research and capability development in support of the Common Security and Defence Policy (CSDP). As such, there is dual opportunity arising whereby Defence can incorporate agile innovation into its capability development processes, whilst also supporting Irish research institutes and enterprise in accessing the new funding streams to deliver these capabilities.

A Defence Research, Technology and Innovation (RTI) Unit, as proposed in this study, would deliver benefits in terms of defence capability, defence value-for-money, national prosperity and the creation of a defence research & innovation ecosystem. There are challenges ahead in reaching that objective, but this study report is a first and very welcome step in that direction. We would encourage all personnel, civil and military, in the Defence Forces and the Department of Defence to engage pro-actively with the RTI Study team in advancing innovation right across our organisation.

Jacqui McCrum
Secretary General
Department of Defence



Vice Admiral Mark Mellet
Chief of Staff
Defence Forces

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EXECUTIVE SUMMARY

INTRODUCTION

This report assesses the feasibility of establishing a Research, Technology and Innovation (RTI) capability for the Defence Organisation[1]. Chapter 1.1 sets out the introduction and background for the study. The report includes the context, methodological approach taken, findings and recommendations and is accompanied by a set of study products that, taken collectively, provide a recommended implementation pathway for a future RTI capability.

The findings from the project team are based on stakeholder engagement, detailed analysis and evaluation of the likely costs and benefits of such a capability. The team identified relevant good practice from international comparators that informed the conclusions of the study. The report also considers how defence RTI can access the existing national innovation network and support and develop a partnership approach with actors from across wider government, academia and the private sector.

The study commenced in October 2019 and was sponsored at senior level by Assistant Secretary Ciaran Murphy and Major General Seán Clancy. The team was composed of members from Defence Forces (DF) and the Department of Defence (DoD) personnel and was supported by external consultants, Vedette Consulting.

FEASIBILITY ASSESSMENT

The nine-month project concluded that a Defence RTI capability is feasible and would deliver a range of benefits to the Defence Organisation. The analysis demonstrated that Defence RTI also delivers a positive return on investment and would thus contribute to national prosperity through an economic multiplier effect.

Defence Research, Technology & Innovation Vision

Leverage the benefits of research and technology to support current and future Defence capability needs and further develop a culture of innovation across the Defence Organisation

by

creating a joint unit that embeds evidence-based decision making and accessing the national and international innovation network across defence, government, academia and the private sector.

1 Defence Organisation (DefOrg) refers to the Department of Defence and the Defence Forces

KEY ROLE OF RESEARCH TECHNOLOGY AND INNOVATION (RTI)

The role of the RTI capability will be to facilitate, enable and fund technology and innovation that supports agreed Irish policy objectives and those missions and capabilities that are aligned with national defence policy. The formation of a national defence industry that is focused on the production and export of arms is categorically not an aim of the initiative. The defence RTI capability will focus on technologies, typically at lower technology readiness levels (TRL), that have broad potential utilisation (meaning that they could be exploited in a range of commercial applications) and on leveraging innovations from the civilian sector (at more advanced stages of technology development).

This would be achieved through the creation of a joint Defence Organisation unit that provides data and insight for evidence-based decision making in the Defence Organisation and can access existing innovation networks across defence, government, academia and the private sector. This would augment the work of the Defence Enterprise Committee (DEC) and align with the emerging capability development process. The unit would also strengthen the ability of the Defence Organisation to support the Department of Business, Enterprise and Innovation (DBEI[2]) and Enterprise Ireland (EI) in gaining access to international collaborative RTI investment, including the European Defence Fund (EDF) for Irish research institutes and industry. More specifically, the RTI capability would:

- Support academia and industry in terms of exploiting technology developments, which can support defence capability development;
- Enable engagement of the Defence Organisation with academia and industry to examine how to exploit technology developments to support defence capabilities;
- Take account of European defence funding programmes such as the (European Defence Industrial Development Programme (EDIDP) and the European Defence Fund (EDF), to support and assist DBEI, EI and academia in maximising drawdown from these funding instruments;
- Inform future procurement cycles and support the capability development process; and
- Help to fulfil or complete some PESCO[3], CARD[4] and the Defence White Paper 2015 project requirements.

STAKEHOLDER ENGAGEMENT

Preliminary discussions were held with a range of external national stakeholders including government departments, government agencies, academia, research institutes and the private sector as well as international stakeholders including the EDA, the EU Commission, other EU Member States (MS) and international RTI agencies. The national level engagement strongly suggests that the defence RTI capability will be welcomed and seen as "mutually beneficial" due to the unique competences that the Defence Organisation would bring through subject matter experts and end user expertise in defence domains. This report outlines the place that the defence RTI capability would occupy within the existing innovation landscape and how it would work with partners.

2 Department name at time of writing
3 Permanent Structured Cooperation in the context of the Common Security and Defence Policy (CSDP)
4 EU Coordinated Annual Review of Defence process

BEST PRACTICE FINDINGS

Analysis across a range of international case studies identified a number of key themes that are relevant to building the defence RTI capability, including:

- The importance of culture and building an innovation ecosystem across the triple helix[5] of government, academia and the private sector;
- Expanding the defence forces supplier base to non-traditional defence actors (recognising that relevant technology is mostly dual-use);
- Distinctive branding and positioning to work across government and the supplier base;
- Implementing proportionate governance and performance metrics based on requirements, inputs, outputs and outcomes;
- Leveraging other sources of funding to multiply defence investment;
- Building a joint and integrated team drawing on a range of disciplines and backgrounds;
- Establishing channels for simple and fast award of funding;
- Working closely with customers or users with a challenge-led approach to funding;
- Adopting a 'portfolio' approach to projects and activities, accepting that research and innovation has inherent uncertainties;
- Clarifying the distinction between innovation and R&T, including different associated competences and cultures;
- Ensuring that knowledge is managed and curated effectively and can be exploited for positive benefits.

FEASIBILITY STUDY PROPOSALS

This report presents a three-stage operating model for the RTI unit, with a progressive level of ambition at each stage. An outline plan is provided, illustrating a pathway to reach the full RTI capability over a four-year period. Each stage will conclude with a formal review measuring success against pre-agreed metrics and KPIs and to capture lessons learned, which will be used to refine the design of the next stage. It is acknowledged and understood that progression from stage 1 to stage 2, and from stage 2 to stage 3, cannot happen without the prior relevant approval process.

The joint unit would comprise uniformed and civilian staff and would build upon the joint approach adopted throughout this feasibility study. It is proposed that it would be hosted within the Defence Organisation with a Steering Board comprising of both internal and external stakeholders, which is a governance model that has been proven to be effective on similar initiatives as articulated in Chapter 3: Good Practice in Defence RTI. The composition of this steering board will be defined during stage 1. The outline plan includes an emphasis on review and learning, to provide opportunities to draw lessons and refine the approach over time. This study presents a series of 'products' in the report annexes which summarise other operational aspects and provide an outline implementation plan for establishment of the RTI unit.

5 The triple helix model of innovation refers to a set of interactions between academia, industry and government, to foster economic and social development

The proposed operating model is based on a set of building blocks, shown in Figure 0-1, which collectively constitute the full capability.

- Stage One would focus on further developing a culture of innovation within the Defence Organisation and building networks and partnerships, catalysed through a challenge-led innovation[6] campaign to address identified capability requirements. Stage 1 is a 'test' stage where details on Governance and resourcing would be further refined.
- Stage Two is a more comprehensive capability, introducing applied research activities, which can deliver strategic, longer-term benefit.
- Stage Three augments Stage Two with decision support and analysis functions by allowing for greater focus on informing decision-making and internal innovation.

There are clear linkages between RTI and capability development and these linkages must be defined and co-evolved to ensure coherence between RTI and any future DefOrg capability development planning process. Further discussions on the types of defence capabilities that should initially be prioritised by an RTI capability is required. White Paper Project 31 and the resulting Capability Development Process will be required to inform elements of the RTI work.

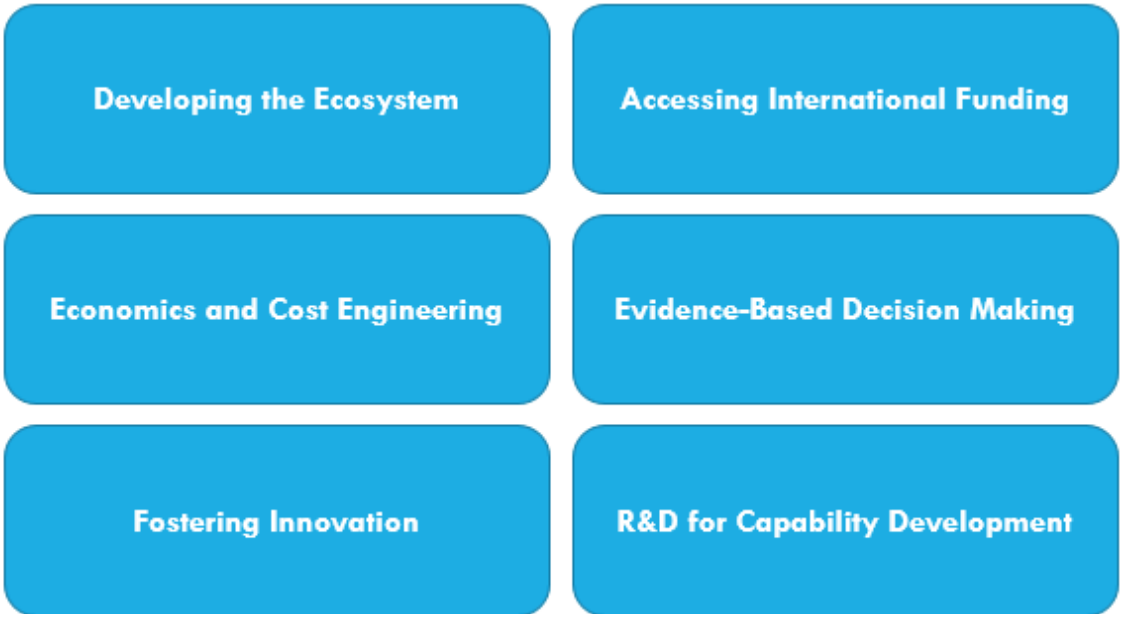


Figure 0-1: Functional building blocks of RTI capability

6 Challenge led innovation is a defined problem or challenge distributed to an appropriate open or closed channel for innovating. This allows organisations to tap into diverse perspectives and talent to solve problems faster, more cost-effectively and with less risk as the solutions tend to be at a high technological readiness level.

ECONOMIC CASE FOR RTI INVESTMENT

The primary purpose of the defence RTI unit is to increase the effectiveness of defence capability. However, in terms of the wider financial business case, a synthesis of published literature (Annex 5) also provides a compelling case for investment in defence RTI in terms of an economic multiplier effect. Recent research[7] suggests that 'mission-oriented'[8] investment in RTI – policies that are deliberately challenge-led and co-ordinated – are the most effective form of government spending (in terms of economic impact). This is partly due to breakthrough innovations but also associated with 'crowding in'[9] of private sector investment that increases the overall return on investment of the government RTI spending. This report describes the full range of anticipated benefits and also outlines how these would be monitored and measured.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The analysis conducted by the study team culminated in a set of conclusions that summarise the key findings and five specific recommendations to deliver an RTI capability over the coming years.

Conclusion 1: Establishing a Defence RTI capability is feasible and would deliver substantial benefit in terms of defence capability, defence value-for-money, national prosperity and the creation of a Defence innovation ecosystem.

Conclusion 2: An analysis of literature and studies referenced in Study Product 8 indicates that there is solid evidence that RTI investment delivers economic benefit and other socio-economic impacts including knowledge creation; highly-skilled jobs; tax revenues; GDP increases (2:1 minimum); and wider technology spill-over effects.

Conclusion 3: A synthesis of stakeholder interviews indicates that there may be challenges in achieving the proposed solution outlined in this study: not least the sustained stakeholder engagement campaign that will be necessary to secure buy-in for the aims of the project and to effect a significant cultural change.

Conclusion 4: It is important to be clear that the formation of a national defence industry that is focused on the production and export of arms is categorically not an aim of the initiative.

Conclusion 5: A Defence RTI capability would form part of the existing national research and innovation ecosystem, providing support to it and leveraging benefits where appropriate.

Conclusion 6: Ireland's membership of the EU provides an opportunity to benefit from a number of significant European initiatives to increase coordination between EU Member States on defence requirements including RTI.

Conclusion 7: Innovation is, and will continue to be, part of the defence forces day-to-day business but there is a need to formalise RTI structures to develop applied research, technology foresight and challenge led innovation capabilities.

Conclusion 8: The links between RTI and capability development are clear and they must be co-evolved to maximise effectiveness for the defence forces.

7 www.ucl.ac.uk/bartlett/public-purpose/sites/public-purpose/files/macroeconomic_impact_innovateuk_iipp_report_final_web.pdf
8 Innovation focused on concrete societal problems that can only be solved by multiple sectors interacting in new ways
9 Innovation is endogenous and determined by targeted public policies that positively stimulate private initiative/ investment

Conclusion 9: There is a need for a novel approach to resourcing the nascent RTI capability particularly in terms of staffing. Conclusion 10: An assessment of the benefits of joint working identified that the civil-military working relationship has been positive and mutually beneficial for this study.

Conclusion 11: A three-stage operating model for future RTI capability that is scaled over time is proposed to allow opportunities for success and to allow time to build the corporate knowledge and confidence before moving through each stage.

Conclusion 12: The use of metrics and key performance indicators (KPIs) to measure activity, progress and success is an important aspect of RTI risk management.

RECOMMENDATIONS

Recommendation 1: The feasibility study, along with tailored communication material, should be shared across the Defence Organisation with all relevant Branches, Services and Corps in order to ensure a global understanding of the proposals and engender a unity of purpose.

Recommendation 2: It would be preferable that a whole of Government approach to defence RTI be developed to ensure issues outside of the control of the DefOrg are addressed and supported by the relevant Departments and Agencies. Examples of such issues include (1) continuing to work with DBEI in seeking to extend the mandate of EI (pursuant to s.8(5) of the Science and Technology Act 1987), to allow Enterprise Ireland to promote and assist Irish Industry and Academia in accessing funding available under the European Defence Fund (EDF), (2) addressing the significant challenges of a national security clearance regime for civilians and facilities in order to partake in EDIDP and EDF fund programmes.

Recommendation 3: A mechanism should be established to identify the technology requirements of key defence capability areas and to identify gaps in the market that could facilitate innovation within the national RTI structures. Mapping the National Research Priorities with EU Capability Development Priorities and the EDF themes is required in order to down-select key areas of interest in the short term.

Recommendation 4: Secure approval of the findings and endorsement of establishing the RTI capability from the SMC and approve the next steps.

Recommendation 5: Once the decision is taken to move to the implementation of Stage 1 of the RTI capability a business case should be prepared setting out the resources necessary for agreement by the SMC.

Chapter 1

Introduction and feasibility study objectives

1.1 Introduction and Background

The security environment globally is changing dynamically and the Defence Forces need to be able to adapt to that change and become more agile in addressing new security challenges, integrating technology to support capability to address this changing environment. While new technology provides opportunities it also presents challenges. The barriers to entry to acquire and exploit these new technologies are continually lowering, enabling state and non-state actors including dissidents and criminals, to exploit these new technologies and undermine state institutions designed to protect our democracy, our citizens, the rule of law and the international order.

The Defence Forces are an instrument of the executive authority of the State designed to protect national sovereignty, to provide for the territorial defence of the State and increasingly, in the modern age, to support our democracy and the international order. To do this, they must be able to change and adapt, understand the potential of new technologies, which are used for good and evil, and be capable of developing new scalable capabilities to counter and suppress new and emerging threats.

Traditional military systems of kinetic force and armour will not defeat threats arising from cyber and hybrid warfare, nano-technology, artificial intelligence, robotics, autonomous systems, the adverse exploitation of social media, bioscience, materials technology, the internet of things, ICT and networks. If we are to maintain the necessary defence capability to counter the adverse effects of new technology, then we need the knowledge, capacity and skills to harness and exploit these technologies in support of the State. We also need to incubate and develop a dynamic and holistic understanding of the interplay between land, air, sea, cyber and space domains in order to enable how they can be best integrated and deployed.

The incorporation of agility and innovation within our Defence Forces, across all services, corps' and disciplines is necessary to this end. We can no longer think in terms of distinct air, naval and land systems or even cyber, CIS and space systems, To address 21st century threats, it is essential that we lose the silos of service-based thinking and re-imagine outcomes which are service blind. This requires a Defence Force that is linked into the latest thinking and research on new and emerging technologies and their potential application in support of Defence Forces operations and the threats arising therefrom.

New opportunities for the Defence Forces to engage with enterprise and research institutions and industry were developed under the Defence Enterprise Initiative and the Defence Enterprise Strategy. These initiatives were designed to support the Defence Forces in securing access to new technologies to support defence capabilities and also to support Irish enterprise and research institutions to access funding and to exploit national civilian technology development efforts in the defence and military

domain. While these efforts have been moderately successful in some areas - Ordnance Corps and Naval capability development, we have not had a systemic organisational drive to support cross organisational innovation and the adoption of new technology within defence.

To remain relevant and capable in terms of national defence and international crisis management operations, the Defence Forces must be at the cutting edge of capability as measured in EU and NATO terms. The Defence Forces needs to have the capacity to incorporate new and emerging technologies necessary to address new threats.

Developments at EU level are also placing defence capability development on a new footing with significant funding now available for research and capability development in support of CSDP. As such, there is dual opportunity presenting whereby the Defence Forces has the opportunity to incorporate agile innovation into its capability development process and avail of significant funding to support this capability development and to support Irish research and enterprise institutions in accessing the new funding streams, to deliver these capabilities.

These requirements and opportunities cannot rely on individual efforts. Rather it requires a structured and appropriately resourced institutional effort in supporting and mentoring innovation to drive forward design thinking, capability development and innovation with linkages to enterprise and research institutions through the organisation.

This Study takes this requirement as its starting point and proposes a path to deliver a structured and phased approach to support research and innovation in the Defence Forces both in terms of future advanced capability development and support to Irish enterprise and research institutions, while exploring access to EU funding. Its intention is to support a paradigm shift in the approach, to networked capability development thinking, so as to address in a holistic manner the dynamic new and emerging challenges. It will link the Defence Forces into Ireland's existing national innovation enterprise and research strategies thereby delivering economic benefits for RTI in Ireland and secure a return on Ireland's contribution to the EDF and the EDA.

1.2 Structure

This report comprises six chapters and a set of study products.

- This chapter introduces the study and provides a synthesis of the relevance, benefits and national context associated with establishing a Defence RTI capability.
- Chapter 2 outlines the methodological approach undertaken to conduct the feasibility study and highlights the use of a mixed methods approach both to generate an evidence base and to analyse that evidence to produce findings and recommendations.
- Chapter 3 provides an analysis of a number of international case studies to identify good practicE in the development and operation of a defence RTI capability that are relevant in the national context.

- Chapter 4 presents analysis of the current DefOrg baseline situation and summarises the wider national supports using interview evidence and document review conducted by the study team.
- Chapter 5 presents a three-stage operating model for future defence RTI capability and a set of study products to provide the RTI capability implementation blueprint as summarised in Table 1.
- Chapter 6 outlines the conclusions & recommendations

Serial	Project Artefact
1	Vision, purpose and objectives
2	High level stakeholder engagement and communications plan
3	Think piece on defence industry and dual use technology
4	High-level project timeline
5	Process maps for leveraging innovation and supporting R&D
6	Risk register
7	Metrics and KPIs
8	Strategic business case (and economic analysis)

Table 1.1: List of project artefacts

1.3 Overarching Aim

The overarching aim of the study is to assess feasibility of the establishment of a future DefOrg RTI capability. In the summer of 2019, a concept paper was produced by the DF highlighting the strategic business case for the development of a 'Defence Research, Technology and Innovation Support Cell'. This paper identified a number of expected benefits that are associated with investment in defence RTI, inter alia:

- Supporting academia and industry in terms of exploiting technology developments, which can support defence capability development for crisis management;
- Enabling engagement with academia and industry to examine how to exploit technology developments, which can support defence capabilities;
- Taking account of European defence funding programmes such as the EDIDP and EDF, the DefOrg could support and assist the Department of Business Enterprise and Innovation (DBEI), Enterprise Ireland (EI) and academia in maximising drawdown from these funding instruments;
- Informing future procurement cycles and supporting the capability development process; and
- Helping to fulfil or complete some Permanent Structured Cooperation (PESCO), Coordinated Annual Review on Defence (CARD) and White Paper 2015 project requirements

Alongside the concept paper, a Project Initiation Document (PID) was produced that detailed the work required to conduct a feasibility study for the establishment of a Defence RTI support cell, with a project end date of 30 June 2020. In the course of this study White Paper Projects 17 and Project 18[10] were amalgamated and the work of the Feasibility Study was subsumed into Project 17.[11]

1.3 Associated Benefits

Theory and practice point to a range of benefits associated with investment in defence RTI, while noting the evolving landscape. Defence organisations around the world have long recognised the importance of leveraging technology and innovation into operational service. These benefits include: capability planning efficiencies, assisting with longer term strategic procurement; economic prosperity; job creation; exports; international influence; technological spill-overs into adjacent fields; stimulating research in academia; and stimulating the national technological and industrial base (in Ireland's case by facilitating access to EU and EDA funding).[12] The scope of national and supranational RTI capabilities has now broadened to leverage investments from the civil sector and adopt a range of models and approaches. One particular change in recent years has been the increasing speed of the technology cycle and the need for defence organisations to be innovative in terms of processes, people and information in order to utilise the benefits that advancements in technology can bring. This study provides a model to ensure that innovation will help to nurture ideas and a vibrant ecosystem across the DefOrg and with its external partners in Ireland.

This study has been based on the concept of an innovation ecosystem that emphasises the importance of connections between a range of actors and agents, rather than a transactional customer-supplier approach to research and innovation. This resonates with the triple helix model of innovation, which focuses on the nature of the interaction between three different groups: government, industry and academia.[13] In the Irish context, university representatives previously expressed concern that there has been little investment to establish such collaborations, particularly in relation to dual-use technological capabilities. This means that researchers working in some of these fields are said to be doing so in adjacent ways and the Irish state is not taking full advantage of research being conducted in the country. This is especially problematic where Irish research, perceived to be among the best in class in fields such as ICT and artificial intelligence/ machine learning is not linked to defence capability requirements and not leveraged by industry.

The study team recognises that these are important underlying aspects relevant to the development of a DefOrg RTI capability. As a result, the study connects the Irish Defence RTI needs with other national RTI stakeholders. It develops a model that supports the future development of mutually reinforcing relationships between the three groups of industry, government and academia. This model facilitates the best approach to engagement with industry, academia, government, other EU Member States and European Institutions (the European Commission and the European Defence Agency) on defence innovation.

In addition to directly enhancing Defence Forces' capabilities, indirect future added value could also

10 Project 18:Establish a Security and Defence Enterprise Group to support Irish-based enterprise in their engagement with the EDA and in accessing EDA and Horizon 2020 programmes, to the benefit of Irish Enterprise and Defence Forces capability.
11 Project 17: Identify opportunities for co-operative collaborative engagement between the Defence Forces and Irish-based enterprise and research institutes, including third level colleges and give appropriate stimulation to innovation networks.
12 See, for example, Ecorys and Vedette Consulting (2018), Impact Assessment study on EU funding for collaborative defence R&D funding. Prepared for DG GROW
13 Etzkowitz, H (2003). Innovation in innovation: the triple helix of university-industry-government relations. Social Science Information 42, (3): 293-337

include additional economic benefits, as well as adding benefit to the national RTI ecosystem and Irish SMEs. This could be especially relevant in the case of dual-use technologies. This study finds that through supporting the development of dual use and key enabling technologies, the RTI capability will strengthen the national R&T base in technology areas that are aligned with national defence capability needs. This will also increase the competitiveness of companies and universities that are bidding for grants under the European Defence Fund and financial support from other European funding sources. This has some multiplier effects in terms of research funding in that the same technologies can then be applied in a range of markets, which has a wider prosperity and applied benefit than just defence.

Other factors considered by the team in the initial phases of the study included the importance of examining funding modes for RTI and the applicability of approaches at different stages in the technology life cycle and innovation phase. For the purposes of this study, we use the TRL and innovation phase framework set out within Annex 2, which also includes a categorisation of funding models.

1.4 Features & Challenges of the Irish context

The study team originally identified four strategic challenges that impact the feasibility of establishing the DefOrg RTI capability which are addressed within the study report.

1.5.1 A need for a one-stop shop for RTI capability embracing a 'triple helix' approach to create an ecosystem of innovation

The study team identified concerns among Irish stakeholders about fragmented responsibilities and the need for a one-stop-shop at national level in relation to RTI capability. There is an acknowledgement among stakeholders that we must seek the right platform or channel to enable innovation to identify defence solutions, and to both directly and indirectly extract value from this investment.

While stakeholders see value in collaboration between military, industry and academia/research institutes, there has been past uncertainty surrounding how such a collaboration could be sustainable and achieve the best competitive advantage. The study model consequently proposes the 'triple' helix approach to address how the DefOrg could engage with these stakeholders.

1.5.2 Linking RTI capability with DefOrg capabilities' needs

Further national discussions are required on the types of defence capabilities that should initially be prioritised by an RTI unit. Past suggestions for innovation and defence funding or research include the need to identify niche areas such as developing capabilities linked to, for example, CBRN response, disaster relief, ICT dual-use capabilities, peacekeeping, and climate change/sustainability. The prioritisation of capabilities should go beyond current capabilities' needs and focus on other long-term defence capability requirements. The study further identifies the need for horizon scanning activities and a Defence Technology Strategy to identify and prioritise technology sectors of defence interest.

1.5.3 International drivers and access to EU funding streams

In recent years, there have been a number of significant developments in terms of European initiatives to increase coordination between EU Member States on defence priorities including RTI. The European Defence Fund was announced in June 2017 alongside the European Defence Industrial Development Programme (EDIDP). The European Defence Fund originally proposed annual spending through dedicated programme(s) of €0.7m for collaborative defence research and €1.5 bn for the collaborative development of defence capabilities for the period after 2020.[14] The latest proposal in September 2020 was for a budget of just over €7.9 billion split between research (€2.6 billion) and development actions (€5.3 billion) over the seven-year Multiannual Financial Framework (MFF).

The study recognises the opportunity for Irish industry and government to position itself to secure investments (and create potential jobs) through the expected available funding from the European Defence Fund (EDF) 2021-2027. Ireland is contributing to the aims of these funds, which include helping EU Member States spend money more efficiently, reduce duplications and get better value for money by coordinating, supplementing and amplifying national investments in defence research and development activities. A key question for Irish governmental and non-governmental stakeholders is how Ireland can benefit from the State's contribution to the EDF (~ €150 million at time of writing).

However, several stakeholders remain sceptical about the Irish community's ability to take advantage of such EU funding streams and the desire of other EU stakeholders to obtain a return on their funding. Observations expressed include: (1) Recommendations that Irish stakeholders become more plugged in and work to have priority themes and subjects included in EU work programmes; (2) There could be obstacles in accessing EU funding, including the current EDF budget for 2021-2027, because of the need to compete with larger European MS with strong defence industries, the pressure on the DBEI/ DoD resources and the size of the Irish security/defence related industry; (3) The need to leverage key national experts; (4) A need to address the significant challenges of a national security clearance regime for civilians and facilities; (5) The implications of industry seeking total control of European defence budget portions related to capabilities. Despite these concerns, this study proposes an operating model that has structures in place to support stakeholders' access to such EU funding.

1.5.4 Concerns about the creation of a national defence industry

The study team initially identified the potential that the current public narrative surrounding defence and concerns about the creation of a defence industry or defence industrial complex in Ireland could undermine ambitions to create a sustainable defence RTI capability. Even though the intention behind establishing the RTI capability is not to create a defence industry, there is widespread apprehension, and sometimes misperceptions, surrounding 'defence' matters in Ireland. Concerns about international defence matters is a long-term challenge in Ireland and there are already examples of negative responses on social media in relation to the public discourse about Ireland's need and opportunity to reap the benefits of its contribution to the EDF.

This study proposes to address this challenge by providing a high-level stakeholder engagement and communications plan (Study Product 2). A number of overarching themes present themselves. First,

14 In the original proposal €1.5 bn was planned. According to the updated budget proposal an annual spending of €2.17 bn will be provided.

some stakeholders already propose that defence RTI capability should be linked to the State's economic security – a matter that is heavily emphasised in Irish circles already. The study finds that by creating an innovation ecosystem across academia, industry and SMEs, a range of benefits will accrue that are not exclusively for defence applications.

Second, the RTI capability must align with overarching Irish foreign policy and national defence objectives. A key message for stakeholders is that the role of the RTI will be to facilitate, enable and fund technology and innovation that supports agreed Irish policy objectives, overseas missions and capabilities that are aligned with national defence policy. This could include priority areas such as disaster relief, cybersecurity, climate change and sustainability, CBRN response. It could also include other defence applications that can assist with border controls, airports and critical installations which provide a social good and align with overarching Irish Government policy objectives. In other words, the study emphasises that it is not an aim of the RTI capability to create a national defence industry that is focused on the production and export of arms.

Third, the study provides particular detail on the nature of dual-use capabilities (Study Product 3). The study identified obstacles that could arise in relation to the feasibility of the RTI capability associated with dual-use technologies. In particular, the RTI capability will focus on technologies (typically at Technological Readiness Level (TRL) 3-6 – see Annex 2 for the TRL framework) that have broad potential utilisation (meaning that they could be exploited in a range of commercial applications) and on leveraging innovations from the civilian sector (at higher TRL). The creation of an innovation ecosystem that better enables the delivery of defence objectives will not lead to a defence industry for two reasons: (1) Economics (the focus on enabling technologies means that defence will not be the dominant customer); and (2) Policy (as a consequence of focusing on national defence policy rather than allowing a defence industrial strategy to drive policy). For this reason, the study finds that a whole of Government approach will ensure issues outside of the control of the Department of Defence such as export control matters are addressed and supported by the relevant Departments and Agencies - a suitable defence export licensing policy should enable national prosperity without compromising the wider national defence posture.

Fourth, the study examines how to provide better measurements of the sometimes intangible and hard to measure benefits of RTI by identifying returns on investment and providing an indication of metrics and key performance indicators (KPIs). These indicators are outlined in Study Products 6 and 8. There must be a strong case for the RTI capability return on investment given that defence budget is constrained and to ensure that the public and DefOrg partners across government are certain that the proposed RTI capability supports Defence Forces' capabilities and the prosperity of Ireland Inc.

Chapter 2

Methodological approach

This section describes the study's methodological approach. A mixed methods approach was used whereby RTI case studies were examined to identify good practice and analysis was conducted on the basis of interview evidence and document review. Synthesis of evidence was conducted through study team workshops and structured analysis.

2.1 Mixed Methods Approach

The study team used a mixed methods approach. Analysis was conducted on evidence from a set of interviews held between the study team and key stakeholders within the DefOrg, the Irish RTI ecosystem and the international defence RTI ecosystem relevant to the establishment of an RTI capability as well as review of relevant documents.

RTI case studies were examined in parallel by the study team to identify relevant good practice to inform the model proposal for the RTI capability. Synthesis of this evidence was conducted through a number of team workshops and structured analysis.

Furthermore, the study team used a logic modelling methodology to structure an analysis of the framework with which to link inputs, processes, outputs and outcomes that underpin the strategic business case for an RTI capability. This also provides the means to develop performance indicators and key metrics.[15]

2.2 Feasibility Study Timeline

Project Timeline (Project Start Date 21st Oct 2019)	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020
Literature Review										
Stakeholder Engagement										
Analysis of Evidence										
Course of Action (COA) Mapping										
Interim Project Briefing for Project Sponsors – Decision Brief										
Development of Proposed Solution										
Interim Project Briefing for Project Sponsors										
Preparation of Final Report										
Submission of Final Report (Final report submitted 31st July 2020)										

Figure 2.1 Feasibility Study Timeline

15 Logic modelling is a standard tool used to develop strategic change programmes and articulate how critical aspects are related. They are also used as an evaluative frame with which to inform metrics and monitor success.

2.3 Case Studies

The study team visited three EU Ministries of Defence, conducted interviews and examined case studies on defence RTI organisations to identify the current state-of-the-art and inform the development of outline options for a future RTI capability. Relevant features from different case studies were elicited and tailored for the Irish Defence context to inform the development of an outline option for the RTI capability. Kipling's 'Six Friends' are used as a problem analysis method – i.e., 'who, what, where, when, why and how.

The following case studies were examined for discussion with the project sponsor:

- The UK Defence and Security Accelerator (DASA);
- The UK Home Office/Vivace Accelerates Capability Environment (ACE);
- The Estonian Ministry of Defence RTI model;
- The Dutch Ministry of Defence approach to RTI capability;
- The Portuguese Ministry of Defence approach to RTI capability;
- The US Defense Innovation Unit (DIU); and
- The U.S Defense Advanced Research Projects Agency (DARPA).

In parallel, the study team drew on their own experience and networks in the international landscape to identify key actors and interfaces for the Defence Organisation: primarily the European Commission and the European Defence Agency. The developments of the past four years relating to the European Defence Fund and PESCO are of particular relevance given the focus on defence research, technology and innovation.

2.4 Current Situation

In order to baseline the current situation, the study team mapped the existing competences and capacities both within the Irish Defence Organisation and those of partner organisations relevant to the establishment of an RTI capability. The study team conducted semi-structured interviews with national stakeholders identified by the project sponsor across DefOrg as well as relevant government agencies such as Enterprise Ireland and research entities such as Science Foundation Ireland. The DefOrg project team also informed the study team of their own interview findings and observations related to their engagement with representatives from wider government, the private sector, and EU bodies. Concurrently, the team collated and conducted a high-level synthesis of existing artefacts through a systematic review.

Table 2 outlines the roles of a sample of key stakeholders who took part in semi-structured interviews. The interview protocol sheet is attached as Annex 3. Key themes discussed throughout these semi-structured interviews were focused on three areas:

- Examining to what extent the DefOrg is currently open to innovation and accessing new technology, methods, processes and ways of working. In other words, to what extent does the DefOrg support a culture of innovation?

- An examination of how stakeholders perceive success in terms of RTI.

- Functional aspects related to establishing an RTI capability such as models of RTI functions and factors that should be considered in assessing the feasibility of developing an RTI capability for the DefOrg (e.g. governance, culture, processes, people, stakeholder engagement, resources, structures).

Baselining the current situation in this manner allowed the study team to confirm drivers and anticipated benefits of establishing a defence RTI capability. These activities enabled the study team to create an initial stakeholder map of the Irish defence innovation ecosystem using standard tools to assess stakeholder's interest and influence in the establishment of an RTI capability and their potential future role.

Document review was also conducted on current policy and strategy documents such as the Defence White Paper 2015-2025 (and the 2019 update), Innovation 2020, Programme for a Partnership Government (2016), Our Public Service (OPS) 2020, the Defence Enterprise Strategy and PESCO commitments.

Interviewee	Role/Organisation
Garrett Murray	National Director, Enterprise Ireland
Michael Murphy	National Delegate & Lead, Secure Societies, Enterprise Ireland
Marguerite Bourke	Small Business Innovation Research, Enterprise Ireland
Imelda Lambkin	Disruptive Technologies Innovation Fund, Enterprise Ireland
LTC Ray Murphy	Strategic Planning Branch, DF
Comdt Damian Griffin	Communications and Information (CIS) Corps, DF
Fiona Lafferty	Principal Officer, Head of Procurement, Contracts Branch, DoD
Col Rossa Mulcahy	Head Strategic Planning Branch, DF
Col Matt Byrne	Director, Ordinance Corps, DF
Bernie Maguire	Principal Officer, International Security Defence Policy Branch, DoD
Cathal Duffy	Principal Officer, Planning and Organisation Branch, DoD
Killian McGee	Assistant Principal, Planning and Organisation Branch, DoD
Capt (NS) Brian Fitzgerald	OC Naval Operations Command & 2IC Naval Service, DF
Prof. Mark Ferguson	Director General, Science Foundation Ireland
Nicholas Moiseiwitsch	Deputy Head, Defence and Security Accelerator (DASA), UK
Col Mick Moran	Chief of Air Support Staff, Air Corps, DF
Nikki O'Connor	Senior Policy Advisor, Higher Education Authority (HEA)
William Beausang	Head of Higher Education & Training Policy, Dept of Education and Skills (DES)
Breda O'Brien	Public Service Innovation Team, OPS 2020, DPER
Gerard Flaherty	Aerospace & Industry, IDA
Dr Eavan O'Brien	Irish Research Council (IRC)
Lt Col Gareth Prendergast	Military Finance Branch, DF
Jonathon Middleton	International Programmes, Police Service of Northern Ireland (PSNI)

Table 2.1: List of interviewees*

*** Only the main representative for each interview is listed. Most of the interviews were with teams from each organisation.**

2.5 Evidence was synthesised through structured analysis and team workshops

Key case study findings and insights from the team's baselining of the current situation in the context of DefOrg RTI capability were synthesised through structured analysis and team workshops between the study team. The study team presented these findings through an interim briefing report to the Project Sponsors in order to refine and develop the preferred option for RTI capability.

The final part of the study considers recommendations on how to develop the preferred option for establishment of an RTI capability. A high-level implementation plan comprises a set of study products on the preferred RTI capability option - a three-stage RTI model. This blueprint draws on the evidence gathered by the study team and the expertise of the team. Finally, this high-level implementation plan was presented to the Project Sponsors for discussion, prior to preparation of the final report.

Chapter 3

The business case for investment and a review of international good practice in Defence RTI

This chapter summarises the findings from a review of the literature regarding the economic benefits of defence RTI and then highlights lessons from an analysis of international case studies for the development of a Defence RTI capability.

3.1 The business case for investment in Defence RTI

Four important distinctive benefits that form part of the business case are as follows:
First, operational benefits for the Defence Organisation through leveraging the benefits of RTI in terms of increased defence capability.

Second, the national prosperity and wider social benefits that would accrue from public investment in defence RTI.

Third, wider return on investment through an increasing focus on greater defence collaboration with EU partners and with the UK; including on joint development projects.

Fourth, the need to create a Defence innovation ecosystem through 'pump-priming' the dual-use sector to help access future European Defence Fund (EDF) projects.

It is widely accepted that government investment in research, technology and innovation has a number of positive socio-economic impacts including knowledge creation; highly-skilled jobs; tax revenues; GDP multiplier; and wider technology spill-over effects.16,17,18,19,20

A minimum GDP multiplier of a factor of two would be a prudent estimate and in line with estimates on the multiplier effect of defence investment (including equipment procurement). Evaluations of the economic multiplier effect of R&D are much higher. For reference, the EU Framework Research Programme estimates a GDP multiplier of between 6.0 and 8.5 on the initial investment. It is likely that investment in translational innovation (i.e. leveraging off-the-shelf civil technologies into a defence application) would have a lower multiplier effect than applied R&T.

Recent research conducted by UCL on behalf of Innovate UK, suggests that 'mission-oriented' investment in RTI – policies that are deliberately challenge-led and co-ordinated – deliver the greater economic impact through a 'super-multiplier effect'. This is partly due to breakthrough innovations but also associated with 'crowding in' private sector investment that increases the overall impact of the government RTI spending.21 They have estimated a GDP multiplier of 7.8 for non-military R&D and 8.8 for military R&D (based on a longitudinal study of data from US defence spending).

The full strategic business case and economic analysis including reference material can be found in Annex 5.

16 https://dbei.gov.ie/en/Publications/Economic-and-Enterprise-Impacts-from-Public-Investment-RD-Ireland.html
17 https://sciencebusiness.net/news/80354/R%26D-pays%3A-Economists-suggest-20%25-return-on-public-investment-for-research-and-innovation
18 https://www.iua.ie/wp-content/uploads/2019/09/Indecon-Independent-Assessment-of-the-Economic-and-Social-Impact-of-the-Irish-Universities_full-report-4.4.19-3.pdf
19 https://www.oecd.org/sti/inno/frascati-manual.htm
20 https://dbei.gov.ie/en/Publications/Publication-files/Innovation-2020.pdf
21 https://www.ucl.ac.uk/bartlett/public-purpose/sites/public-purpose/files/macroeconomic_impact_innovateuk_iipp_report_final_web.pdf

3.2 International case studies indicate a range of defence approaches to RTI

The study team explored a range of international defence/security approaches to RTI and a number of relevant lessons and good practices were synthesised for developing a preferred model for defence RTI capability. The key aspects that were examined across these international case studies are:

a. Why is RTI important to national defence in terms of the business case for investment of time and resources?
b. What is the approach taken?
c. How are the benefits of RTI delivered and how are they measured
d. Who is involved and what are the key technical and behavioural competences?
e. Where is the RTI capability vested in terms of organisational structure?
f. Which partnerships are important in delivering RTI benefits?

Analysis across the seven case studies, as listed in Chapter 2.2, identified a number of key themes that are relevant to building a defence RTI capability including:

- The importance of culture and building an innovation ecosystem across the triple helix of government, academia and the private sector;
- Expanding the defence supplier base to non-traditional defence actors (recognising that relevant technology is mostly dual-use);
- Distinctive branding and positioning to work across government and the supplier base;
- Implementing proportionate governance and performance metrics based on requirements, inputs, outputs and outcomes;
- Leveraging other sources of funding to multiply defence investment;
- Building a joint and integrated team drawing on a range of disciplines and backgrounds;
- Establishing channels for simple and fast award of funding;
- Working closely with customers or users with a challenge-led approach to funding;
- A 'portfolio' approach is useful, accepting that research and innovation is uncertain by nature;
- Clarifying the distinction between innovation and R&T, including different associated competences and cultures;
- A recognition of the importance of managing, curating and applying knowledge.

A summary of findings from each case study is attached in Annex 4.

3.3 Particular areas of learning that are relevant for the national context

The study team identified specific areas of learning that are relevant for the national context, synthesising these areas of learning as six functional areas. These are proposed as modular building blocks to create a future defence RTI capability. These six 'building blocks' each deliver additional levels of benefit in terms of capability and prosperity, namely:

i. **Developing the ecosystem** (i.e. creating a knowledge and innovation culture in DefOrg as well as building networks and relationships);

ii. **Fostering innovation** (e.g. through DASA[22] type challenge-led innovation, with a focus on higher TRL23, readily exploitable and often dual-use)

22 UK Defence and Security Accelerator programme

iii. **Accessing International Funding** (e.g. Shape and influence European Defence priorities, leverage EDF for Ireland Inc, international collaboration);

iv. **R&D for Capability Development** (in other words, similar to DARPA24 thematic, key enabling and disruptive technologies, horizon scanning, lower TRL, build long-term capability);

v. **Economics and Cost Engineering** (e.g. Life cycle costing, balance of investment, efficiency, economic appraisal and prioritisation); and

vi. **Evidence-Based Decision Making** (e.g. to inform capability requirements across Lines of Development, operational analysis, intelligent customer).

Additional areas of learning surrounded the importance of partnering and collaboration with other stakeholders in both funding research and exploiting outputs. This means that collaboration with stakeholders such as DBEI, Enterprise Ireland, and the IDA as well as the Department of Education and Skills25, the Higher Education Authority and the Irish Research Council could be beneficial to develop the defence innovation ecosystem and access international funding. The ways in which this collaboration could be achieved includes, among other areas, work on the prosperity agenda, smart economy matters, commercialisation and support for the European Defence Fund (EDF) and Framework Programme (eg Horizon Europe) funding. Collaboration with Science Foundation Ireland could further assist in fostering innovation and R&D for capability development through initiatives such as joint calls on projects within their existing research centres, the granting of awards and the ability to leverage competences in smart economy competitions.

3.4 The right governance arrangements are important to align activity with strategic objectives

The study team found there are a number of good practices for effective RTI governance arrangements that are important to align activity with strategic objectives. These include the following practices: a need for a suitable organisational structure; clear leadership, strategic direction, and coherence of effort; agreed outcomes and benefits that are understood and managed; well-defined roles, responsibilities, accountability and empowerment; a strong narrative and effective strategic communications; creation of a culture that enables programme outcomes; the right skills and access to technical expertise in leadership groups; and a focus on outcomes rather than process. Effective governance arrangements should enable an organisation to make the right decisions, by the right people, using the right evidence at the right time. There are different RTI governance approaches that can be adopted to align activity with strategic objectives.

23 Technological Readiness Level – See Annex 2 for definition of each TRL
24 US Defense Advanced Research Projects Agency responsible for the development of emerging technologies for use by the military.
25 At the time of writing the Department of Higher Education, Innovation and Science had just been announced as a new Government Department.

Chapter 4

Baselining existing arrangements

This chapter provides a synthesis of the themes that emerged from the stakeholder interviews conducted in this study.

4.1 Current ways of working

The existing Defence Enterprise Committee (DEC) work is staffed by International Security and Defence Policy (ISDP) Branch and Strategic Planning Branch (SPB). Much of the day-to-day work is completed by a Higher Executive Officer (HEO) in ISDP and a Lt Cdr in SPB. The Defence Enterprise Committee was set up in 2012 following the Government Decision in 2011 to extend Enterprise Ireland's (EI) mandate to work with the Defence Forces to support SMEs, academia and research institutes. Any support given should be in line with development of Defence Forces current and future capabilities. The White Paper on Defence (2015) reaffirmed this commitment of support while also highlighting the need for an Intellectual Property (IP) Policy for the Organisation. Project 19 - the development of an IP policy - has been completed and approved. White Paper Projects 17 and 18 have been amalgamated and the work of the Feasibility Study is subsumed into Project 17. The Defence Enterprise Strategy was finalised in May 2019.

Findings to date show that work in the RTI area is currently done on an ad hoc basis. To a certain extent the DEC fulfils the needs of the external stakeholders but not the internal DefOrg RTI needs. Whilst some Defence Forces' capabilities have been enhanced and Defence Forces have had access to new and emerging research, the focus of the engagement is mainly reactive as opposed to proactive. (See Annex 6 for examples of successful innovation projects).

The study team identified a trend whereby those DF personnel who are already engaged with the DEC initiative are continuing to do so, building relationships with different partners, and getting involved in successive projects. However, there is little new engagement from other areas of the Defence Forces in the DEC.

There is no known central point of contact for DefOrg RTI activity for external stakeholder needs. The offices of SPB and ISDP are currently the designated points of contact. However, there is still a culture of potential collaborators making contact with the various branches, services and corps of the Defence Organisation directly, rather than through the designated channels.

4.2 The interviews were instructive in highlighting the work required to develop RTI capability

The study findings below are a synthesis, rather than analysis, of salient themes that became apparent across the semi-structured interviews. Analysis of baseline arrangements is integrated within the study

products, primarily in Study Product 2 on stakeholder engagement and communication. Six key themes were identified, which are described in more detail below.

4.2.1 Interviewees hold a range of different views on the benefits case for an RTI capability

Internal stakeholders generally support the concept of RTI but they hold a range of different views on the rationale for future RTI capability. This means that communicating the purpose and benefits of this RTI capability will be essential to secure buy-in across all stakeholder groups and to achieve a unity of understanding. More specifically, these interviews highlighted the need to clearly define the 'what is this for' so that outputs, outcomes and impact of RTI for the DefOrg are defined. One example of divergence in thought is the varying understanding on the links between the RTI initiative and the EDF. The second area that requires more clarity is the 'what is this on/about' aspects whereby interviewees feel that the RTI capability could fill certain gaps such as informing DefOrg requirements, capability priorities, and long term needs. In particular, even though interviewees hold a positive view of innovation, there is a need to clearly specify and communicate the benefits of innovation across the DefOrg given the potential vague nature of innovation as a concept. As a result of these findings, Study Product 1 lays out a clear vision statement and benefits table for the RTI capability.

4.2.2 There is agreement that exploiting the benefits of RTI in DefOrg is far more than the creation of a new cell/unit

There is broad agreement that wider cultural change is needed and a joint, integrated approach to innovation is required in order to fully exploit the benefits of RTI in the DefOrg – in other words, this is far more than the creation of a new unit. While there are clear examples of bottom-up innovation occurring across DefOrg, there is no real history of a structured approach to RTI. Moreover, given that there is a perception of the need to continue to develop a culture of innovation across the DefOrg as a whole, a deliberate and sustained effort will be needed to achieve this goal. This is particularly the case where there are concerns that the siloed nature of the DefOrg may create barriers to innovation by, for example, not allowing horizontal sharing of new ideas. Interviewees further indicated that support from senior leadership by way of endorsing and visibly championing the exploitation of RTI will be essential. A key study finding is the need to conduct additional work to achieve broader stakeholder buy-in to the concept as a key part of this RTI initiative. This could be assisted through a stakeholder and communications high-level plan which is addressed through Study Product 2.

4.2.3 The links between RTI and the future capability development process needs to be made explicit.

There are clear linkages between RTI and the future capability development process which must be coherent. First, interviewees raised the need to establish clear overarching ambitions and policy or strategy objectives – a policy 'chapeau' - to guide both future RTI and capability development. There is then a need for RTI and equipment development planning to align closely with a capability development plan and a set of capability priorities. This means that governance matters must be considered in relation to the establishment of a future RTI capability as well a new capability development process. In particular, this has implications for questions related to the relationship between capability development and RTI in terms of processes, structures, and sequencing. Lastly, interviewees

emphasised that RTI and capability development does not only mean equipment but that innovation is important across all lines of development – in other words, Doctrine, Organisation, Training, Materiel, Leadership, Personnel, Facilities, Interoperability (DOTMLPFI).

4.2.4 The DefOrg should align its role alongside other organisations to leverage national benefit

The DefOrg should align its role alongside other organisations such as SFI, EI, IDA, HEA, IRC and government departments such as DBEI nationally in relation to RTI. It must also integrate the appropriate aspects of related efforts in international organisations such as the EU Commission DEFIS, the EDA, and NATO and programmes such as PESCO and the EDF. Interviewees mentioned academia, the private sector and other government departments to varying degrees as partners in defence RTI. In particular, the relationship with EI is especially robust currently, but there is a risk that the roles of each organisation in the defence RTI endeavour could become overlapping rather than mutually reinforcing. This means that these roles should be clearly defined and that the role of DefOrg RTI should be couched within the existing policy framework. The intent is not to duplicate existing mechanisms, agencies or their roles but rather to focus on enabling and support activities and accessing existing mechanisms.

External interviewees acknowledged that there is an opportunity to support the development of the nascent Defence RTI ecosystem which has long term benefits for the DefOrg and supports the national agenda where benefits not only accrue for the DefOrg but for the social good, national prosperity and related industry sectors. Nonetheless, DefOrg interviewees agree that the primary purpose of the RTI initiative is to enhance defence capability and the wider prosperity dividend for Ireland Inc. is arguably a secondary benefit. A summary of the key themes which emerged from external interviews are summarised below:

- The development of a defence RTI capability is mutually beneficial for many reasons including access to a wider research network including EDA CapTechs and a move to other end use perspectives for research.

- There is a willingness amongst all external stakeholders to provide support to the DefOrg through structured cooperative mechanisms and also informally.

- There are a range of suitable mechanisms to further research in defence that are currently existing and could include defence or be shaped for defence: Some of these include:

    a. **SFI:** Centres for Research Training, Research Centres, Innovation partnerships, Societal Fellowship Programme, Challenge based funding.
    b. **IRC:** Partnership programmes such as New Foundations, COALESCE, Employment Based Research Programme, Government of Ireland Scheme.
    c. **EI:** The Disruptive Technologies Innovation Fund (DTIF), Small Business Innovation Research (SBIR).
    d. **IDA:** Innovation partnership supports available including feasibility study supports which their client companies working on behalf of the DefOrg could avail of.
    e. **HEA:** Strategic contribution and support in accessing and navigating the higher education research system.

4.2.5 There are differing perspectives on the meaning of risk, success and failure in the innovation context

Interviewees hold different perspectives on the meaning of risk, success and failure in the innovation context. Moreover, there is a concern that while innovation can imply the need for a degree of risk and trial, which could be challenging for the Department of Defence and wider Government. This means that there is a need to carefully consider governance, accountability and the latitude to try things out. In this case, a governance approach will likely be needed that can enable rather than inhibit innovation. This could possibly combine with a DevOps or an agile management philosophy[26]. An overarching policy chapeau would be preferable for operating given the lack of some overarching policy documents currently such as a defence technology strategy. Notably, this also points towards a need to have an integrated, joint RTI function across civilian and uniformed staff. Study Products 6 and 7 address measurement metrics, key performance indicators and risk and how they could facilitate well informed and well managed risk taking when taking decisions on RTI projects.

4.2.6 It will be important to develop an effective governance and operating model for the future RTI

In terms of governance, it is important that the right governance and operating model is developed for the future RTI capability. There is an assumption amongst interviewees that the proposed RTI capability will be hosted within the DefOrg. However, as described earlier in the report, there are different international models of best practice. For example, some countries have their RTI capability at arm's length for reasons that include engendering independence. In addition, some interviewees assumed that the proposed RTI capability would be rolled into the Strategic Planning Branch (SPB) and align with plans for capability development.

Other aspects of interviewee concern are a need for the RTI to show a return on investment, whether through efficiency or effectiveness (or wider benefits). Moreover, the current retention crisis in the DF means there are interviewee concerns that issues related to staffing shortages should be addressed so that the RTI does not in fact exacerbate these shortages. Some suggestions include a mix of core staff and secondees from DefOrg and partners. Additional matters raised by interviewees include the need for KPIs and metrics of success that should include short-term and longer-term indicators (see study product 6 and 7) as well as a need for top-level ownership and board level sponsorship.

4.3 A tailored approach is needed to engage stakeholders on RTI development

The study team mapped the existing competences and capacities both within the Defence Organisation and those of partner organisations relevant to the establishment of an RTI capability. The interest and influence of each stakeholder group was then assessed in order to produce the stakeholder map shown as Figure 1. The range and level of supports and partnership/ collaborative opportunities was evaluated. A high-level 'Stakeholder and Communications Plan' (Study Product 2) was also produced that provides greater detail on how to increase buy-in and support for the initiative among each stakeholder group.

26 DevOps means a type of agile relationship with a goal of changing and improving the relationship between different sections or branches by advocating better communication and collaboration between the two sections or branches or business units.

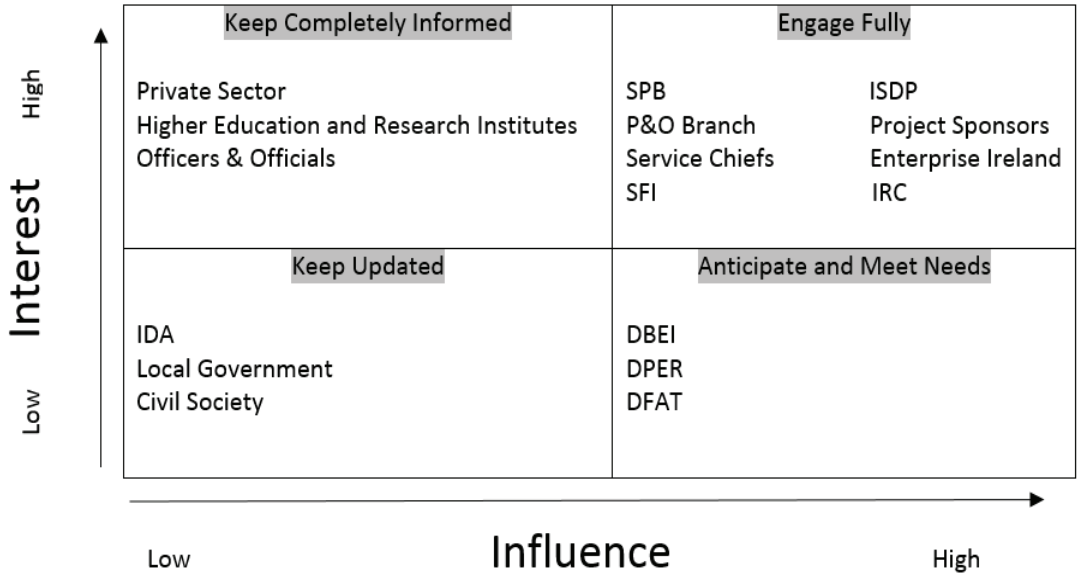


Figure 4.1: Stakeholder Map

The overarching aim of the stakeholder engagement and communications plan is to increase the likelihood of project success through the achievement of three target objectives:

1. To create a shared understanding of the RTI initiative, its vision, purpose and benefits. This is particularly important given the range of different views currently held.

2. To increase buy-in for the RTI initiative and a collective sense of ownership among key people and stakeholder groups (internally and externally).

3. To ensure senior-level support for the RTI initiative, to create a unity of purpose among the core team driving the work, and to help secure funding and resourcing for the project.

There are a several topics to be addressed, including:

- Clarifying that the aim of the RTI initiative is not to create a traditional defence industry. Balancing the need to increase defence capability within national policy and agreed commitments to CSDP and other international obligations.
- Some divergence of understanding on links between the RTI initiative and EDF – implying a need to articulate the relationship between the two more clearly and to emphasise that RTI is not EDF dependent.
- Ensuring that RTI and capability development/planning will be aligned and mutually reinforcing.
- A range of views on the nature of innovation and how to realise the benefits of leveraging new ideas, building on the positive view of RTI within the DefOrg.

- Scepticism about the proposed 'joint' RTI capability given organisational/DefOrg cultural obstacles.
- Clarity surrounding dual-use activity (see Study Product 3 'Food for Thought paper: Defence industry and dual-use technology').

Chapter 5.

Operating Model, Governance and Implementation Proposals

This chapter provides details of the suggested operating model for the future defence RTI capability. It begins with a description of the three-stage model that was developed by the study team. Governance options are then outlined through three potential organisational structures, specifying their different advantages and disadvantages. Finally, the chapter sets out the high-level implementation pathway to operationalise the RTI capability.

5.1 A three-stage model was developed for future defence RTI capability

The aim of the final stage of the study was to develop a future model for a Defence RTI capability and an outline implementation plan. This was developed by the study team based on an analysis of the evidence collected, a synthesis of the findings summarised in Chapters 3 and 4, and the professional expertise of the team.

A three-stage operating model for future RTI capability that is scaled over time was developed. This model was then further refined through discussions with the project sponsors and the study team. Each stage of the model has a different level of resourcing and ambition, based on the building blocks described earlier in the report. The six building blocks are illustrated as Figure 2.

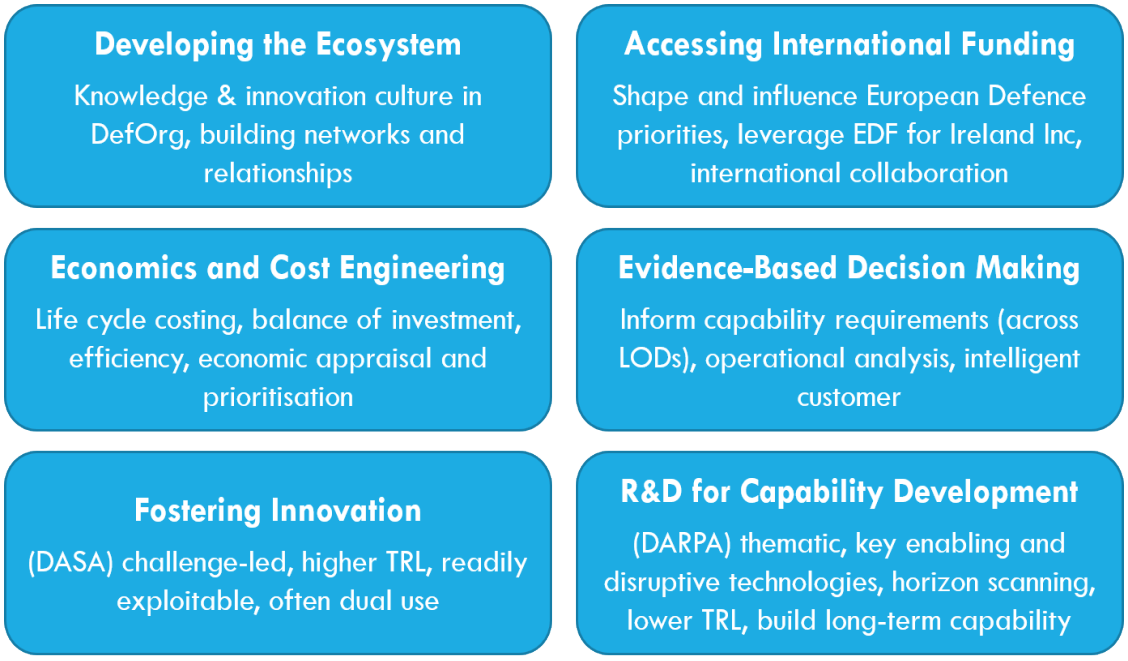


Figure 2: Functional building blocks of RTI capability

In broad terms, the target operating model is focused on delivering clearly defined outcomes such as contribution to national prosperity; outputs directly in support of the DefOrg across Lines of Development; and the building of a Defence R&D and innovation capability. Benefits associated with the

target operating model include a financial return for Ireland Inc. as well as benefits for Defence in terms of effectiveness, efficiency and economy. In addition, this model would seek to leverage financial inputs from other national public bodies (e.g. SFI, IRC, EI) and co-funding from the private sector. It would also seek to leverage international funding through the EDF and EDA and also seek to leverage expertise through networks such as the EDA Capability Technology Groups (CapTechs) and NATO Science & Technology Organisation (STO).

A schematic evolution from Stage 1 of the model through Stage 2 and to Stage 3 is shown as Figure 3, overleaf. A high-level timeline with proposed steps is provided as Study Product 6. Each stage will conclude with a formal review measuring success against pre-agreed metrics and KPIs and to capture lessons learned, which will be used to refine the design of the next stage. It is acknowledged and understood that progression from stage 1 to stage 2, and from stage 2 to stage 3, cannot happen without the prior relevant approval process.

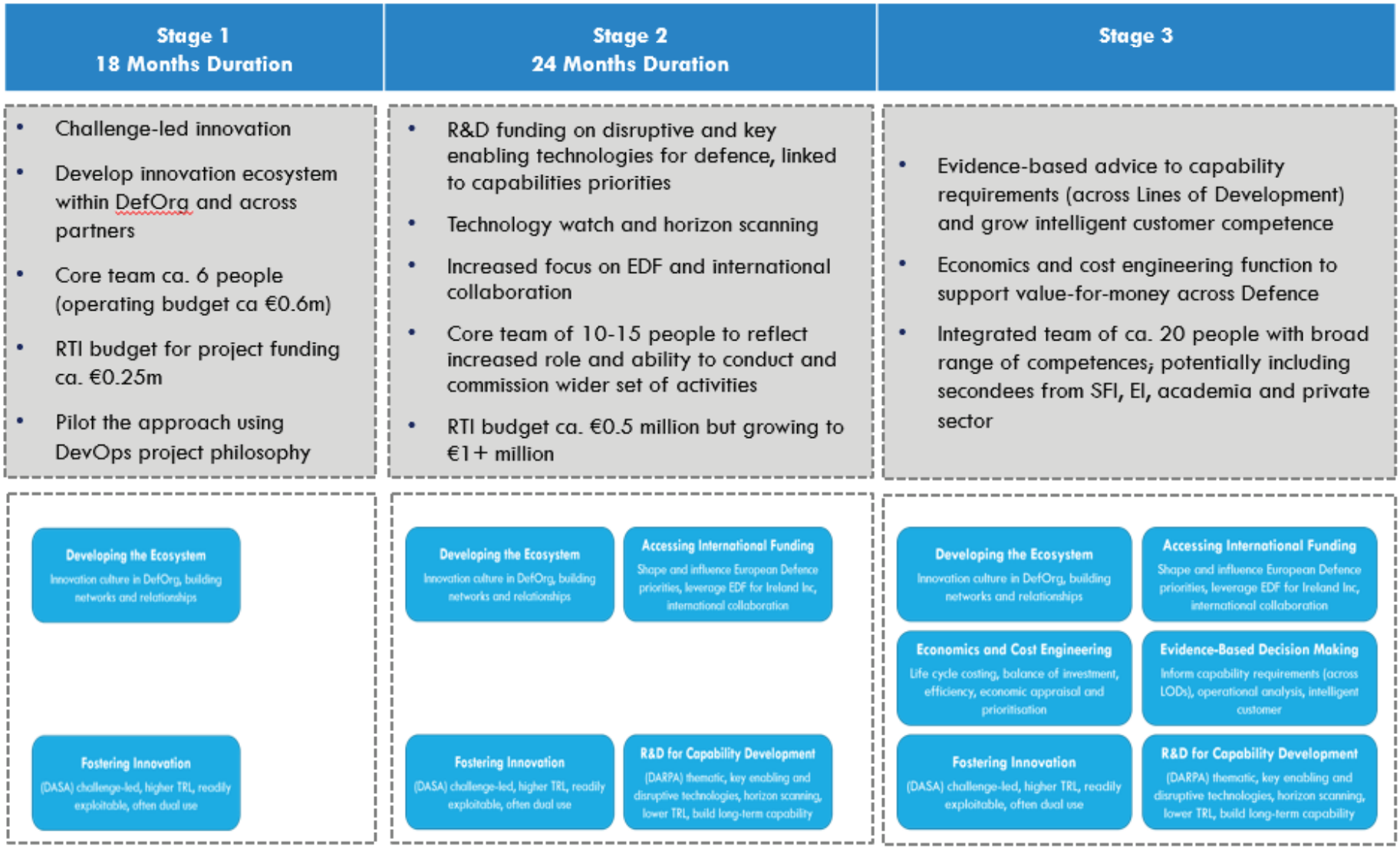


Figure 5.2 Evolution of the three-stage model over time

5.2 Stage One focuses primarily on challenge-led innovation

The first step – Stage One of the full operating model – focuses primarily on challenge-led innovation. We believe this should be achievable in the short term based on a small, dedicated team with an innovation fund and allow for the RTI capability to build on existing work. This approach would also create an opportunity for quick wins and help to facilitate the type of buy-in that is required across DefOrg stakeholders. An additional benefit of this approach is that it could allow for the time and space to plan for the future and to better align the RTI capability with capability planning. Key operating aspects of Stage 1 are captured in Figure 1 below.

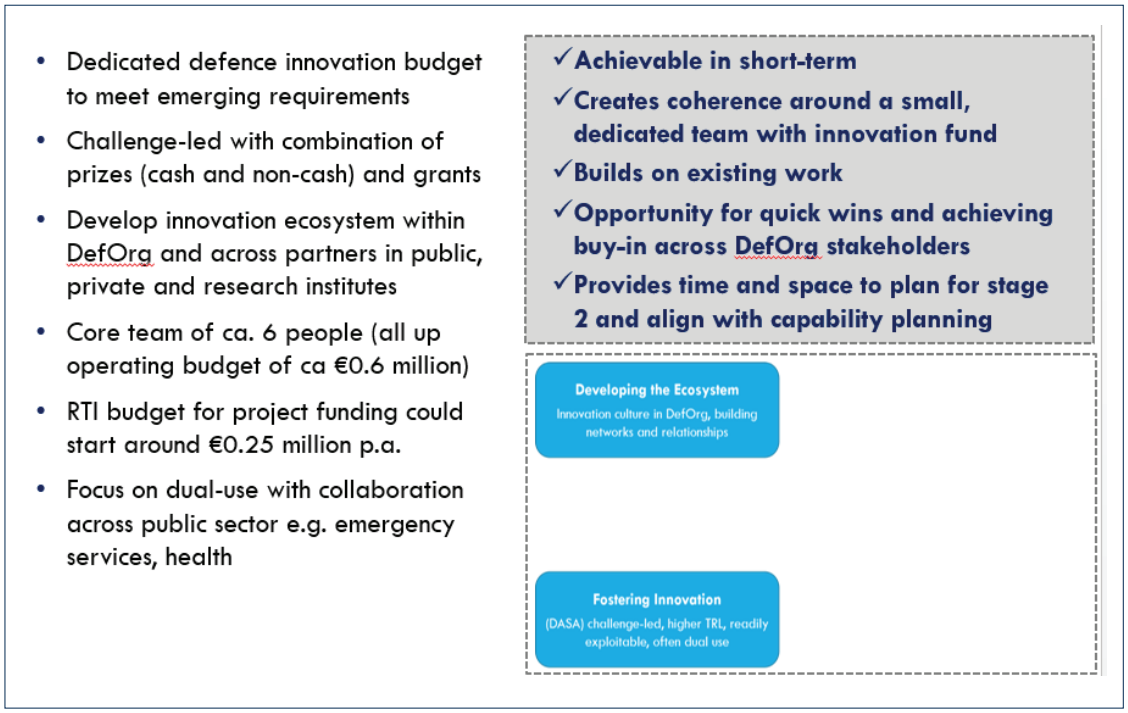


Figure 5.3 Stage One of the model

5.3 Stage Two adds capability-driven R&D and an explicit focus on international engagement

Stage Two is a more comprehensive capability than Stage One, which can deliver strategic, longer-term benefit. This stage of the RTI capability introduces thematic R&D funding on disruptive and key enabling technologies for defence that are linked to capabilities priorities. It would also incorporate horizon-scanning and a technology-watch competence as well as introduce an explicit focus on international collaboration and defence-related funding programmes (including EDF).

It is likely that this stage would allow for the RTI capability to achieve wider objectives in terms of national government policy and EU commitments such as PESCO. It would further allow the DefOrg to be better able to engage with EDA Capability Technology Groups[27] and NATO's Science and Technology Organisation. It is likely that this approach could also be beneficial in that it would act as a force multiplier in terms of leveraging national and international funding. Key aspects are illustrated in Figure 5.

Figure 5: Stage Two of the model

27 EDA CapTechs are networking fora for experts from government, industry, small and medium enterprises (SME) and academia to develop its R&T priorities in different Capability Technology Areas.

5.4 Stage Three comprises the full RTI capability across all functional areas

The third and final stage of the proposed RTI capability augments Stage Two with decision support and analysis functions by allowing for greater focus on informing decision-making and internal innovation. The purpose of this stage is to build Defence R&D and innovation capabilities with relevance for Defence, and there would likely be a direct benefit for Defence in terms of effectiveness and efficiency. It is proposed that evidence-based advice to capability requirements across all lines of development could be provided and this would further facilitate a maturing of an intelligent customer competence. Other benefits associated with this stage include the positive links that it would have to the national prosperity agenda, the ability of the future RTI unit to provide advice to HLPPG and branches on equipment or technology decisions, and the ability for cross-pollination with other organisations. Functional operating aspects to consider are highlighted in Figure 6.

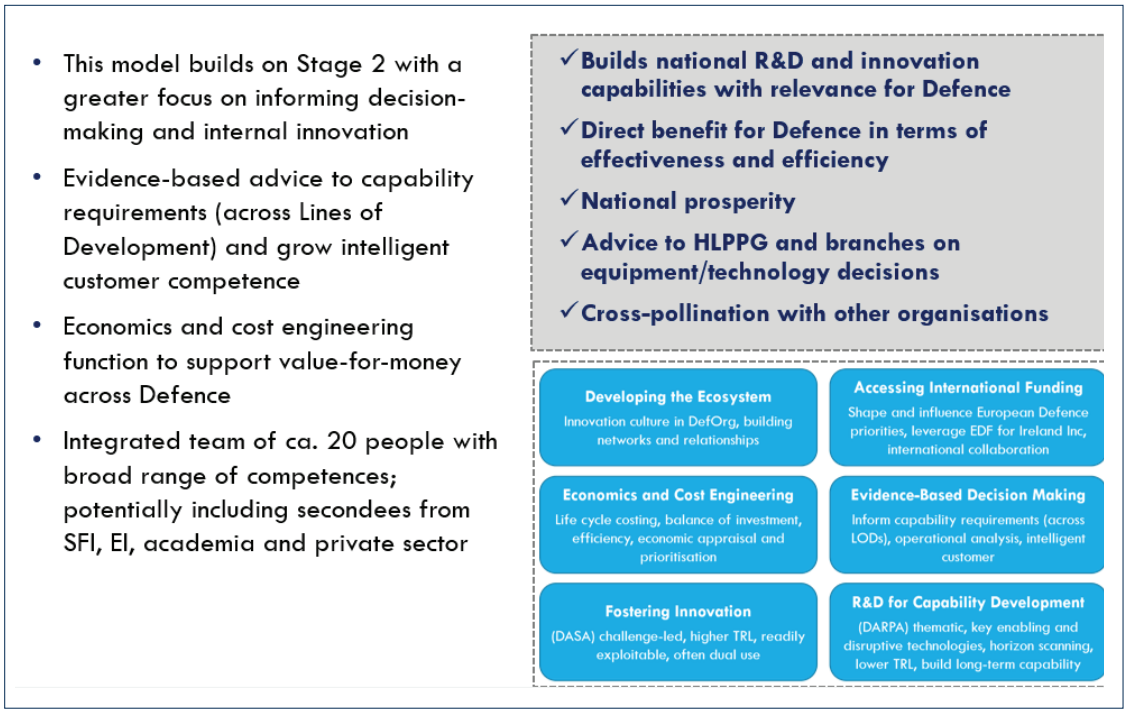


Figure 5.5 Stage Three of the model

5.5 Governance findings

The study team identified three potential organisational structures, specifying their different advantages and disadvantages for the project sponsor.

- The first proposed organisational structure was a new joint unit, hosted within the DefOrg with a steering board comprising both DefOrg and external stakeholders (for example, SFI, EI, IDA, DBEI). This structure is most similar to the DASA model which seeks to combine objectivity and focus with the advantages of being integrated within a Defence Organisation. The advantages of this structure include visibility and accountability in DefOrg; challenge and support through the Steering Board; an ability to focus on RTI outcomes; it is rather straightforward to establish quickly; and it facilitates the opportunity to create the right culture and work across the Defence Forces and the Department of Defence. The disadvantages of this structure include challenges in recruiting or seconding staff into the unit.
- The second proposed organisational structure was an arms-length agency, accountable to DefOrg, with clearly defined outcomes and success metrics. This is analogous to the DARPA model (and functionally similar to many Ministries of Defence). This would emphasise the benefits of organisational independence and a distinct culture, and allow for reporting into a customer function within the Defence Organisation. Several advantages associated with this structure include its independence and ability to build a bespoke organisational identity; its sole focus would be on outcomes as set by DefOrg (and thus allow for greater accountability); it would create an ability to establish direct links with other agencies; and there would be a ring-fenced budget for RTI. Disadvantages, however, include the potential for administrative friction and it is likely to be more expensive for reasons that include, among other items, overhead costs of facilities and support staff.
- The third organisational structure proposed for consideration was an RTI capability that is folded within a future Capability Development branch so that the RTI function forms part of the future Capability Development Branch in order to maximise coherence between these activities (and those of SPB/P&O). This would allow for intimate involvement with capability development and delivery function, and potentially reduce frictional barriers. However, this structure would mean that the RTI capability would potentially lack independence and there would be a risk that the RTI capability would only deliver RTI benefits for capability development rather than realising the full range of benefits associated with an RTI capability. Moreover, there is currently no DefOrg capability development function for the proposed RTI capability to be integrated.

5.6 Operationalising RTI: Implementation pathway

Finally, once the target operating models were confirmed, the study team developed a high-level implementation plan for the RTI capability. The blueprint of the implementation pathway is attached to this report through a set of study products. These are outlined in Table 3 overleaf.

Ser	Study Products	Purpose
1	Vision, purpose & objectives	This document includes the RTI vision and a benefits table highlighting the 'why', the 'how' and the 'to what end' (a development of 'the why'). product
2	Stakeholder engagement and communications plan	This document summarises the key messages which need to be communicated and the stakeholder's level of influence/involvement/ motivations. This plan would be the core of a future communications strategy.
3	Food for Thought paper: Defence industry and dual-use technology	The study team developed this think piece to further expand on one of the key messages in study product 2, dealing with the nuance and sensitivities around 'Defence' and 'Defence Industry' and what that means for Ireland and the feasibility of the proposed RTI capability.
4	Process maps for leveraging innovation and supporting R&D	In order to operationalise the RTI capability, the study team developed two outline process maps that provide a series of activities that collectively fulfil parts of the vision. The intention is that once approved at a high level, these would be developed to provide an operating model to map the functions of the RTI unit and also include governance activities.
5	High-level project timeline	The study team developed a high-level timeline to realise the level of ambition in each of the three Stages of the operating model. Note that Stage 1 is envisaged as a pilot programme, but as part of a coherent plan to achieve the full RTI capability of Stage 3.
6	Metrics and KPIs	The study team produced a summary of potential or sample metrics and KPIs that could be used by the RTI unit. It illustrates that the RTI activity is measurable and manageable.
7	Risk management & register	The study team created a detailed risk management overview which deals with a future DefOrg RTI specifically, rather than in a theoretical way. It will serve as a basis for a future risk management plan.
8	Strategic business case (and economic analysis)	The study team developed a short summary of the economic case for establishing an RTI capability including an estimate of quantifiable costs and benefits; in addition to wider benefits.

Table 5.1: List of study products

The suite of study products can be found in Annex 5.

Chapter 6.

Conclusions and Recommendations

6.1 Conclusions

Conclusion 1: Establishing a Defence RTI capability is feasible and would deliver substantial benefit in terms of defence capability, defence value-for-money, national prosperity and the creation of a Defence innovation ecosystem.

The main benefits of the RTI capability include:

1. Enhancing defence capability and inform capability planning and development
2. Contributing to the national prosperity agenda
3. Maximising return on defence investment through gains in efficiency and effectiveness
4. Creating an effective innovation ecosystem within the Defence Organisation and with partners in wider government, academia and the private sector

Conclusion 2: An analysis of literature and studies referenced in Study Product 8 indicates that there is solid evidence that RTI investment delivers economic benefit and other socio-economic impacts including knowledge creation; highly-skilled jobs; tax revenues; GDP increases; and wider technology spill-over effects.

Measuring the full economic impact of public investment in RTI is challenging. However, studies (referenced in study product 8) show that there is broad agreement that investment in RTI has a sizeable and measurable return on investment. It also has a significantly greater economic impact than capital investment which in turn has a much greater economic impact than consumption spending. Recent research suggests that 'mission-oriented' investment in RTI deliver the greater economic impact.

Conclusion 3: A synthesis of stakeholder interviews indicates that there may be challenges in achieving the proposed solution outlined in this study: not least the sustained stakeholder engagement campaign that will be necessary to secure buy-in for the aims of the project and to effect a significant cultural change.

The high-level stakeholder engagement and communications plan proposed by this study will require a strategy designed by experts. The plan should aim to create a shared understanding of the RTI initiative including its vision, purpose and benefits. It should also aim to encourage a unity of purpose among the core team driving the work, and to help secure funding and resourcing for the unit.

Conclusion 4: It is important to be clear that the formation of a national defence industry that is focused on the production and export of arms is categorically not an aim of the initiative.

The creation of an innovation ecosystem that better enables the delivery of defence objectives will not

lead to a defence industry for two reasons. First, economics (the focus on enabling technologies means that defence will not be the dominant customer). Second, policy (as a consequence of focusing on national defence policy rather than allowing a defence industrial strategy to drive policy).

Conclusion 5: A Defence RTI capability would form part of the existing national research and innovation ecosystem, providing support to it and leveraging benefits where appropriate.

The concept of the RTI capability is one that emphasises the importance of connections between a range of actors and agents; rather than a transactional customer-supplier approach to research and innovation. External stakeholders expressed concern that there has been little investment to establish such collaborations, particularly in relation to dual-use technological capabilities.

Conclusion 6: Ireland's membership of the EU provides an opportunity to benefit from a number of significant European initiatives to increase coordination between EU Member States on defence requirements including RTI.

The European Defence Fund was announced in June 2017 alongside the European Defence Industrial Development Programme. The latest proposal in May 2020 was for a budget of just over €8 billion over the seven-year Multiannual Financial Framework. Irish Government and industry has an opportunity to secure investments through the expected funding available from the European Defence Fund in the period 2021-2027. These funds are designed to help EU Member States spend money more efficiently, reduce duplication and get better value for money by coordinating, supplementing and amplifying national investments in defence research and development activities. Irish Governmental stakeholders should examine how Ireland can benefit from the State's contribution to the EDF (€150 million) and this study proposes the support role that the Irish Defence Organisation can play.

Conclusion 7: Innovation is, and will continue to be, part of the DefOrg day-to-day business but there is a need to formalise RTI structures to develop applied research, technology foresight and challenge led innovation capabilities.

There is a strong innovative instinct among soldiers. However it is not enough simply to encourage employees to innovate. The organisation's culture must support innovators to move promising ideas forward. To a certain extent the Defence Enterprise Committee (DEC) fulfils the needs of the external stakeholders but not the internal Research, Technology and Innovation needs in its entirety. Whilst some Defence Forces capabilities have been enhanced and Defence Forces have had access to emerging research, the focus of the engagement is mainly reactive as opposed to proactive. Those DF personnel who are already engaged with the DEC initiative are continuing to do so, building relationships with different partners, and getting involved in successive projects. However, there is little new engagement in the DEC from other areas of the Defence Forces.

Conclusion 8: The links between RTI and capability development are clear and they must be co-evolved to maximise effectiveness for the DefOrg.

There are clear linkages between RTI and capability development and but these linkages must be defined

and co-evolved to ensure coherence between RTI and any future DefOrg capability development planning process. Further discussions surround the types of defence capabilities that should initially be prioritised by an RTI capability is required. The study further identifies the need for horizon scanning activities and a Defence Technology Strategy to identify and prioritise technology sectors in the long term. In the short term, mapping the National Research Priorities with EU Capability Development Priorities (including the strategic context cases roadmaps, the overarching strategic research agenda technology building blocks and the key strategic activities), and the EDF themes is required in order to down-select key areas of interest.

Conclusion 9: There is a need for a novel approach to resourcing the nascent RTI capability particularly in terms of staffing.

The proposed RTI capability including model and roadmap can only be successfully implemented if resourced sufficiently, both from a people and financial perspective. The need for permanent staff dedicated to the unit and a defined budget for operational and research work must be accepted as essential to success.

Conclusion 10: An assessment of the benefits of joint working identified that the civil-military working relationship has been positive and mutually beneficial for this study.

There are benefits and efficiencies from working jointly and these should be reflected and replicated in any future RTI organisation. In the field of RTI there is a need for technical and policy interaction on an ongoing basis.

Conclusion 11: A three-stage operating model ('crawl, walk, run') for future RTI capability that is scaled over time is proposed to allow opportunities for success and to allow time to build the corporate knowledge and confidence before moving through each stage.

Stage One focuses primarily on challenge-led innovation at higher TRLs. This approach would create opportunities for quick wins and help to facilitate the type of buy-in that is required across DefOrg stakeholders. Stage Two is a more comprehensive capability, introducing low TRL, applied research activities which can deliver strategic, longer-term benefit. The third stage augments Stage Two with decision support and analysis functions by allowing for greater focus on informing decision-making and internal innovation. The full operating model will allow the RTI capability to build national R&D and innovation capabilities with relevance for Defence.

Conclusion 12: The use of Metrics and Key Performance Indicators to measure activity, progress and success is an important aspect of RTI risk management.

Connecting research inputs to tangible outputs is difficult for a number of reasons including the delay between early research and the final economic impact. Therefore continuous measurement of activities is important. Significant amounts of data can be harvested annually that would help evaluate the return on investment as well as societal and organisational benefits. Such verifiable data would facilitate well informed and well managed risk taking when taking decisions on RTI projects.

6.2 Recommendations

Recommendation 1: The feasibility study, along with tailored communication material, should be shared across the Defence Organisation with all relevant Branches, Services and Corps.

The feasibility study should be shared across the Defence Organisation with all relevant Branches, Services and Corps in order to ensure a global understanding of the proposals and engender a unity of purpose.

Recommendation 2: It would be preferable that a whole of Government approach to defence RTI be developed to ensure issues outside of the control of the DefOrg are addressed and supported by the relevant Departments and Agencies

A whole of Government approach to defence RTI is preferable to ensure issues outside of the control of the DefOrg are addressed and supported by the relevant Departments and Agencies. Examples of such issues include (1) continue to work with DBEI in seeking to extend the mandate of EI (pursuant to s.8(5) of the Science and Technology Act 1987), to allow Enterprise Ireland to promote and assist Irish Industry and Academia in accessing funding available under the European Defence Fund (EDF) (2) addressing the significant challenge of a national security clearance regime for civilians and facilities in order to partake in EDIDP and EDF fund programmes.

Recommendation 3: A mechanism should be established to identify the technology requirements of key defence capability areas

A mechanism should be established to identify the technology requirements of key defence capability areas and to identify gaps in the market that could facilitate innovation within the national RTI structures. Mapping the National Research Priorities with EU Capability Development Priorities and the EDF themes is required in order to down-select key areas of interest in the short term.

Recommendation 4: Secure approval of the findings and endorsement of establishing the RTI capability from the SMC and approve the next steps.

Recommendation 5: Once the decision is taken to move to the implementation of Stage 1 of the RTI capability a business case should be prepared setting out the resources necessary for agreement by the SMC.

Annex 1: Table of abbreviations and acronyms

ACE	The UK Home Office Accelerated Capability Environment
CARD	Coordinated Annual Review on Defence
CBRN	Chemical, Biological, Radiological, Nuclear
CIS	Communications and Information Corps, Defence Forces
CSDP	Common Security and Defence Policy
DARPA	The US Defense Advanced Research Projects Agency
DASA	The UK Defence and Security Accelerator
DefOrg	Defence Organisation (Includes Defence Forces & Dept of Defence)
DBEI	Department of Business, Enterprise and Innovation
DEFIS	Directorate General Defence Industry and Space
DEC	Defence Enterprise Committee
DES	Department of Education & Skills
DOTMLPFI	Doctrine, Organisation, Training, Materiel, Leadership, Personnel, Facilities, Interoperability
DoD	Department of Defence
DF	Defence Forces
DIU	The US Defense Innovation Unit
DevOps	Development and Information Technology Operations
EDA	European Defence Agency
EDF	European Defence Fund
EDIDP	European Defence Industrial development Programme
EI	Enterprise Ireland
EU	European Union
FP	Framework Programme
HEA	Higher Education Authority
HLPPG	High Level Planning and Procurement Group
ICT	Information and Communications Technology
IDA	Industrial Development Agency
IRC	Irish Research Council
ISDP	International Security and Defence Policy Branch, Department of Defence
KPI	Key Performance Indicator
LOD	Lines of Development
NATO	North Atlantic Treaty Alliance
OPS	Our Public Service
PESCO	Permanent Structured Cooperation
P&O	Planning and Organisation Branch, Department of Defence
R&D	Research and Development
R&T	Research and Technology RTI Research, Technology and Innovation
SFI	Science Foundation Ireland
SME	Small to Medium Enterprise
SPB	Strategic Planning Branch, Defence Forces
TRL	Technology Readiness Level
WP	Work Programme

Annex 2: Funding Models & TRL / Innovation Phase Framework

For the purposes of this study, the categorisation of funding models and the TRL and innovation phase framework are presented below.

Funding mode	Key characteristics	Main pros and cons
Grants	Co-financing of R&D. Can be up to 100% of eligible costs (TRL 1-7).	• Tested, well established R&D funding modality • Creates leverage depending on funding rate and co-financing • Application procedures can be cumbersome, in particular of co-financing
Inducement prizes	Competition model with a cash reward for the best solution (TRL 2-5).	• Strong demand-driven approach which gives much freedom for innovative solutions • Own investment required may deter participation • Can invite broad participation • Transaction costs are often low
Guarantee	Guarantee to financial intermediary for SMEs and MidCaps (TRL 4-6).	• Enables access to finance SMEs and Midcaps to overcome financing issues in prototyping phase • Application procedures can be burdensome
Pre-Commercial Procurement	Procurement instrument targeted at R&D procurement. (TRL 2-7).	• Stronger demand driven approach compared with grants (focus on user requirements) • Suitable if no near-the-market solutions are yet available • Can potentially increase the efficiency of R&D
Procurement	Procurement can be applied to specific R&D activities or R&D combined with (pre-) production activities (prototyping/ supplies of equipment).	• Demand driven approach in which user requirement are normally defined ex-ante; • Commonly used in Member States • Can be effective in triggering collaborative R&D funded from various Member States

Figure A2.1 Examples of Funding Models

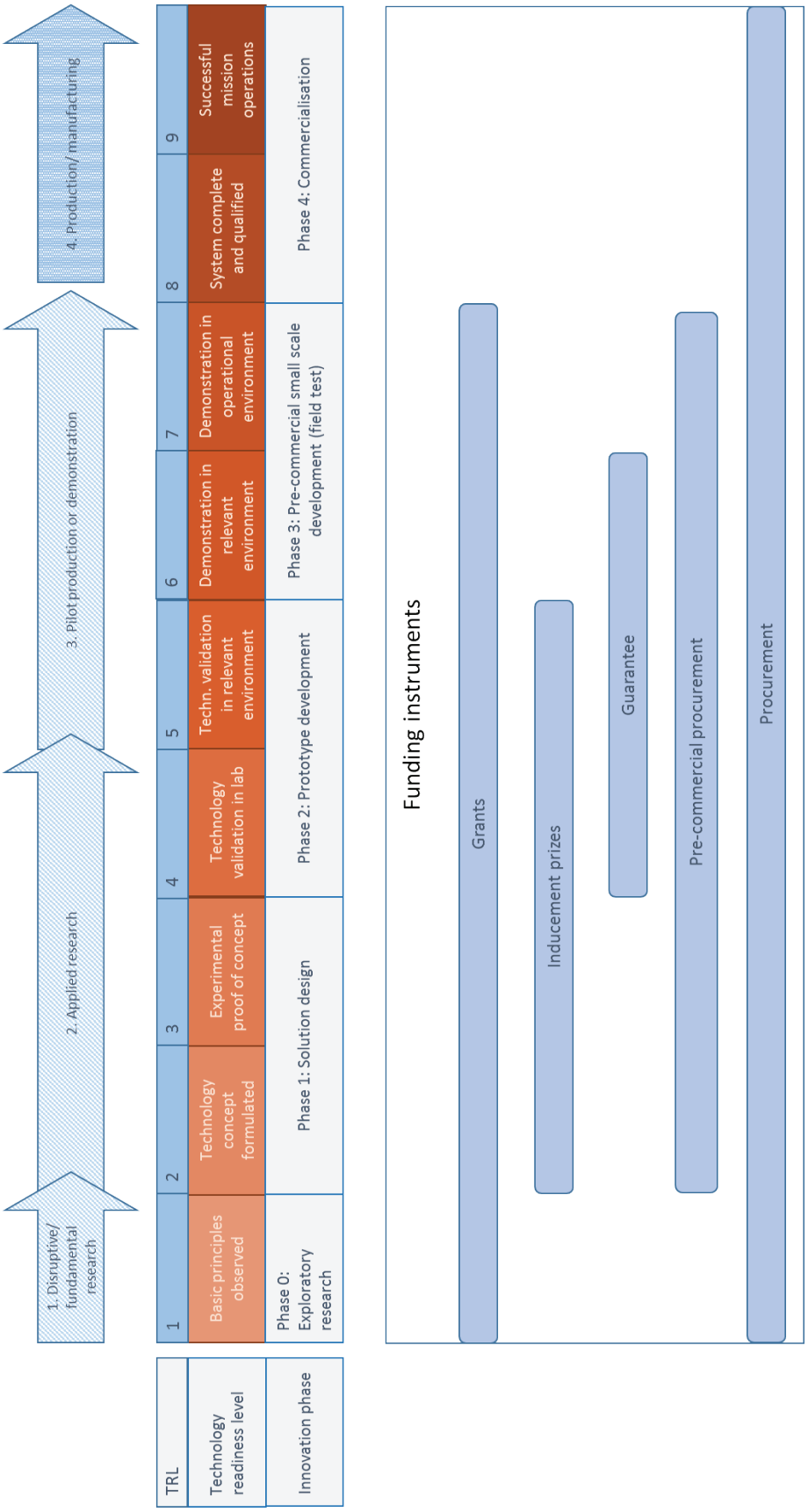


Figure A2.2 Funding modes and R&D stages

Annex 3: Interview Protocol

This interview protocol is a structure to help guide a wider discussion. It is not an exhaustive list of question but provides the key themes that the team would like to cover.

Preliminaries

- Introductions
- Outline scope and purpose of Research Technology & Innovation (RTI) study

Section 1: Baselining the current situation in terms of leveraging innovation into Defence

- To what extent is the Defence Organisation currently open to innovation and accessing new technology, methods, processes and ways of working? To what extent does the Defence Organisation embody a culture of innovation?
- What are the key enablers and barriers in this regard?
- Can you think of any examples of innovation in the Defence Organisation? What worked well in that instance?
- Can you think of areas where innovation might have adverse impacts? Why?
- In your view, is there a compelling case to change?

Section 2: What would constitute success in terms of RTI?

- Looking ahead 5 years, what would be the main elements of a Defence RTI capability?
- In a perfect world, what benefits would it deliver/enable for Defence?
- Does the Defence Organisation have the functional competence to prioritise particular technologies or defence capability gaps? If so, what would you point to?
- Which other actors outside the Defence Organisation would need to be involved? What would they bring?

Section 3: Establishing an RTI capability

- Can you point to any models of RTI functions – nationally or international – that provide learning?
- What factors need to be considered in assessing the feasibility of developing an RTI capability for the Irish Defence Organisation? E.g. governance, culture, processes, people, stakeholder engagement, resources, structures.
- What is the unique added value that an Irish Defence RTI capability would provide – with reference to existing actors in the national and international space?

Finally, is there anything else you would like to add?

Annex 4: International RTI case studies

1. DASA (Division of UK MOD)

Defence and Security Accelerator

WHAT?

- Build an innovation network of government, private sector, academics and individuals for defence and security, including those who have never worked with us before
- Understand the requirements of defence and security stakeholders and help them scout out, develop and exploit innovative ideas, inform decision making and find potential solutions to their challenges
- Find, fund and support industry, embracing small and medium-sized enterprises and academia to develop their innovative ideas into exploitable products and services for defence and security customers
- Work collaboratively to form partnerships, co-ordinate and complement existing activity, and avoid any duplication, to enhance the overall innovation ecosystem
- Experiment with novel methodologies and innovative approaches to facilitate accelerating delivery of the best solutions

HOW?

- Cross-Government team of around 60 people from a wide range of backgrounds (defence, security, private sector and academia)
- Regional innovation partners
- Part of the Defence Innovation Directorate in MOD but branding and culture are distinct
- Governed by a Board of Director level representatives from across our customer base
- Challenge-led with ringfenced money from Defence Innovation Fund

2. UK Home Office ACE/Vivace

ACE
ACCELERATED CAPABILITY ENVIRONMENT
Powered by vivace

WHAT?

- Support data-enabled investigations, law enforcement and counter terrorism operations
- Agile innovation delivering solutions within just weeks or months
- Provide public sector customers with direct access to industry expertise and capabilities
- Give small and medium sized enterprises a simpler way to work with government customers
- Provide forward-looking insights into emerging threat and opportunity landscapes
- Create common purpose across a complex stakeholder community and diverse sectors with focus on solving problems with customers to ensure buy-in to solutions

HOW?

- Customer/sponsor/commissioner in OCST (govt) with funding
- Partnered with industry network (Vivace) formed of almost 200 companies and Universities
- Build ecosystem through very regular engagement events with government customers
- Agile/DevOps approach with very fast turaround to solve operational requirements
- Focus on existing technology, tools and methods that can be tailored to fit needs

3. Estonia

REPUBLIC OF ESTONIA
MINISTRY OF DEFENCE

Aim:

- Focus RTI efforts to support EE defence and capability development by acknowledging the gaps and finding solutions through research and innovation

Structure:

- Small team of 3 people at MOD level (RTI Strategy & Policy and 'smart decisions'.
- Larger team for applied research in the military academy – 24 permanent and 12 temporary researchers - cross pollination with civil society

Partnerships:

- All main EE Universities
- Strategic Partner with the EE Defence Industry Association
- R&D coordinators in all ministries in EE since 2016: a four-year programme funded by European Research Agency. Whole of government approach to R&D

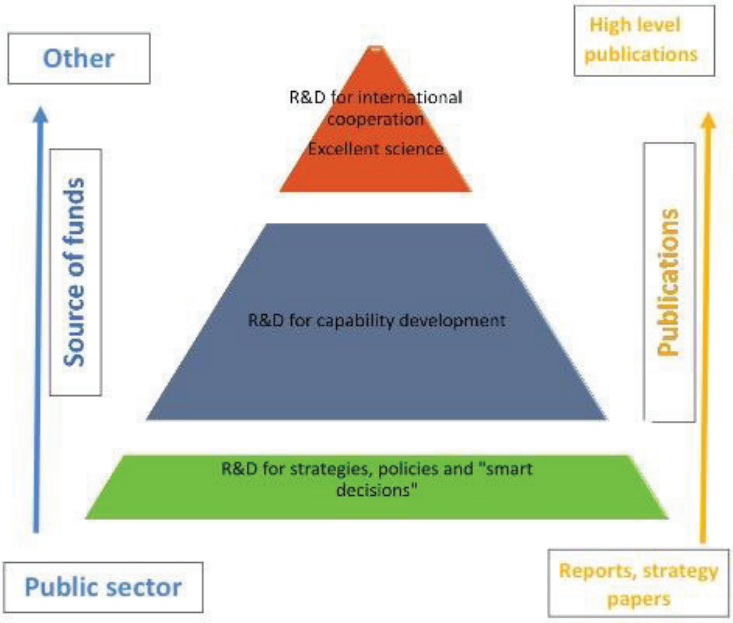
Budgets

- Budget of ca. €2m
- Innovation prize fund of €0.6m (started at €0.2m)
- Leverages ca. €10m of international funding

Five Research Areas:

- Leadership
- Social Science
- Operational Analysis
- Resource management
- Technology

The Estonian model is founded on three building blocks



SOURCE: Estonian MOD presentation

4. Netherlands

Ministerie van Defensie

TNO innovation for life

nlr

Aim:

- Focus RTI efforts on maintaining a strategic knowledge base to be smarter and stronger customers

Structure:

- Large MOD structure for policy & strategy and change agenda (25 people)
- All applied research conducted by TNO, Marin and NLR (private research consultancies – TNO is heavily subsided by defence) – focus on applied science (LTRL), technology development (MTRL) and Innovation (HTRL)

Partnerships:

- No strategic partnership with national Universities or other ministries. Starting to move into this area of engagement
- Strong on international cooperation and partnerships for defence include NATO and EDA.

Budget

- Ca. €80m

Research Areas:

- Sensors
- Weapons
- Human performance
- Protection
- Platforms
- C2 & Decision support
- Cyber
- AI
- Quantum
- Synthetic Biology

5. Portugal

Aim:

- Focus RTI efforts on policy development and coordination of the armed forces RTI execution to support national defence

Structure:

- Small MOD R&T structure (5 people) based in the resources directorate of the MOD in the armament & equipment services branch
- Applied research conducted by the three services through military academies which are University-accredited

Partnerships:

- R&T representatives on every EDA CapTech and NATO STO Panel formally nominated by Director General of Resources
- National Defence Industry Association (idD) is a state entity but is funded by MOD and acts as the focal point and information conduit for industry and SMEs

Budget

- Budget of ca. €1m for MOD R&T activity which leverages ca. €3m; will increase budget to annual €2m for next 10 years
- Military academies get a small budget from the MOD but have to win their own funding

Research Areas:

- Technologies
- Systems
- Integration Domains

6. US Defense Innovation Unit

DEFENSE INNOVATION UNIT

- Three objectives:
  - Accelerate DOD adoption of commercial technology
  - Transform military capacity and capabilities
  - Strengthen the national security innovation base
- Five technology areas: AI, autonomy, cyber, human systems, space
- Guiding principles: Integrity, initiative, impact
- Reforming culture and processes across triple helix model: fast, agile, open
- Effectively a dating agency to match demand with solutions
- Around 60 staff drawing from military, national guard, civilians, secondees/contractors

7. DARPA

DARPA

- Defense Advanced Research Projects Agency (DARPA) is an agency of the United States Department of Defense responsible for developing emerging technologies
- Four strategic priorities: re-thinking complex military systems; harnessing biology as technology; expanding the technological frontier; mastering information expansion.
- It is organised into six thematic areas:
  - Biological Technologies Office
  - Defense Sciences Office
  - Information Innovation Office
  - Microsystems Technology Office
  - Strategic Technology Office
  - Tactical Technology Office
- In terms of project selection, DARPA follows a risk-taking approach and is tolerant of failure

Annex 5: Study Products

Product 1: Vision, purpose & objectives

Defence Research, Technology and Innovation Vision

Leverage the benefits of research and technology to support current and future Defence capability needs and further develop a culture of innovation across the Defence Organisation by
creating a joint unit that embeds evidence-based decision making and accessing the national and international innovation network across defence, government, academia and the private sector.

What	Why	How	To What End
Create a clearly identified joint unit with personnel who are the face of RTI in the organisation with a communication and engagement strategy that points internal and external stakeholders directly to this dedicated unit. A jointly staffed Unit bringing together technical and policy expertise.	Enhance Defence Capability & Inform Capability Planning and Development	By coordinating DefOrg RTI, supporting & enabling applied research activities and by being a proactive research partner on defence related RTI. By ensuring that Defence research is capability oriented and, to ensure its impact, is part of the organisational structure. Conduct threat assessments, horizon scanning & TechWatch of emerging technologies, operational research, and economic analysis.	To find novel solutions to existing and future challenges for users across the Defence Organisation. To support capability planning and a coherent, affordable equipment plan. To exploit technology developments to support defence capability development. This could be through better equipment, tailored training, innovative concepts, novel processes, or other components of capability.
	Contribute to the National Prosperity Agenda	Support Irish academia and industry in Defence research and technology innovation. Support Irish enterprise and research institutions to avail of current and proposed EU initiatives. Support Enterprise Ireland (EI) and Department Business Enterprise and Innovation (DBEI) to improve access to European Defence Funding (EDF) by creating linkages and conduits through an innovation network of people and organisations in Ireland and being proactive with key stakeholders in the EDA (through the CapTechs), in NATO (through the STO panels) and the European Commission (through the EDF). Supporting EI and DBEI to fund innovative ideas that have a defence and security application through dual-use technology development and that have the potential to lead to new spin-outs and spill-overs.	To support wider Government in: 1. Job creation 2. Development of the Smart Economy 3. Growth of the Irish SME/Industrial Base
	Maximise Return on Defence Investment	Conduct Technology Watch and Horizon Scanning activities. Inform smarter procurement approaches, new ways of working and leveraging off-the-shelf technologies with support from partners in academia and industry	To analyse and assess a range of emerging technology options and have a clear understanding of the technologies that will be available in the future, and what their impact will be on Defence.

		Build on collaborations and successes and learn from failures and setbacks.	To assess the relevance and value of emerging technologies that may inform future procurement cycles and to develop long-term strategic procurement strategies.
	Further Develop an effective Innovation Ecosystem	Get the right people involved including upper-level management, leaders who have had success with past innovations, technical experts and external experts. Cultivate the defence enterprise network. Hold regular meetings, events, and talks where innovators from across the organization can get together and share their experience. Lead innovators need to meet regularly with a variety of groups that are working on innovative projects to help connect together groups that are undergoing similar problems. Educate others; both future leaders within the organisation (which many organisations do well) and the rank-and-file who will ultimately play a significant role in innovation success (which fewer organisations do well). Communicate clearly how the organisation will support innovators and innovation projects.	To meet the challenges of the changing security situation. Although militaries are naturally innovative, formal innovation is not guaranteed. In order to encourage and harness innovation, intelligent ideas and risks must be supported, bottom up innovation as well as top down innovation needs to exist. By creating a broad innovation ecosystem, groups involved in innovative projects will reach out to each other directly to solve problems. This collaborative structure helps to create a healthier culture of innovation allowing innovative ideas to not only be formed but also thrive and grow.

Table A5.1 RTI capability purpose and objectives

Product 2: Stakeholder Engagement and Communications Plan

The overarching aim of the stakeholder engagement and communications plan is to increase the likelihood of project success through the achievement of three target objectives:

1 To create a shared understanding of the RTI initiative, its vision, purpose and benefits. This is particularly important given the range of different views currently held.
2. To increase buy-in for the RTI initiative and a collective sense of ownership among key people and stakeholder groups (internally and externally).
3. To ensure senior-level support for the RTI initiative, to create a unity of purpose among the core team driving the work, and to help secure funding and resourcing for the project.

The sections below set out the main elements of a high level framework that could be considered for a coherent stakeholder engagement and communication approach.

There are a several topics to be addressed, including:

- Clarifying that the aim of the RTI initiative is not to create a traditional defence industry but to increase defence capability within national policy and agreed commitments to CSDP and other international obligations.
- The divergence of understanding on links between the RTI initiative and EDF – implying a need to articulate the relationship between the two more clearly and to emphasise that RTI is not EDF dependent.
- Ensuring that RTI and capability development/planning will be aligned and mutually reinforcing.
- The range of views on the nature of innovation and how to realise the benefits of leveraging new ideas, building on the positive view of RTI within the DefOrg.
- Addressing scepticism about the proposed 'joint' RTI capability given organisational/ DefOrg cultural obstacles.
- Clarity surrounding dual-use activity (see Study product 3 'Food for Thought paper: Defence industry and dual-use technology').

Key messages:

- The Vision

Defence Research, Technology and Innovation Vision

Leverage the benefits of research and technology to support current and future Defence capability needs and further develop a culture of innovation across the Defence Organisation by
creating a joint unit that embeds evidence-based decision making and accessing the national and international innovation network across defence, government, academia and the private sector.

- The Benefits
  - Enhance defence capability and support capability planning and development
  - Contribute to the national prosperity agenda
  - Maximise return on defence investment through gains in efficiency and effectiveness
  - Continue to support the creation of an effective innovation ecosystem within the Defence Organisation and with partners in wider government, academia and the private sector
- The joint initiative between DF and DOD will deliver benefits in terms of enhanced defence capability and contribute to the national prosperity agenda.
- An incremental approach to developing the RTI capability will be taken: initially through a challenge-led initiative.
- In terms of sector focus, the development of dual-use research and technology will be supported (including related endeavours of research institutes and the private sector) through funding efforts and leveraging investments from the civil sector that are linked explicitly to requirements that support national defence policy and identified capability needs across all lines of development (DOTMLPFI). This is not the development of a national defence industry.
- The role of the RTI will be to facilitate, enable and fund technology and innovation that supports agreed Irish policy objectives and those overseas missions and capabilities that are aligned with national defence policy.
- There are important links to ongoing and future cross-government efforts on innovation. The Defence Organisation will work with partners across government to maximise benefits. Structures will be put in place to further enable these partnerships.
- There are also links with international partners in Europe (through Ireland's contribution to CSDP tasks and PESCO) through membership of the European Defence Agency and support to peace and security overseas. Structures will be put in place to further utilise these partnerships in the RTI context.
- The aim of the defence RTI activity is to foster partnerships that leverage the best of the private sector and national universities and research entities.
- Proposed governance/processes will enable rather than inhibit innovation.
- Funding will primarily come from a mix of three streams – European funding, national funding streams, and an organic budget. It is expected that over the longer term, there will be an exploration of match funding from industry

The table below outlines each identified stakeholder group and their specific concerns (interviewees) or their anticipated concerns (stakeholders who were not interviewed as part of the study). This should guide the identification of those elements that must be addressed for effective stakeholder engagement with each group in the table. In addition to national stakeholders identified in the below table, a number of international partners such as the European Defence Agency, the European Commission and other EU Members States should also be engaged on an ongoing basis.

Stakeholder Group	Role	Importance	Engagement to date	Concerns	Focus Questions
Sponsors	Project sponsors Senior champions of RTI	Very high	Supportive and want project to succeed.	Organisational & Economic Benefits.	"How does this contribute to delivering defence objectives?"
Service Comdrs Corps Directors	Represent ultimate users of capability. Will generate bottom-up requirements and challenges. Note: DASA has gateways into each service.	High	Understand the importance of innovation and keen to exploit. Want to build on what works already. (Note: not all key corps/ service chiefs have been engaged as yet)	Need to feel that they are 'partners' in the RTI capability initiative. Want to be recognised for innovation, and have interaction with RTI so that RTI is not a separate silo: i.e. an organisational culture or appreciation of innovation is desirable. Concerns this will add extra burdens, distract from day job, and should be linked to specific KPIs	"How to link RTI capability to service/ corps level KPIs/ success?"
SPB P&O	Capability planning and development. Strategic futures.	High	Very engaged. Understand how RTI can support capability development.	Needs to align with future capability development process. They own the 'what on'.	"How will this fit in with Cap Dev process?"

Stakeholder Group	Role	Importance	Engagement to date	Concerns	Focus Questions
ISDP Brussels Office Contracts Finance	Develop overarching policies that enable effective RTI. DefOrg link to EDA (CapTechs) and EDF.	High	Very engaged. Particular interest in providing decision-support and structure around equipment procurement.	Governance and assurance/risk management. Need to have policies and processes in place.	"How will this align with defence and national/ EU policy objectives?" "How can this increase our influence, engagement and impact with international partners, EC and EDA?"
Junior-Mid career officers and DoD officials	Implementers and Innovators	Medium	Sample of officers in consultation interviews	Concerns over organisational tolerance for risk Heavy work burdens and the perception that RTI might add more burden;	Non-technical: "How will this impact my day-to-day work?" Technical: "Is this going to distract and redirect budget and already overburdened personnel"? All: "How will this improve our capabilities'

Stakeholder Group	Role	Importance	Engagement to date	Concerns	Focus Questions
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Junior-Mid career officers and DoD officials	Implementers and Innovators	Medium	Sample of officers in consultation interviews	Concerns over organisational tolerance for risk Heavy work burdens and the perception that RTI might add more burden;	Non-technical: "How will this impact my day-to-day work?" Technical: "Is this going to distract and redirect budget and already overburdened personnel"? All: "How will this improve our capabilities'

Stakeholder Group	Role	Importance	Engagement to date	Concerns	Focus Questions
Partners across government: DBEI	Policy makers and enablers	High	Extensive engagement to date	The technical requirements of the EDF which is only a fraction of other budgets, Security clearance issues, new portfolio management.	"How do we address the complexities of defence related activities from an enterprise point of view".
Enterprise Ireland	Lead in H2020 secure societies programme	High	Very engaged. How to assist Ireland Inc. to access EDF funding.	Longstanding expertise that can inform the RTI capability and official role in accessing EU funding for enterprises. Delineating roles to avoid duplication.	"How do we access EU defence funding and support Ireland Inc./the prosperity agenda?"
IDA	Attracts and support Foreign Direct Investment	Potential to be Medium-High.	Low	Third country participation prospects in the EDF Possible long-term prospects with the RTI capability in terms of defence directed research	"How could we support this endeavour if it links to the Ireland Inc. prosperity agenda?"

Stakeholder Group	Role	Importance	Engagement to date	Concerns	Focus Questions
SFI	SFI research promotes and assists the development and competitiveness of industry, enterprise and employment in Ireland through research supports.	Medium-High	Medium A potential partner in some areas through their research centre - hub and spoke - model	Focus mainly on STEM and the National Research Priorities	"How can we collaborate to increase impact of research?"
Private sector and industry associations (e.g. IBEC)	Potential DefOrg project partners; Dual-use research	Diverse across different actors	Medium – EI/RTI team consultation with representative sample	See opportunities for their sector and are looking doe defence related opportunities.	"How do we access EDF funding?" "How can we test our products with the DefOrg for end-user requirements?" "What levels of national support are available in terms of funding and support?"
Universities and research institutes	Potential DefOrg project partners; RTI Subject matter expertise;	High	Medium through RTI team consultations	Interested in engagement and potential opportunities	"How do we access defence related EU funding/national funding?" "How do we create stronger research products with end-user requirements?"

Stakeholder Group	Role	Importance	Engagement to date	Concerns	Focus Questions
Ministerial level/ High level political level	Ministerial approval/ High-level civil servants	High	The minister office was not consulted for the purpose of this study. These are anticipated or potential matters and concerns that might arise.	Predicted Concerns: Any activity in this area must be within existing policy boundaries and support policy objectives.	"How this this enhance the Defence Forces capabilities to enable them to continue to operate in support of Irelands Foreign policy objectives?" "What does this mean to the public, for jobs and the economy?"
Local government	DASA interview highlighted their use of regional partners	Low	Local Government was not consulted for the purpose of this study. These are anticipated or potential matters and concerns that might arise	Predicted Concerns: Lack of awareness of opportunities	"What does this mean to the public, for local jobs and regional development?"
The public	Taxpayers; Government elected for the people and important to protect the "trust" of the public.	Medium	The public was not consulted for the purpose of this study. These are anticipated or potential matters and concerns that might arise.	Predicted Concerns: Generally agnostic toward defence.	"What does this mean for the economy and why is money being spent on defence but not on healthcare or the housing crisis?"

Stakeholder Group	Role	Importance	Engagement to date	Concerns	Focus Questions
NGOs	Civil society	Medium-High	NGOs were not consulted for the purpose of this study. These are anticipated or potential matters and concerns that might arise	Predicted Concerns: Creating a 'defence industry concerns'; Ireland's engagement on defence with the EU – and links to NATO	"Is the Government creating a defence industry?"

Table A5.2: Stakeholder concerns and anticipated concerns

Product 3: Food for Thought Paper: Defence Industry & Dual-Use Technology

One key objective of establishing the RTI capability is to connect with an innovation network across government, academia and private sector that supports the delivery of agreed national defence policy and capability requirements. Specifically, the creation of a defence innovation ecosystem that fosters new connections and encourages fruitful collaboration between stakeholders in government, academia and other research institutions, and the private sector.

However, it needs to be recognised that there are national concerns around defence in general, and defence industry in particular. It is important to be clear that the formation of a national defence industry that is focused on the production and export of arms is categorically not an aim of the initiative.

The role of the RTI will be to facilitate, enable and fund technology and innovation that supports agreed Irish policy objectives, domestic and overseas missions and capabilities that are aligned with national defence policy

For investments in R&D, these will be thematic and almost certainly in enabling technologies. In this case the focus is on strengthening the technology sector (e.g. advanced materials, biotechnology, data science). The implication of this is the requirement for a Defence Technology Strategy[28] document that identifies and prioritises these technology sectors. For investments in innovation, the aspiration is to be part of an innovation ecosystem across academia, industry and SMEs. This will have a range of benefits and not exclusively for defence. Buy in from across a number of Government Departments is essential. This whole of Government approach will ensure that issues outside of the control of the Department of Defence are addressed and supported by the relevant Departments and Agencies.

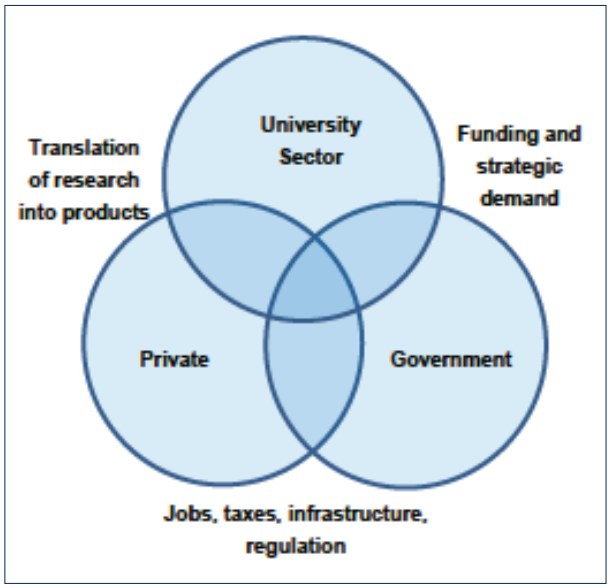


Figure A5.1 Innovation Triple Helix

The triple helix model of innovation, illustrated in Figure A5.1, emphasises the complementary and mutually reinforcing roles of three groups. First, universities engaging in basic research; Second, the private sector commercialising and producing goods and services; and Third, governments that act as funder, regulator and strategic customer. As interactions increase within this framework, each component evolves to adopt some characteristics of the other institution, which then gives rise to hybrid institutions. Bilateral interactions exist between university, industry and across government.

28 A DTS allows for the identification of technological challenges and opportunities, allows for understanding and development of technologies that offer the most promising cross-cutting applications and creates the mechanisms to exploit those technologies at a speed of relevance.

Through the last fifty years, defence industries have emerged (often as a result of direct government policy) in major global defence powers. This is often characterised by a monopoly-monopsony situation (one buyer-one seller) among the largest defence spending nations and regions due to large defence R&D and production contracts for which there is no commercial application (in sectors including missiles, warships and combat aircraft). Not only has this caused a variety of market distortions when compared with freely-functioning markets, but also led to the creation of a distinctive defence industry with arms exports being actively supported by governments to defray the non-recurring costs of development and fixed costs of manufacture.

In contrast, the Defence RTI capability will focus on technologies (typically at TRL 3-6) that have broad potential utilisation, in that they could be exploited in a range of commercial applications, and on leveraging innovations from the civilian sector (at higher TRL). The creation of an innovation ecosystem that better enables the delivery of defence objectives will not lead to a defence industry for two reasons.

- First, economics (the focus on enabling technologies means that defence will not be the dominant customer).
- Second, policy (as a consequence of focusing on national defence policy rather than allowing a defence industrial strategy to drive policy).

However, a third pillar is required: a suitable defence export licensing policy that enables national prosperity without compromising the wider national defence posture. The existing export licensing regime should be reviewed to confirm that it is fit for purpose in a rapidly changing technology landscape. (Note: this is not the remit of the DoD – it is the remit of DBEI but situational awareness of this requirement is important in the context of the EDF)

This is particularly salient given the evolving policy on defence at European level, which has metamorphosed from baby steps around security and dual use technologies a decade ago to the launch of the PESCO, CARD and European Defence Fund initiatives; and most recently the formation of DG Defence Industry and Space.

Clarity on the definition of dual use in the national context is important too, which is challenging given the increasing overlap and synergies between civilian and military technologies. At low TRL levels, almost all technologies can be thought of as being application-agnostic. For example, basic research on advanced materials, machine learning or electro-optics could have a wide range of civil applications; but are also key enabling technologies for defence applications (such as Unmanned Aerial Systems). A good overview of dual use technologies was published by the European Commission to frame the funding policy and link to economic growth.[29]

Through supporting the development of dual use and key enabling technologies, the RTI capability will strengthen the national R&T base in technology areas that are aligned with national defence capability needs. This will also increase the competitiveness of companies and universities that are bidding for grants under the European Defence Fund and financial support from other European funding sources. This has some multiplier effects in terms of research funding in that the same technologies can then be applied in a range of markets, which has a wider prosperity benefit than just defence.

29 https://ec.europa.eu/docsroom/documents/12601/attachments/1/translations/en/renditions/pdf

Figure A5.2 provides a schematic representation of how innovation (applying and adapting solutions for defence problems) can be leveraged in a dual use context.

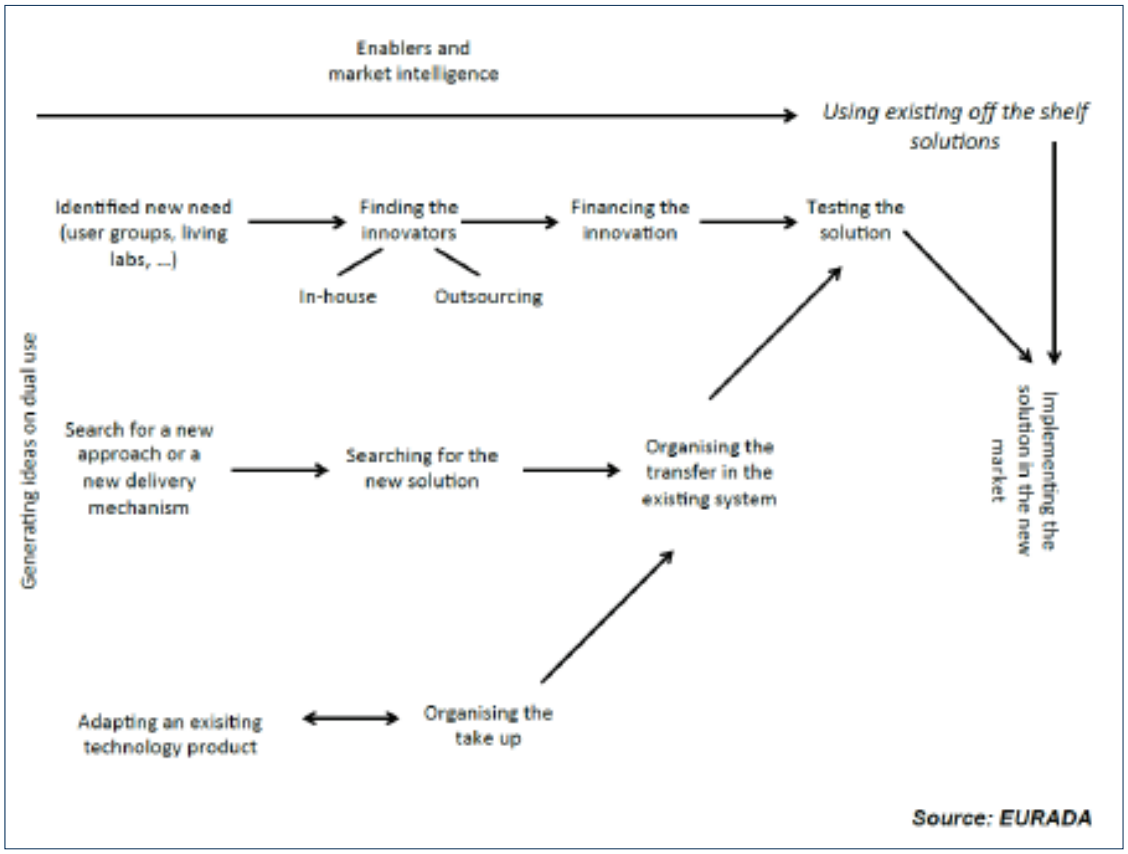


Figure A5.2 Pathways from needs or ideas to dual use markets [Source: EURADA]

Product 4: Process Maps for Leveraging Innovation and Supporting R&D

In order to begin to operationalise the RTI capability, two outline process maps have been developed that provide a series of activities that collectively fulfil parts of the vision. The intention is that once approved at a high level, these would be developed to provide an operating model to map the functions of the RTI unit and also include governance activities.

1. Innovation Process Map

The first map shows the activities that enable the identification of innovative solutions to existing challenges in the Defence Organisation (DefOrg).

It is initiated by the elicitation of a challenge from a DefOrg user, with the cycle completing with the provision of a potential solution. Feedback loops are present throughout the process map to ensure that the RTI cell is fully integrated with internal and external stakeholders. This is a key activity in building a defence innovation ecosystem.

The governance layer – represented in light blue – ensures that activities are aligned with policy; that funding is allocated according to the right priorities; and that projects are awarded on the basis of technical feasibility, alignment with user need, wider exploitability, and overall value-for-money.

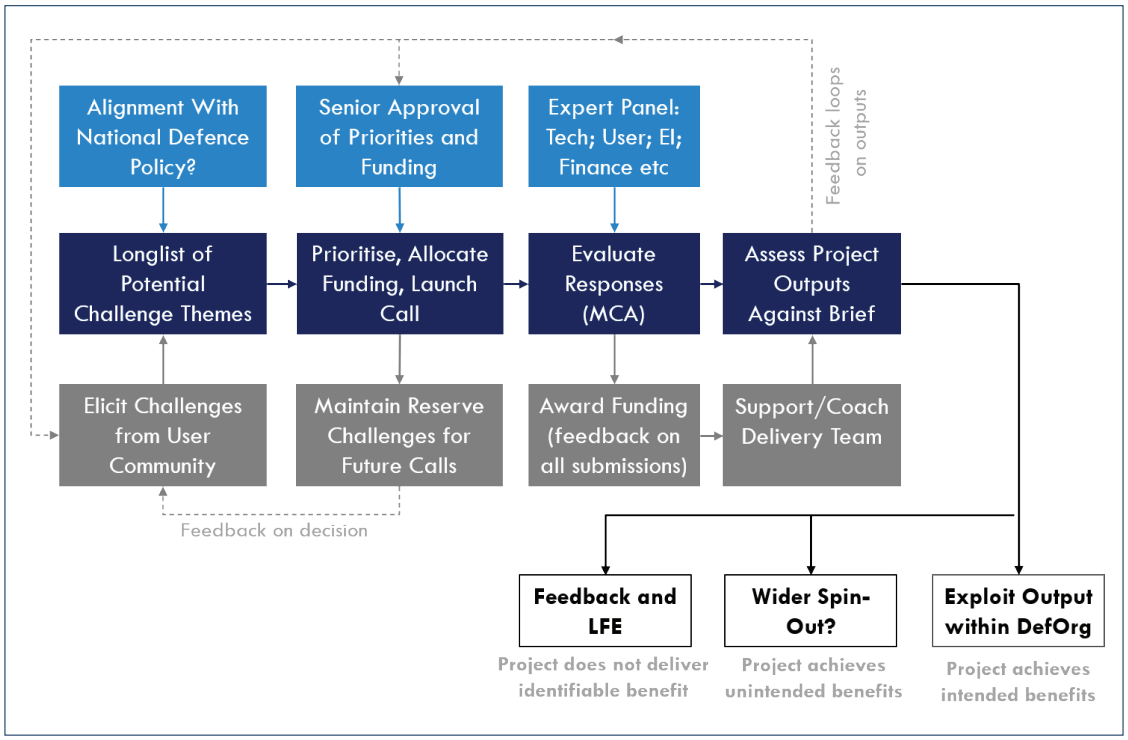


Figure A5.2 Pathways from needs or ideas to dual use markets [Source: EURADA]

2. R&D Process Map

The second map shows the activities that enable the identification and development of technology that support capability priorities; and have the potential to contribute to national prosperity. The navy-blue activity – that led by the RTI cell – is centred around defining the role that DefOrg should play in the acquisition of capability (that of smart developer, smart specifier or smart buyer) and the implied role on a technology sector basis of active monitoring (where technology is directly relevant to delivery of military tasks, but the development itself is already ongoing), passive monitoring (where there is not a direct link to defence capability) or joint development (where DefOrg should play a leading role in supporting the development of technology).

The map highlights the need for a Defence Technology Strategy that sets out technological priorities, their link to defence capability needs and the role of Defence in each technology sector. The link to SFI in terms of coherence and joint development is also emphasised to maximise the impact of R&D funding and other forms of support.Again, the process map is cyclical with feedback loops both at the governance layer and back to capability planning and development.

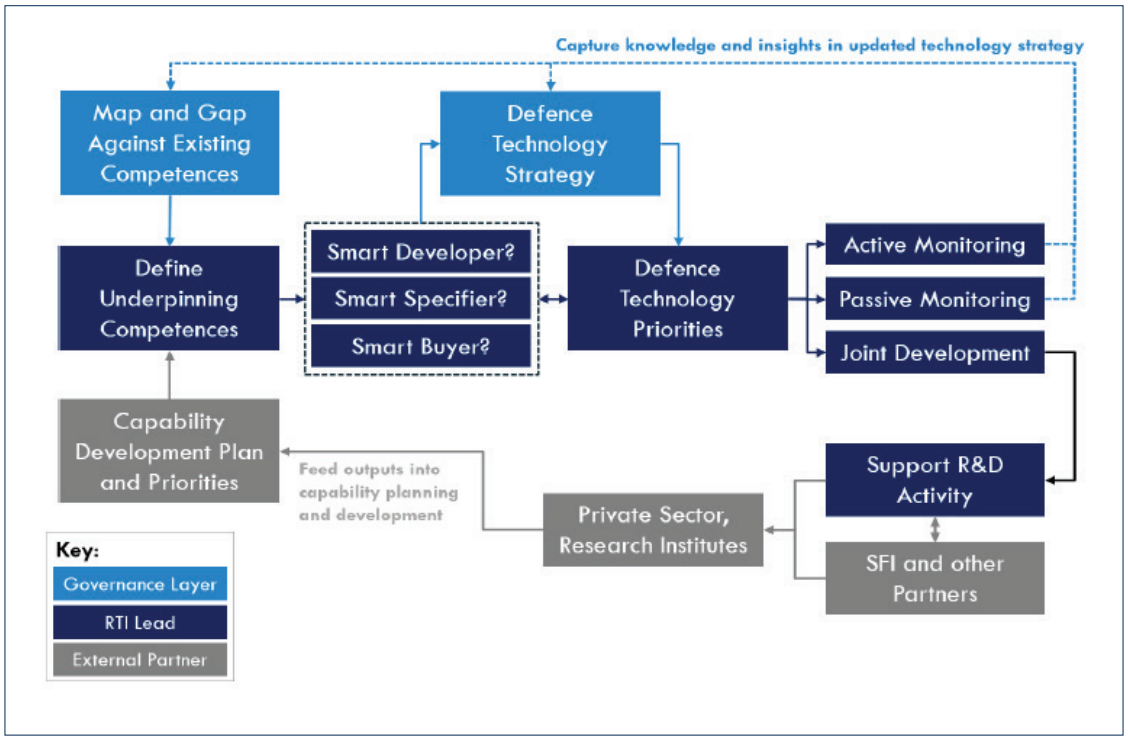


Figure A5.3 Process map for R&D

3. Illustrative Mapping of Capabilty Areas and Technologies to Potential DefOrg Role

Definitions[30]:

- Smart developer: Defence takes on the development of a technology or platform itself, because the market cannot provide it.
- Smart specifier: Defence supports the relevant industry by stipulating technical specifications in the development phase.
- Smart buyer: Defence is able to stipulate the correct functional specifications in the procurement process of technology and equipment.
- Joint development: Defence, knowledge institutes and companies will actively participate in the (further) development of the field in order to help to determine the direction and timing of the development.
- Active monitoring: The technology is important for the effective execution of military tasks, but the development itself is mainly external to the Defence domain. Developments will be followed closely.
- Passive monitoring: The link with military tasks is limited or can be organised ad hoc. It is therefore sufficient to follow the mainly civilian-driven developments and the potential military application thereof.

30 Note that these have been adapted from the Netherlands Strategy for Defence R&D with permission from the Netherlands MoD.

Areas of Knowledge & Expertise	Procurement Level	Priority Technological Areas	Development Engagement
Defence Analysis	Smart Developer	Artificial Intelligence	Monitor Actively for threats and friendly force capabilities Joint Developer for C4ISR (high level of national responsibility)
Materials Readiness, Energy & Logistics	Smart Buyer	Cyber, Electromagnetic Analysis & Quantum Computing	Cyber operations - Joint Developer EMA & Quantum – Monitor Actively
Personnel Readiness & Human Performance	Smart Developer	Sensors (including quantum sensors and nano sensors)	Joint Developer for military spec sensors Monitor Passively for civil driven sensor developments
Command & Control	Smart Developer for integrated C2 systems. Smart Specifier/ Smart Developer for underlying task critical sub systems	Human-Systems Integration	Monitor Actively
Situational Awareness	Smart Developer for integrated I2 systems and high-end sensors. Smart Specifier/ Smart Developer for underlying task critical sub systems	Space/Satellites	Monitor Actively
Protection	Smart Specifier/ Smart Developer (with trusted partners) for deployed units and in the context of national security	3D Printing & new materials	Monitor Passively
Platforms	Smart Buyer/ Smart Specifier	Biotechnology	Monitor Actively
Network Infrastructure & Cyber Security	Smart Developer at the integrated network level. Smart Buyer for (normally civil driven) sub systems	Simulation & Virtualisation	Joint Developer/ Monitor Actively
		Human Enhancement	Joint Development in Military Niche Areas/ Monitor Actively
		Robotics & Autonomous Systems	Joint development/ Monitor Actively

Table A5.3 Mapping of Capabilty Areas and Technologies to Potential DefOrg Role

Product 5: High Level Project Timeline

A high-level timeline has been developed to realise the level of ambition in each of the 3-Stage model agreed by the sponsors. Note that Stage 1 is envisaged as a pilot programme, but as part of a coherent plan to achieve the full RTI capability of Stage 3. Each stage will conclude with a formal review measuring success against pre-agreed metrics and KPIs and to capture lessons learned, which will be used to refine the design of the next stage. Prior to launch of each stage, a business case will be prepared for approval before proceeding.

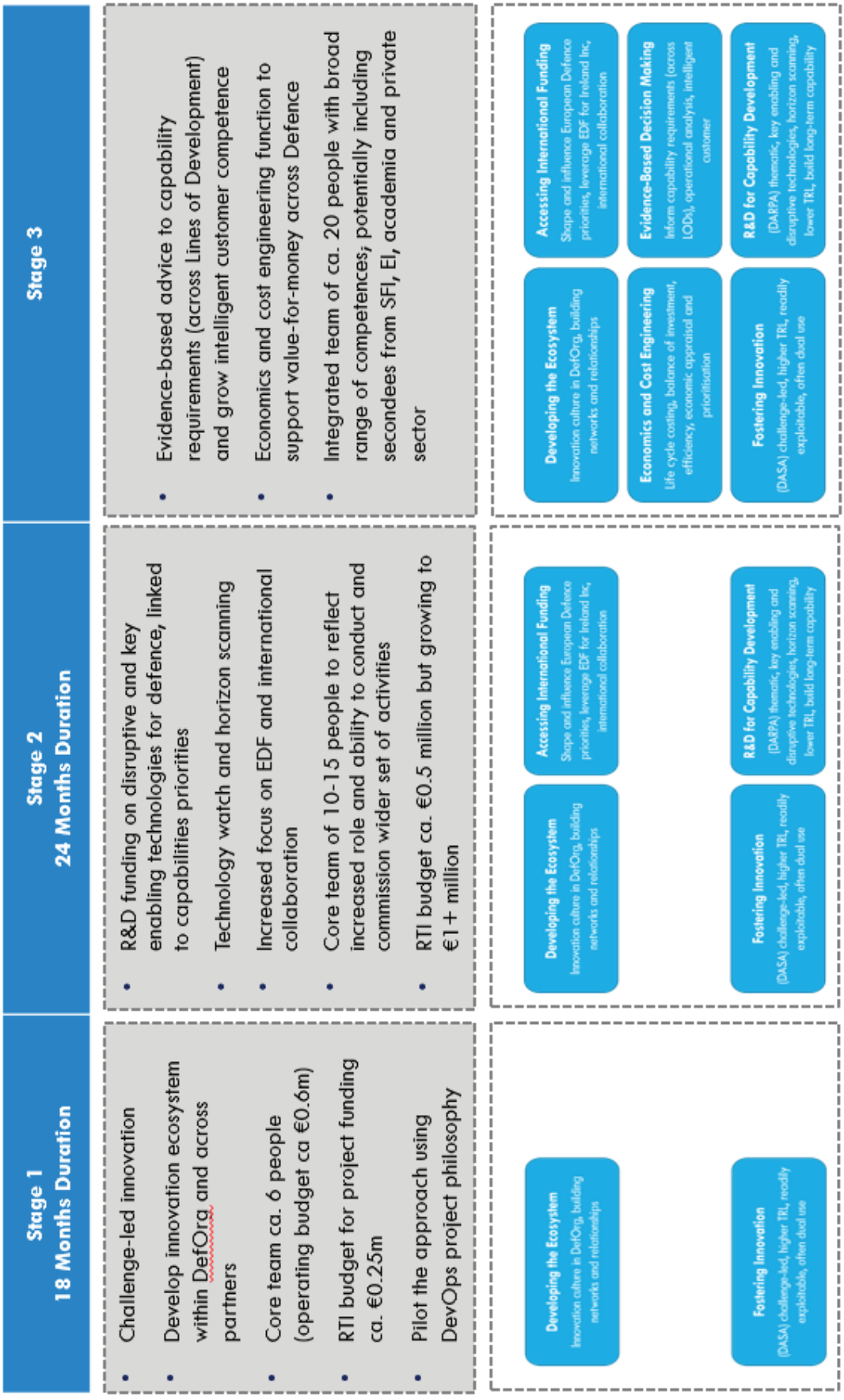


Figure A5.4 High-level full RTI imlementation timeline

1. Stage 1: Fostering Innovation and Developing an Innovation Ecosystem (Oct 20 – Mar 22)

The timeline below provides an indicative, high-level plan for Stage 1. It is envisaged that this is centred around a challenge-led innovation programme, with a range of engagement events both internally and externally.

Following approval of the final business plan and endorsement of the operating model and blueprint for the RTI cell, a communications campaign will accompany the launch of a dedicated, joint RTI cell. Creating the right culture, behaviours and ways of working will be a key enabler of success; consequently, focused effort will be needed to embed this culture within the dedicated RTI team.

In addition to running a themed Innovation Challenge, the RTI cell will support and build on the existing work underway (including efforts relating to European Defence Fund and EDA engagement).

The Innovation Challenge will run for approximately 12 months (a 3-month funding window including supplier engagement events across the country and a 9-month delivery phase).

Stage 1 will then conclude with a formal review measuring success against pre agreed metrics and KPIs and to capture lessons learned, which will be used to refine the design of Stage 2.

Prior to launch of Stage 2, a business case will be prepared for approval by the project sponsors.

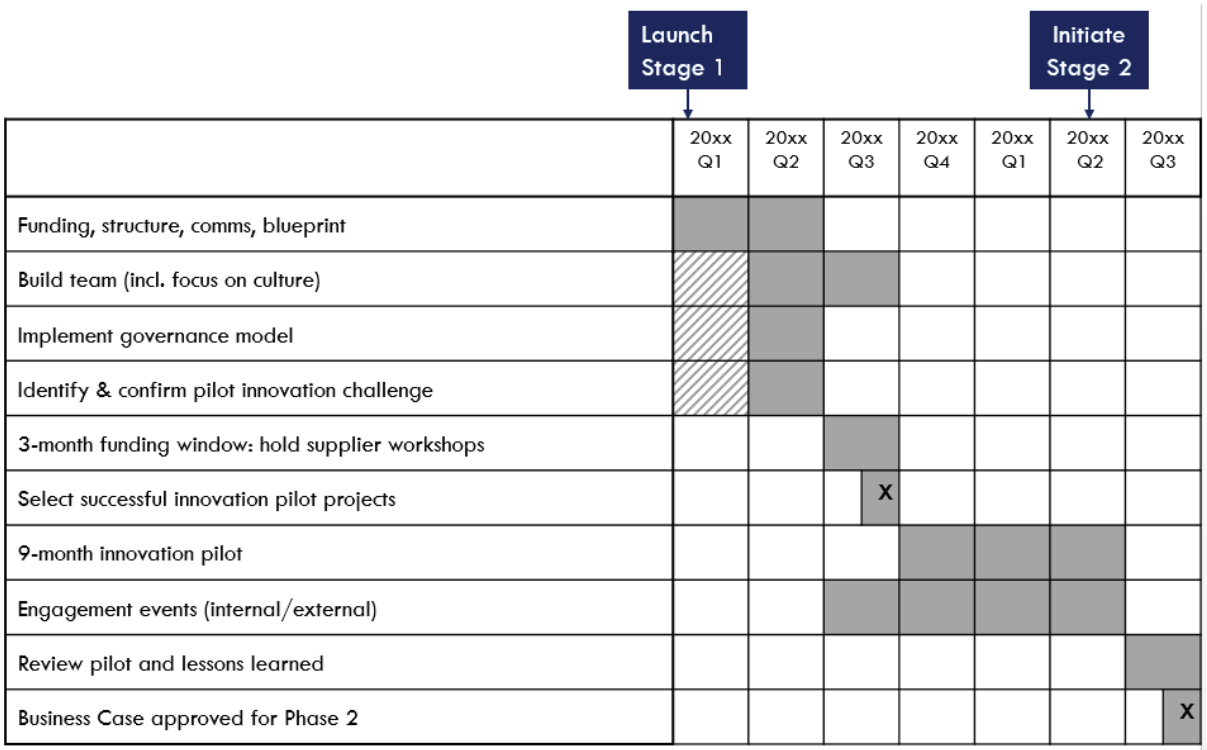


Figure A5.5 Stage 1 timeline

2. Stage 2: Innovation and R&D to Support Capability Priorities (Apr 22 – Jun 24)

The timeline below provides an indicative, high-level plan for Stage 2. This will build on Stage 1 with a second challenge-led innovation programme, and further engagement events both internally and externally. Building the team and a further communications campaign to sell the benefits of the expanded remit of the RTI initiative will be important.

It is proposed that a Defence Technology Strategy is developed and published during the first 9 months of Stage 2. This will serve as the guiding policy document for establishing both key enabling technologies and as the basis to determine the DefOrg posture towards those technologies, namely:

- Active monitoring (where technology is directly relevant to delivery of military tasks, but the development itself is already ongoing),
- Passive monitoring (where there is not a direct link to defence capability) or
- Joint development (where DefOrg should play a leading role in supporting the development of technology).

The process map for R&D provides more detail on the steps required. However, the primary additional focus of the RTI cell in Stage 2 is the support for Joint Development Projects aligned with capability priorities. Ensuring coherence with the capability planning and development process will be a key priority for the RTI cell.

Stage 2 will conclude with a review and lessons learned exercise. Prior to launch of Stage 3, a business case will be prepared for approval.

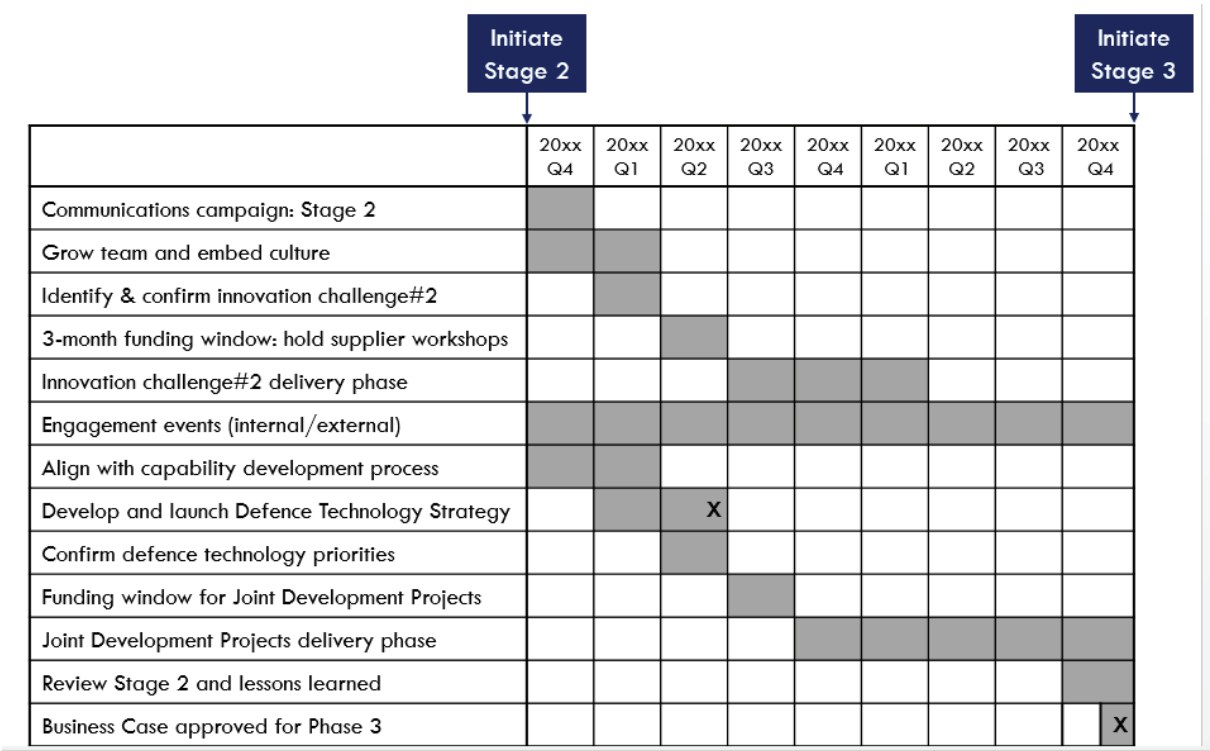


Figure A5.6 Stage 2 timeline

Product 6: Metrics and KPIs

Metrics and Key Performance Indicators (KPIs) can be used to measure the progress of success of the RTI unit. Dashboards used to Display RTI activity metrics and KPIs, provide a visual overview of activity and impact. In order to be useful metrics and KPIs must be linked to the agreed RTI Benefits:

1. Enhance Defence Capability & Support Capability Planning and Development
2. Contribute to the National Prosperity Agenda
3. Maximise Return on Defence Investment
4. Create an effective Innovation Ecosystem

What is a Metric?	What is a KPI?
Metrics provide information that can be digested	KPIs offer comparative insights that guide future actions
Metrics are extracted and organised by activity or process	KPIs are initiated by high-level decision makers
Metrics can be viewed historically but do not identify future action	KPIs incorporate goals and objectives
Command & Control Metrics are static and once extracted do not change	KPIs can be evaluated and reset over time using SMART methodology
Why are Metrics needed?	**Why are KPIs needed?**
• To engage employees • To make leaders accountable • To provide decision-making inputs	• To identify impact and successes • To lay out strategies to overcome challenges • To evaluate program benefits

Table A5.4 Overview of Metrics and KPIs

Analysing the use of Metrics & KPIs in other Government Agencies dealing with RTI identified the following key points:

1. Connecting research inputs to tangible outputs can be difficult for a number of reasons including the delay between early research and the final economic impact, therefore ongoing measurement of activities is important over a long term period.
2. While there is no single perfect indicator of research impact, significant amounts of data can be collected annually that collectively help to frame the return on investment.
3. There should be fewer KPIs (5 or less) used but many metrics can be used and these can change frequently if needed.
4. There shouldn't be a focus on just financial metrics to indicate value - otherwise there is a risk that societal and organisational benefits will be ignored.
5. The use of shared KPIs for common goals e.g. a shared KPI between EI and the DefOrg for Defence Related Enterprise activities should be considered.

Sample Metrics and KPIs to Measure & Display RTI activities linked to the identified RTI Benefits are shown in the table below:

Benefits:

1. Enhance Defence Capability & Support Capability Planning and Development
2. Contribute to the National Prosperity Agenda
3. Maximise Return on Defence Investment
4. Create an effective Innovation Ecosystem

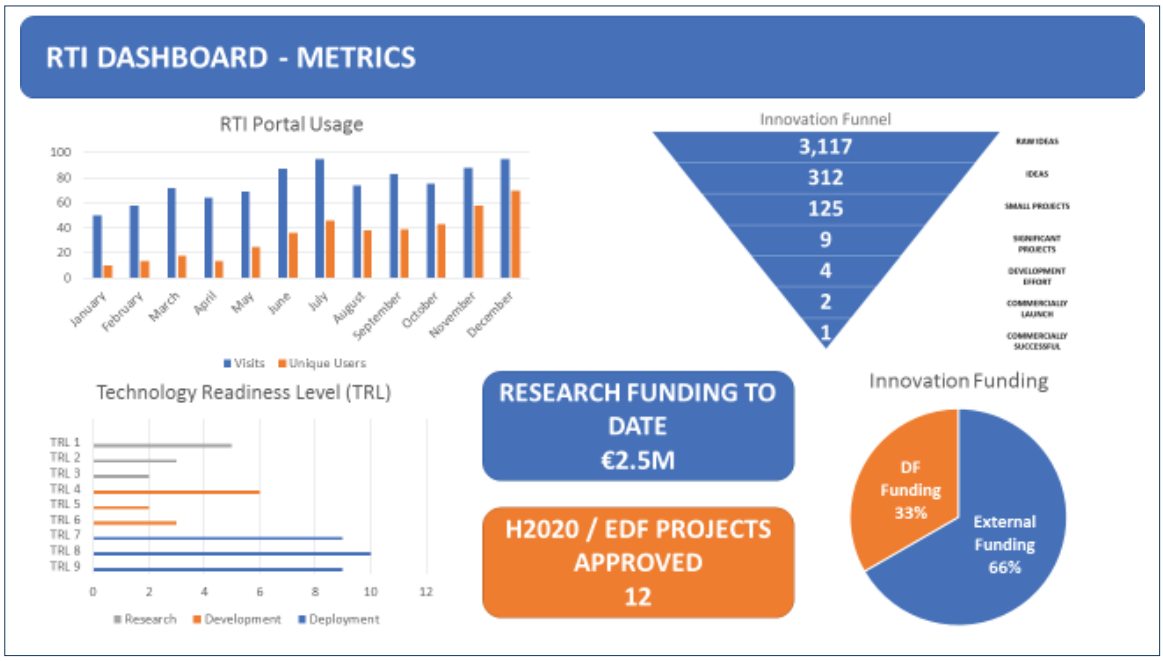
Stage	Fre-quency	Sample Metrics linked to RTI Benefits
Engagement	Annual	• # of internal/ external users engaged with online RTI portal (4) • # of new connections formed (4) • Feedback from online surveys (4) • Participation rate for innovation resources and events (4) • Diversity of attendees (4) • # of internal stakeholders re-engaging with RTI unit (1)
Idea Generation	Annual	• # of ideas generated internally (1) • # of ideas proposed by external actors (2) • # of ideas moving to development stage (1), (2) * need to define 'idea' and 'generated'
Idea Development	Annual	• Rate of participation in idea development (4) • # of ideas reaching project grant/ funding application stage (2), (3) • # of successfully funded and initiated projects (2), (3) • Value of matched funding from other sources (private sector PV, SFI, DASA etc etc) (2)
Projects / Challenges	5 yearly	• # of projects successfully completed as planned (1) • # of projects not completed as planned but with other positive outcomes (1), (2), (3) • # of unsuccessful projects – lessons learned (1) • # of H2020/EDF proposals and successful proposals linked to security: with national involvement and being led by national player (2) • # of patents created (mid TRL) (2) • # of journal papers published/ bibliometrics (low TRL) (2) • Measurement of research excellence (1), (4)
Exploitation	5 yearly	• # of ideas to reach TRL 8/9 (2) • Time to commercialisation (2) • # of ideas commercialised by Defence Forces (1) • # of ideas commercialised by Industry (2) • # of spin out companies (2)

Stage	Frequency	Sample Metrics linked to RTI Benefits
Tangential Effects	5 yearly	• # of jobs created as a result of investment in Higher Education (2), (3) • # of jobs created as a result of investment in Applied Research (2), (3) • # of high level jobs created and associated spin offs (DPER estimate up to 6 x normal jobs for every high level job) (2), (3) • # of publications & as a result of research investment (reach) (2), (3) • Amount of leveraged funding generated – what is the multiplier effect? - EU, other MS resources, industry. (2), (3) • Possible impacts on Ireland's economy if the RTI unit is NOT created (2), (3)

Table A5.5 Sample Metrics linked to Identified Benefits

Impact	Sample Key Performance Indicators
Innovation Magnitude	• Total capital and operational investment / successful projects (successful as planned or with other positive outcomes) (1, 3)
Innovation Success Rate	• Successful ideas (# of ideas reaching project funding application stage) / Total ideas explored (# of ideas moving to development stage) (1) • Learn from experience (LFE) exercises conducted (1, 4) • Spill over benefits audit (2, 4)
Investment Efficiency	• Ideas explored (# of ideas moving to development stage)/ total capital and operational investment (4) • Successful 'Value for Money' Audit (1, 3) • Reduced length of procurement cycles (1, 3) • Total cost of Ownership/ Life cycle costs Reduced (1, 3) • EDF success rate (2, 4)

Table A5.6 Sample KPIs linked to Identified Benefits



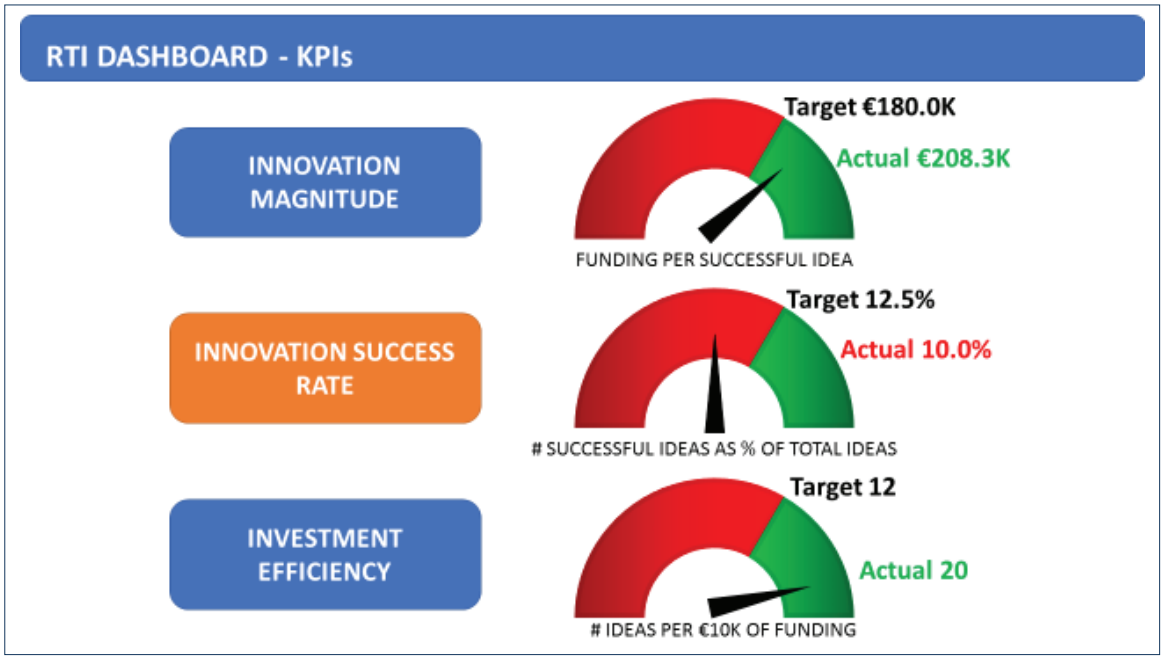


Figure A5.7 Sample RTI Metrics and KPIs Dashboards

Product 7: Risk Management

A proposed risk management and monitoring approach for RTI will consider the following:

1. Our Public Service (OPS) 2020, Action 6: Promoting a Culture of Innovation in the Public Service identifies the following key enabler to success: "Tolerating managed risk and allowing controlled failure". It also identifies as a barrier to success: "risk aversion" and "poor tolerance of failure". In order to support innovation it suggests that "structures to encourage managed risk taking" are developed in the following way:
    a. Encourage well managed risk taking through leadership commitments to encourage well- considered risk taking.
    b. Pilot a risk appetite statement within a public service organisation.
    c. Integrate risk taking into strategies and business plans.

2. 'Risk' is not an abstract concept. Risks normally fall under three areas, Strategic, Operational and Financial. Risks must be identified, examined, understood, controlled and accepted/ not accepted.

3. A risk register should be created for each project. The project risk register should include key risks applicable to each project – strategic, operational and financial. If the project is accepted, the risks and controls should be brought to a higher level and incorporated into the overarching RTI Risk Register and the project risk register should be subject to ongoing review and maintenance by the project team.

4. At least one member of the RTI unit will have responsibility for operational and financial risk management. Strategic risk management will be shared between the RTI unit and the high level steering board or other strategic lead within the Governance Structure.

5. Risk management will be an integral part of the RTI unit's core business, not a subsidiary activity. Risk management will be an ongoing activity and the risk registers will be 'live' documents, continually updated as projects progress.

6. Risk Management will be Top Down led with regular reviews at unit level, with programme managers and with high level governance representatives.

7. The risk management methods used will be 5-point estimates and Monte Carlo Simulation.

8. The projects will be reviewed from a strategic, operational and financial point of view.

9. Risks must relate to the RTI unit and individual projects and not the organisation as a whole.

10. Monitoring of risks will be done through the risk register[31].

31 A sample risk register was created for the purpose of the study and presented to the sponsors

Risk Categories

The following are a sample of the types of risk within each category that might be considered by the RTI unit.

1. Strategic Risk –The risk that the RTI or Project strategy does not enable the completion of Project tasks. This may result from internal or external factors.

Impact	Sample Key Performance Indicators
Strategy Execution	What could occur that would prevent you from being able to execute the strategy of the project?
Covid-19 Response	What Covid-19 related events could occur that could prevent the project from going ahead / delay the project?
Competitiveness	Is the project at a high standard compared to other projects?
Strategy Development	What could occur to prevent strategy development?
Innovation	Does the project draw from high quality innovative ideas? Or are outdated techniques being used to execute the strategy?
Capacity / Capability	Are there resources i.e. people, technology, materials available to enable the strategy to be executed?
Reputational Legislative	What could occur as a result of the project leading to reputational damage?
Regulatory / Legislative	Are there any regulatory / legislative requirements that need to be met?
Risk Culture	Is there an appropriate attitude to risk within the project? Are all risks discussed and documented once identified?

2. Operational Risk – Inadequate or failed processes and / or people, systems or external events.

People	Are the right people with the right skills available to complete the project?
Governance	Is there the right leadership, processes and procedures in place?
Third Party / Outsourcing	Are additional external resources/services required?
Business Continuity Management / Disaster Recovery	Is there a plan in place for disaster recovery / business continuity?
IT & Data Security	Is there appropriate IT/Data security in place e.g. VPNs, password protection/encryption of sensitive documents?

Impact	Sample Key Performance Indicators
Legal & Compliance	Is the project complying with policy in the organisation? Is the project complying with the law? Is there a risk that this might not happen? Is research required prior to the project?
Fraud / Theft	Are there measures in place to prevent internal / external fraud or theft?
Behavioural	Are staff likely to behave in the appropriate manner? Are staff being given the opportunity to learn desired behaviours? Could this impact the operations of the project?
Cyber Security	Are there sufficient measures in place to prevent online attacks on documentation / knowledge?
Health & Safety	Are there measures in place to prevent injury?

3. Financial Risk – Can emerge from both internal and / or external sources and can result in the Project failing to meet financial obligations or failure to obtain financial requirements

Liquidity	Is there dedicated budget available to complete tasks for the project?
Credit	IDo project partners have required liquidity to meet grant schemes criteria?
Financial Reporting	Is there any impact on financial reporting?
Political	Does it fit with the current Programme for Government Objectives?
Investment	Does the project require investment in resources for project execution?
Funding	Does the project require funding from the organisation? Or externally? If this is not obtained, what would happen?

Risk Assessment Methodology

As the current DefOrg Risk Register details, risks should be scored based on impact and likelihood. The impact and likelihood of the risk (without the consideration of controls) is assessed to determine the total risk. For the purpose of managing RTI risk it is proposed to include the concepts of an **inherent risk** score and the **residual risk score**. Controls or actions which mitigate the inherent risks are identified, documented and scored based on their effectiveness. Controls are applied to

the inherent risk to arrive at the **residual risk**. Residual risk is then reviewed to see if further controls are required. Residual risk must be managed and monitored.

Impact – scored on a scale of 1-5 –what is the impact should the error occur?

Likelihood – scored on scale of 1-5 –what is the likelihood of the risk occurring in the absence of controls?

Control Effectiveness – scored on a scale of 1-4 –how effective are the controls in mitigating the risk?

Risk Tolerance

The tolerance of an organization to accept the residual risk is unique to that organisation and must be assessed internally with external expert input where required. For example, the tolerance for risk in DPER would be different to DBEI and different again to DoD in terms of Strategic, Operational and Financial risk. Organisations (and organisation sub entities) must assess their own risks in the context of their operations and create a risk statement for their unique circumstances

Product 8: Strategic Business and Economic Analysis

This short paper sets out the strategic business case for creation of a defence RTI capability. It begins with a summary of the economic case for investment. A synthesis of the reference literature is included in Annex 5. Crucially, **the proposed RTI unit would be uniquely positioned** to deliver a number of benefits that would differentiate it from other national research entities and support national RTI capability. Our ambition is, through stimulating innovation, the RTI unit would support the wider national aspiration – articulated in Innovation 2020 – to further lift Ireland's ranking in the European Innovation Index amongst the top ten nations.

1. There is solid evidence that RTI investment delivers economic benefit

It is widely accepted that government **investment in research, technology and innovation has a number of positive socio-economic impacts** including knowledge creation; highly-skilled jobs; tax revenues; GDP multiplier; and wider technology spill-over effects.[33,34,35,36,37]

Measuring the full economic impact of public investment in RTI is challenging. However, there is broad agreement in the literature and among government economists that investment in RTI has a sizeable and measurable return on investment and a significantly greater economic impact than capital investment (e.g. on infrastructure) which in turn has a much greater economic impact than consumption spending (e.g. on public services).

A GDP multiplier of a factor of two would be a prudent, cautious estimate of the macroeconomic benefit of Defence RTI investment. This is in line with estimates on the multiplier effect of defence investment (including equipment procurement). Indeed, evaluations of the economic multiplier effect of R&D are much higher. For reference, the EU Framework Research Programme estimates a GDP multiplier of between 6.0 and 8.5 on the initial investment. It is likely that investment in translational innovation (i.e. leveraging off-the-shelf civil technologies into a defence application) would have a lower multiplier effect than applied R&T.

Recent research conducted by UCL on behalf of Innovate UK, suggests that **'mission-oriented' investment in RTI – policies that are deliberately challenge-led and co-ordinated – deliver the greater economic impact** through a super-multiplier effect. This is partly due to breakthrough innovations but also associated with 'crowding in' private sector investment that increases the overall impact of the government RTI spending.[38] They have estimated a GDP multiplier of 7.8 for non-military R&D and 8.8 for military R&D (based on a longitudinal study of data from US defence spending).

32 https://interactivetool.eu/EIS/EIS_2.html#a
33 https://dbei.gov.ie/en/Publications/Economic-and-Enterprise-Impacts-from-Public-Investment-RD-Ireland.html
34 https://sciencebusiness.net/news/80354/R%26D-pays%3A-Economists-suggest-20%25-return-on-public-investment-for-research-and-innovation
35 https://www.iua.ie/wp-content/uploads/2019/09/Indecon-Independent-Assessment-of-the-Economic-and-Social-Impact-of-the-Irish-Universities_full-report-4.4.19-3.pdf
36 https://www.oecd.org/sti/inno/frascati-manual.htm
37 https://dbei.gov.ie/en/Publications/Publication-files/Innovation-2020.pdf
38 https://www.ucl.ac.uk/bartlett/public-purpose/sites/public-purpose/files/macroeconomic_impact_innovateuk_iipp_report_final_web.pdf

2. There are important distinctive benefits that form part of the business case

First, operational benefits for the Defence Organisation through leveraging the benefits of RTI in terms of **increased defence capability**. The report expands on this but specific pathways include:

- Recruitment and retention of talent in the DefOrg through career opportunities in RTI.
- Development of new products and services to directly improve capability
- Provision of test bed opportunities and facilities
- Addition of end-user, practical insight into research activities to improve exploitation

Second, the **national prosperity** and wider social benefits that would accrue from public investment in defence RTI. The experience of the UK Defence and Security Accelerator is that SMEs across the UK (and indeed in Ireland) have benefited from the scheme, with jobs and intellectual property created and sustained in all regions. We envisage the RTI unit:

- Advising and mentoring SMEs and researchers on end-user requirements during R&D phases
- Incentivising multi-national companies with interest in dual-use research to provide Foreign Direct Investment in Ireland and/or locate research activity onshore
- Catalysing the development of dual-use technologies with the potential to access a broad market given the range of commercial exploitation routes for dual-use

Third, **wider return on investment** through an increasing focus on wider defence collaboration with EU partners and with the UK; including on joint development projects. National investment in RTI projects will provide a:

- Mechanism for collaboration and help develop greater influence with international counterparts in the defence capability, research and technology spheres.
- Means to increase Ireland's soft power with international partners through defence collaboration, which is especially important in the post-Brexit environment

Fourth, the need to create a **Defence innovation ecosystem** through 'pump-priming' the dual-use sector to help access future European Defence Fund (EDF) projects. Under the most recent financial framework, the value of the EDF is €7.9 billion over the budget period and supporting the creation of a national defence RTI ecosystem is a key objective of the initiative. Without the defence-led research then national industry will be less able to access the EDF. The unit will:

- Provide unique subject matter expertise for EDF and EDA research activities which complements the organisational competences that EI and DBEI are able to bring
- Generate revenue outside of exchequer through leading EU-funded projects. We can also generate revenue through IP where the HEI dealing with defence specific research may require subject matter/ domain expertise and/or test bed facilities
- Provide project coordination as an end user – an opportunity currently not capitalised upon, thus foregoing millions of euros to the exchequer[39]

39 In the context of EU funded projects End Users like the Defence Forces are often an integral part of the proposal, and for certain calls the End User must lead the proposal/project. If DF cannot lead the project as Consortium Coordinator it could be the case that Ireland Inc (particularly the smaller research entities) loses out on an opportunity to bid for funding and be successful.

3. This implies that the administrative costs of the RTI cell should be no more than the investment in defence RTI

Based on an overall economic multiplier effect of 2.0, this implies a **minimum RTI investment of at least twice the operational costs per year in order to recoup costs to the exchequer.**

If:
a_{pers} = no. of personnel working in the unit

b_{cst} = Total Cost per Full Time Employee = direct costs (e.g. salary and other employment costs) plus indirect costs (e.g. travel and marketing) plus overhead costs (e.g. office) per Full Time Employee

c_{invst} = research investment

If $[a_{pers} \times b_{cst}] = c_{invst}$

Then $[a_{pers} \times b_{cst}] + c_{invst}$ = minimum direct financial benefits to the exchequer

Example:
In Stage 2 of the model developed for the future RTI capability, we estimated a team of up to 15 people. Including direct (e.g. salary and other employment costs), indirect (e.g. travel and marketing) and overhead (e.g. office) costs, the all-up operating costs of the RTI capability would be approximately €1.5 million (assuming an average of €100K per FTE). This is a very rough heuristic but gives an order of magnitude.

Based on an overall economic multiplier effect of 2.0, this implies a minimum RTI investment of €1.5 million per year at Stage 2 in order for the direct financial benefits (€1.5 million x 2.0) to be equal to the direct financial costs (total of €3.0 million). If an economic multiplier of 6.0 were to be used (the lower end of the EU Framework Programme impact assessment), this €1.5 million investment would deliver €9.0 million of benefit.

4. The EDA-27 average defence R&D spend is 0.9% of defence spending

For reference, the EDA collective benchmark for defence R&D spending – and a commitment under PESCO – is 2% of defence spending. However, the current average (mean) of EDA-27 defence spending on R&D is 0.9%. For Ireland (with annual defence spending of around €1 billion), this would be equivalent to an RTI investment of €9 million each year.

Synthesis of relevant literature for the economic business case

The results of a recent evaluation of the impact of R&D funding, based on a quantitative modelling exercise, are summarised in Exhibit 1.

Exhibit 1: GDP multiplier effect of different types of government spending [Source: UCL 2019]

Type of government spending	GDP multiplier	Private sector R&D multiplier
Total government spending (excluding R&D)	0.82	0.05
Consumption	1.12	0.03
Investment (including R&D)	2.12	0.08
Non-military R&D	7.76	0.25
Military R&D	8.82	0.51

Several previous studies have attempted to measure the impact of defence investment on the wider economy in a European context. There are two studies in particular that are often used as a reference when considering the case for defence investment (R&D and equipment procurement). They use a simple input-output model to estimate GDP multiplier.

First, a study carried out by Oxford Economics (2009)[40] investigated the economic impact of increasing defence investment in an economic recession environment. The approach adopted in this study looked at eight measures (GDP multiplier, taxation revenue, number of jobs created or supported, share of high-skilled employment, R&D intensity, export intensity, capacity and capital intensity) and compared the metrics for the defence sector with other sectors.

Second, a study carried out by Europe Economics (2013)[41], which was commissioned by EDA. The latter study looked at the EU as a whole and compared the short to medium macroeconomic impacts of a hypothetical investment of €100m in major areas of government spending (transport, education, health and defence). Note that a companion report was produced by Europe Economics (2014) that highlighted differences between member states and also between sectors.

The results from these two studies are shown in Exhibit 2.

Indicator	€100m defence investment in the EU	£100m defence investment in the UK
GDP multiplier	1.6	2.3
Tax revenues	€42 m	£11.5m
Jobs created	2,870	1,885
Skilled jobs created	78	283[42]
Exports revenue	€16.6 m	NA

Exhibit 2: Main results from the two studies
[Sources: Data from Europe Economics (2013) and Oxford Economics (2009)]

40 https://www.oxfordeconomics.com/my-oxford/projects/128878
41 https://era.gv.at/object/document/3218
42 This value is estimated based on the following data provided by the study: 39% of all defence jobs are high skilled and direct defence jobs created were estimated at 726.

The two studies yield similar results, which are however not exactly the same due to a number of factors. Firstly, the GDP multiplier in the UK is considerably bigger than that found for the EU. This is partially explained by the fact that the estimation done for the UK case was done in the context of economic recession where multipliers are usually higher than during normal economic times.

As for the tax revenues generated, the multiplier for the EU is markedly larger than in the UK, which can be explained by the fact that some EU countries have high tax rates. On the other hand, Europe Economics (2013) also estimated the tax multiplier for the UK alone and found it to be equal to 0.34, which is roughly twice as high as the Oxford Economics estimate.

There are also some differences in job creation capacity where an investment in defence in the EU as a whole would generate roughly 1,000 more jobs than if an investment of similar size was done in the UK. The rationale behind this difference stem most likely from the fact that some EU countries (e.g. Poland, Romania) have relatively low productivity levels and therefore disproportionately high number of jobs would be created in such countries. Interestingly, for the UK, the Europe Economics (2013) study found that the employment multiplier was equal to 18.9, which is almost identical to the Oxford Economics estimates of 18.8.

Looking ahead, it is important to understand the implications of the convergence of defence and civilian technologies. It is likely that in the future R&D environment, defence R&D will largely be a minority actor, while the driving forces for innovation will be increasingly found in the commercial sector.[43]

European defence R&T has shifted towards incremental innovation, foregoing riskier technology leaps and slowing down in comparison with competitors, such as US or China. In addition, major disruptive innovations will continue to spin into the military domain from the civilian sector, in particular in areas such as Artificial Intelligence (AI), robotics, small drones, augmented reality, 3D printing, cybersecurity, energy technologies. There is also an increased focus on the role of SMEs with a number of European countries now having active and dedicated policies to engage them in the defence innovation ecosystem.[44]

43 https://www.rand.org/pubs/research_reports/RR478.html
44 Key Trends Affecting the EDTIB, EDA Study 2018 (RESTRICTED)]

Annex 6: Defence Organisation Innovation Case Studies

1.Ordnance Disposal 'Reacher' Robot

RTI category: High TRL Innovation

What: Improved existing EOD capability. The 'Reacher' robot was co-developed for military use in Ireland.

How: By collaborating with the company, Reamda, founded in 2002. From 2004, 95% of research was for Irish Defence Forces. Products evolved to Military Simulation and Control systems for ROV's. All IP (Mechanical, Electronic, Software) developed in house.

Funding: Defence Forces

Lessons:

1. Company benefitted from end user knowledge and expertise by working closely with DF (but DF did not seek any IPR). The robot is now available globally in both military/non-military areas (mining and hazard mitigation). Irish enterprise success story.
2. Enabling companies to collaborate closely with DF end-users can create better solutions for Ireland, as well as for export.
3. Defining end user requirements is difficult and research management is a key skill in order to manage expectations (and budgets) in research and innovation collaborations

2.'Rocsafe' CBRN Situational Awareness Project

RTI Category: Research for Knowledge

What: Remotely operated solutions for CBRN scene assessment and forensic evaluation

How: Research for Doctrine development in collaboration with NUIG

Funding: European Horizon 2020

Lessons:

1. Interest is generally in large budget projects. There is a risk that without a strategic, capability driven research plan other challenges will be missed or ignored.
2. Horizon 2020 acted as a catalyst for DefOrg involvement (reactive). More proactive engagement as well as more opportunities as consortium partners is required.

3. Irish satellite/signals capabilities used by partner nations

RTI category: Innovation for Interoperability

What: On overseas deployments, partner nations have been reliant on unique and useful Irish signals capabilities/satellite operations.

How: These capabilities were created because of the unique experience of DF operations in Ireland and DF overseas deployments. DF often brings unique capability (expertise) to the table when partnership is needed overseas.

Funding: Defence Forces

Lessons:

1. Challenges are drivers for innovation in the search for solutions to problems. Military personnel do not necessarily see their solutions as 'innovation', but a practical, urgent solution to a pressing problem. This may need to be better communicated across the organisation

4. CBRN Decontamination (AB) wipes

RTI category: Applied research for chemical and biological threat mitigation

What: Removes pathogen burden (SARS, Ebola, Flu, Anthrax, tularemia, ricin, botulinum toxin) from surfaces including skin, delicate tissue and open wounds, to protect people and minimise the impact of pathogen exposure. Non-toxic solution. Used during Covid-9 response by front line agencies.

How: Research for capability development in collaboration with NUIG that began in 2015. A spin out company, Aquila Bioscience has since been created with potential for Irish Exchequer benefits.

Funding: EU: EDA Joint Investment Programme (JIP-CBRN Programme)

Lessons:

1. Many lessons were learned during covid-19 about the exploitation and commercialisation phase of research. The product was at TRL-6 when C-19 struck. The company was not receiving financial support to bring the product to commercialisation (This is known as the 'valley of death' phase of research.)
2. Defence forces were the first customers. Since then HSE, An Post and other agencies have procured.
3. Difficulty finding manufacturing plants at short notice despite the crisis situation
4. Since February 2020 the company has received over E2m in research grants to bring it through commercialisation and to conduct further research.

5. Kite technology/sensors

RTI Category: Research for Capability Development

What: Kite technology to power naval vessels and kite sensors for surveillance. Project started as kite technology tow ships and reduce energy usage. Developed into kite carrying sensors to lift radar signature and enhancing maritime surveillance.

How: Project collaboration with IMERC, SEAI, CIT NIMBUS, NS and a German SME called 'skysails'.

Funding: SEAI and other external funding

Lessons

1. Kite was not suited to the navy ships however, NIMBUS still developing the lightweight tech embedded in the kites as a spin-offs/ spin-outs and the company is selling the products.
2. Project took place before the DF IP policy. RTI cell could help with IP issues to ensure DF gets benefits but only if appropriate.
3. Research can often start with one objective but not meeting that objective does not mean 'failure'. Unplanned benefits/ outcomes.

6. Diversity and inclusion strategy and equality policies

RTI Category: Research for Policy Making

What: Diversity and Inclusion Strategy and Equality Policies for the Irish Defence Forces. The Defence Organisation recognises that the Defence Forces must be representative of the changing society it serves at home and abroad. It will also ensure that the 'soldier of the future' who will be required to have different skill and diversity of thought in an agile and high tech environment are attracted to the organisation.

How: Internally catalysed and funded using skill sets of key personnel.

Lessons:

1. This strategy is showcased in Our Public Service 2020 as an example of good practice in line with the new public service innovation strategy.
2. It demonstrates the utility of research for policy making

7.Energy Management Metering & Modelling project

RTI Category: Longitudinal Research for Technical Solutions

What: Involves data collection at multiple locations and at multiple points in time to assess trends, create prediction models and identify causal relationships between variables.

How: The DF is accredited to International Energy Management Standard ISO 50001and is seen as a Public Sector exemplar body for energy & waste management. This requires robust data collection & analysis. Research activity in this area using metering hardware and software began in 2013. This has culminated in a strong knowledge base and a collaboration with the OPW using the state-of-the-art technology.

Lessons:

1. Time consuming and expensive when using proprietary solutions and adapting them to DF needs.
2. Internal organisation mechanisms (security risks) need to be addressed
3. It demonstrates the utility of long term longitudinal research for long term data needs.