European Defence Agency

Study

"**Study on How to measure Strengths and Weaknesses of the DTIB in Europe"**

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Conducted by

University of Manchester (Manchester Institute of Innovation Research)
in association with
The Centre for Defence Economics/ University of York;

CNRS/ GREDEG (FR); and
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ABSTRACT

In January 2008, the European Defence Agency (Industry & Market) asked a consortium led by the Manchester Institute of Innovation Research (MIoIR) to conduct a study on how to measure the strengths and weaknesses of the DTIB in Europe.

This report proposes a methodology to identify and measure the strengths and weaknesses of the DTIB in Europe. The methodology takes account of the EDA Steering Board's statement on the characteristics of a strong future European DTIB and is designed to provide a systematic approach that would be common to all studies of the DTIB in Europe undertaken by EDA (Industry & Market).

The aim of this systematic framework is to facilitate structured dialogue between stakeholders to identify the strengths and weaknesses of the DTIB at the European level and the opportunities for collective action to strengthen Europe's strengths and address our weaknesses. The methodology is designed to be scalable and we provide three options for the EDA depending on the objectives of the studies that it chooses to undertake, the desired scale and scope of those studies and the resources that are available.

The methodology uses a five-step approach. At each step, we pose a series of questions that EDA may wish to consider. For each question, we identify the information that would need to be collected and the tools and techniques that could be used to collect that information. We use the EDA Steering Board's statement as our starting point.

- Step 1: Define the focus of the study. The first step of any study of the strengths and weaknesses of the DTIB in Europe should be to engage with stakeholders from the pMS, industry and the European Commission to define the precise focus of the study, its terms of reference and its link to policy objectives.

- Step 2: Characterise the sector. This characterization stage should aim to establish a general understanding of the sector including key companies including the supply chain, demand and supply in the sector as well as factors driving change in the operating environment for the sector.

- Step 3: Identify required future key DTIB capabilities**.** The third step of the study should be to identify the key DTIB capabilities that are necessary to support future military requirements through life.

- Step 4: Identify the strengths and weaknesses of the identified key EDTIB capabilities. The fourth step that we recommend is to identify the strengths and weaknesses of the key EDTIB capabilities that were identified in Step 3. We propose a series of performance measures to judge the strengths and weaknesses

of the DTIB in Europe against the criteria set out in the EDA Steering Board statement on a strong future EDTIB. We propose tools and techniques to collect the necessary information to assess whether the DTIB is able to meet pMS and EU capability needs; whether it has the necessary competencies; and whether it is competitive.

- Step 5: Identify and evaluate alternative actions. The final step of our proposed methodology would be to identify and evaluate alternative actions to address the issues identified by the DTIB study.

In support of this study, EDA asked us to analyse the tools and methods used to assess existing DTIB (defence technological and industrial base) capabilities. We report the findings of an email survey of pMS practice; case studies of practice based on interviews with officials in five selected countries (France, the Netherlands, Sweden, the United Kingdom and the United States); and, we review the state of the art in industrial and technological analysis.

EDA also asked us to consider how the DTIB may change in the future and with it the definition of a strong DTIB. We consider how the DTIB may change by 2025 and we propose some indicators that might be used as signals that such changes are occurring. We identify some of the key trends that may drive incremental changes in the DTIB and we also identify some "wild cards" that could have more dramatic and discontinuous impacts on the DTIB in Europe.

Finally, we consider next steps and implementation issues.

Executive Summary

INTRODUCTION

1. In January 2008, the European Defence Agency (Industry & Market) asked a consortium led by the Manchester Institute of Innovation Research (MIoIR) to conduct a study on how to measure the strengths and weaknesses of the DTIB in Europe.

2. EDA asked us to analyse the tools and methods used to assess existing DTIB (defence technological and industrial base) capabilities and to do so we conducted an email survey of pMS practice; interviews with officials in five selected countries to generate case studies of practice (France, the Netherlands, Sweden, the United Kingdom and the United States); and, we reviewed the state of the art in industrial and technological analysis. EDA also asked us to design a methodology to identify and measure the strengths and weaknesses of the DTIB in Europe and continuously review its status and to complete this task we reviewed the tools and techniques used by pMS; developed a draft methodology; and, presented the draft methodology to an Expert Group Meeting comprised of pMS and independent experts and representatives of ASD. EDA also asked us to examine and assess how and why the DTIB may change in the future and we addressed this task by collating and analyzing public domain reports; interviewing selected experts; and, conducting a Futures Workshop with experts from industry, think tanks and universities. Finally, we considered the implementation issues that EDA would need to take into account if it wished to undertake a study of the DTIB in Europe using our proposed methodology

AN ANALYSIS OF TOOLS AND METHODS TO ASSESS EXISTING DTIB CAPABILITIES

3. We found that stakeholders have different perspectives on what constitutes a strong DTIB. In general terms, the pMS define a strong DTIB as one that is internationally competitive and capable of delivering the equipment and services necessary to meet desired military requirements with the appropriate level of operational sovereignty. Some pMS gave particular weight to the role of the DTIB as a valuable economic and technological asset in its own right and placed a particular emphasis on international competitiveness as a measure of DTIB strength. In general, industry is driven by the business imperative to achieve acceptable return on its investment and sustain and grow market share through the design, development and delivery of internationally competitive products and services. Successful DTIB assessments recognized these different perspectives and recognized the importance of the business driver as an important element in sustaining a strong DTIB.

4. We found pMS studies of their DTIBs tend to be conducted on an ad hoc basis in response to specific policy questions and that these ad hoc studies attempted to draw

together teams of experts with the specific skills required for the needs of the particular study. Separate to these individual studies, a number of pMS retained dedicated staff, typically in their procurement organisations, who were engaged in the permanent monitoring of the DTIB as part of programme management and supplier relationship management and who also provided an industry watch function to policy makers.

5. We found that DTIB studies tend to focus on the assessment of industrial sectors or sub-sectors rather than the whole DTIB and studies of national DTIBs tend to be built bottom-up from these sector studies. A sector is a group of firms producing the same principal product or service and the focus on individual sectors rather the whole of the DTIB reflects the fact that the military requirements, industrial, technological and market characteristics of individual sectors have distinctive features. Conducting a top-down study of the whole DTIB was felt by the pMS to mask these major differences between sectors and was therefore regarded as unhelpful for policy development.

6. We found that the objectives of pMS DTIB studies vary: *programme studies* focus on identifying gaps between DTIB capabilities and programme requirements; *change studies* assess the DTIB as a mechanism for driving changes in industry structure and behaviours; *sustainment studies* identify critical and/or endangered DTIB capabilities; and, *critical technologies studies* identify new technology needs and priorities for R&T funding.

7. *A variety of tools and techniques* are used by pMS to analyse the DTIB. These range from relatively simple tools such as SWOT analysis to sophisticated economic and financial modeling. Most of the methodologies use some form of gap analysis. *DTIB studies collect a variety of information* including information on: the demand for DTIB products and services; DTIB capabilities and competencies; supplier contract performance; financial and economic performance; and, the structure of the DTIB. This information is based on a mix of hard data; expert analysis; and stakeholder opinion. *The information is collected in a variety of ways*, including: collation and analysis of existing data; meetings with stakeholders; meetings of panels of experts; surveys of industry; and, the creation of databases. A close relationship with industry associations and individual companies was found to be critical to the information gathering process.

8. We found that pMS faced major problems in getting good financial and economic data at the sector level. We found that the *official national statistics* published by pMS often do not identify specific defence industries. Official industrial classifications typically identify various defence-dependent industries, namely, aerospace and shipbuilding; but these often report aggregate data which comprises both civil and military sales. *National industry associations* often publish their own statistical information based on surveys of their members. These can provide useful overviews and typically distinguish defence from other activities (for instance, civilian aerospace) but again pMS found that they rarely disaggregated this data on

the defence industry to a level that was useful for sectoral or sub-sectoral studies. *Commercial market research reports and databases* were also used as a source of information. Commercial market research reports are often written on specific sectors and defence industry and market databases can be interrogated to identify information on specific sectors and companies. The limitations of these publicly available sources of information meant that pMS studies at the sectoral level often depended on *specially collected information on the sector*. This information was collected by surveys of industry or meetings of sector experts and frequently relied on the willingness of individual companies to provide what the companies often regarded as commercially sensitive information. Industry associations were often engaged by the pMS to undertake such information collection exercises.

9. We found that DTIB studies were a major undertaking for pMS. The studies conducted by pMS were often time and resource intensive for the pMS and for industry. Typically, studies took at least nine months and often considerably longer. They required significant resources in terms of the time of those managing the studies; the time of internal stakeholders and experts; and, the time of industry associations and individual companies. The studies were typically supported by relatively large study budgets and often required support from external contractors.

10. Successful DTIB studies were characterised by high levels of communication with stakeholders on the objectives of the study and the link between the study and wider policy development. Working closely with pMS budget holders was identified as critically important by those who had undertaken such studies since the policy recommendations emerging out of those studies are likely to have important implications for funding priorities. Working closely with industry was also seen by pMS as vital since the implementation of many study recommendations depends on some form of strategic and behavioural change on the part of industry and thus recommendations need to be feasible in the industry context.

11. Our assessment of pMS practice and the practical challenges of information collection at the European level lead us to recommend that EDA should not seek to sponsor studies of equivalent detail and complexity to those undertaken by individual governments. There is a need to recognize that an attempt to undertake a fine-grained and highly quantitative analysis of the DTIB in Europe at the sectoral level would be an ambitious data collection exercise that would be technically difficult; costly; and unlikely to get sufficient cooperation from either the pMS or industry.

12. The objective of any EDA-facilitated study of the DTIB in Europe should be to promote a dialogue between stakeholders on the opportunities for collective action at the European level. This requires a systematic framework for analyzing the strengths and weaknesses of the DTIB in Europe that promotes collective understanding of the issues facing a particular sector.

THE PROPOSED METHODOLOGY FOR ASSESSING THE STRENGTHS AND WEAKNESSES OF THE DTIB IN EUROPE

13. The analysis of the DTIB at the European level is a new and ambitious project. To the best of our knowledge such an effort has not been previously undertaken and it represents uncharted territory both methodologically and for stakeholders. Accordingly, our proposed methodology should be regarded as a food-for-thought exercise that aims to identify some possible questions that the EDA and its stakeholders may wish to address and some tools and techniques that might be suitable for the collection of the information required to address those questions.

14. The focus of the methodology is on how to identify and measure the strengths and weaknesses of the DTIB in Europe. The methodology that we propose takes account of the EDA Steering Board's statement on the characteristics of a strong future European DTIB and is designed to provide a systematic approach that would be common to all studies of the DTIB in Europe undertaken by the EDA. The aim of this systematic framework is to facilitate structured dialogue between stakeholders to identify the strengths and weaknesses of the DTIB at the European level and the opportunities for collective action to strengthen Europe's strengths and address our weaknesses.

15. We recommend that the studies focus on sectors or sub-sectors rather than attempt to assess the strengths and weaknesses of the whole DTIB in Europe. Sectors have very different industrial, technological and market characteristics and different military requirements. A study of the whole DTIB in Europe would be too general to be useful for policy makers unless that study was built up from individual sector studies.

16. An important consideration in the design of the methodology has been the practical challenges of information collection at the European level. This methodology starts by recognising that the limitations of the hard quantitative data that is publicly available at the European level means that any DTIB study at the European level will most likely have to rely heavily on expert analysts with deep knowledge of the sector and the willingness of industry and pMS stakeholders to share information.

17. The methodology is designed to be scalable and we provide three options for the EDA depending on the objectives of the studies that it chooses to undertake, the desired scale and scope of those studies and the resources that are available. Our methodology could be used to structure *short studies* of three months duration (or less) based on a series of meetings between sectoral experts and supported by some internal EDA staff work to collate basic and readily available information on the sector. Our methodology could be used for *comprehensive studies* of nine months (or longer) that would allow for more detailed information gathering and analysis. These comprehensive studies might have a core team of seconded experts working full-time for their duration. Our methodology could also be used to conduct *issue-specific studies* that focus on a single issue of particular policy concern and for these studies

the methodology could help to inform the questions that would need to be addressed and the tools and techniques that could be used.

18. *A five-step approach* is recommended. We believe that the five-steps that we identify represent important generic stages that ought to be considered in any study irrespective of its scale although short studies would of course have to consider each stage in less depth and with less original information collection. At each step, we pose a series of questions that EDA may wish to consider although as we have already emphasised it is not our intention that all the questions need to be addressed for all studies. For each question, we identify the information that would need to be collected and the tools and techniques that could be used to collect that information. We use the EDA Steering Board's statement as our starting point.

19. Step 1: Define the focus of the study. The first step of any study of the strengths and weaknesses of the DTIB in Europe should be to engage with stakeholders from the pMS, industry and the European Commission to define the precise focus of the study, its terms of reference and its link to policy objectives and in particular to address three questions. (1) *What are the aims of the study?* A clear definition of study aims is critical since those aims will determine the specific questions that will need to be selected from those presented in the methodology and the tools and techniques that are appropriate for information collection. (2) *Should the study assess a sector or a sub-sector?* In the case of large and complex sectors, a preliminary scoping study should be undertaken by EDA staff and in consultation with ASD and pMS experts to understand the characteristics of the sector. Where a sector is comprised of distinct sub-sectors and those sub-sectors have very different industrial and technological characteristics, there may be a case for considering whether an assessment of one sub-sector may be more appropriate. (3) *Will the study include an assessment of the supply chain?* A thorough analysis of a sector would include an analysis of the supply chain. However, this could be a complex and time consuming process and few pMS have developed effective tools and techniques to assess supply chains. One approach may be to work with stakeholders to focus the supply chain element of the study on areas of particular stakeholder concern.

20. Step 2: Characterise the sector. This characterization stage should aim to establish a general understanding of the sector and the questions may include (1) *Defining the sector: who are the suppliers of products and services in the sector?* We might wish to begin by identifying prime contractors, sub-systems suppliers and suppliers of components and materials. This may include the geographical location of those companies. (2) *What is the demand for the sector's products and services?* We might wish to assess current and anticipated future demand from pMS and the rest of the world from new programmes and also upgrades and service support. (3) *What is the structure of the sector?* This would require an assessment of features such as ownership; industry concentration; and, the nature of the supply chain. (4) *What factors are driving changes in the operating environment for the sector?* A wide range of factors are likely to drive change and performance in the sector, including political, economic, technological and regulatory issues and, ideally, these need to be

considered to understand the dynamics of the sector. (5) *What are competitive conditions in the sector?* An assessment of the strengths and weaknesses of the DTIB in Europe is likely to wish to assess competitive conditions in the sector since these influence the strategies and investment decisions of firms operating in that sector. The information required for the characterisation stage could be collected through desk research supported by meetings of expert groups. Many of these features are likely to be well known to sector experts in the pMS, industry and elsewhere. Other useful sources of information may include commercial market research reports and databases; investment bank reports; information from the pMS, industry associations and other work being undertaken by EDA.

21. Step 3: Identify required future key DTIB capabilities**.** The third step of the study should be to identify the key DTIB capabilities that are necessary to support future military requirements. We propose a whole-life cycle approach that defines DTIB capabilities as the technologies, skills, knowledge, facilities and equipment and processes needed to design, develop, produce, repair, maintain or dispose of equipment used by the military. The questions we recommend a study addresses here are: (1) *What is an appropriate taxonomy of EDTIB capabilities for the sector?* The first stage should be to develop a taxonomy of industrial and technological capabilities for the sector. The WEAG Technology Taxonomy could be used as a starting point for this exercise. (2) *What is the desired level of national and European operational sovereignty in the capabilities?* The study would also need to establish the desired level of European and national operational sovereignty in the industrial and technological capabilities supplied by the sector. (3) *What capabilities are needed to sustain a viable EDTIB in the sector?* There is a complementary and interlinked question that needs to be considered from the perspective of industry and that is what capabilities are needed to sustain a commercially viable DTIB in Europe. This is important because if the DTIB in Europe is not commercially viable it is unlikely to be able to sustain the desired level of European and national operational sovereignty in the longer term. An Expert Group could be convened to develop the EDTIB capabilities taxonomy. The information that is required to assess the desired level of operational sovereignty will need to be undertaken in cooperation with pMS and can draw on existing initiatives by EDA Industry & Market. Assessment of commercial viability will need to be undertaken in cooperation with industry.

22. Step 4: Identify the strengths and weaknesses of the identified key EDTIB capabilities. The fourth step that we recommend is to identify the strengths and weaknesses of the key EDTIB capabilities that were identified in Step 3. Starting from the EDA Steering Board statement on a strong future EDTIB, an assessment of the strengths and weaknesses of the EDTIB raises three main questions: (1) Is the sector able to meet pMS and EU capability needs? (2) Does the sector have the necessary competencies? (3) Is the sector competitive?

23. Step 4.1: Is the sector able to meet pMS and EU capability needs? To address this question, we recommend that EDA adopt a gap analysis approach that considers the following questions: (1) *What are the key EDTIB capabilities needed to deliver future*

pMS and EU military requirements? The starting point for the assessment is an understanding of the key capabilities needed to deliver future pMS and EU military requirements. This provides a statement of where we want to be in the future. (2) *Will the EDTIB be able to sustain and develop the necessary capabilities to meet these pMS and EU military requirements?* The next step is to consider the likely future EDTIB capabilities that will exist in the sector. (3) *What are the implications of identified strengths and gaps between EDTIB capabilities and future pMS and EU military requirements?* The final stage of the process would be to compare the key EDTIB capabilities that are needed to deliver future military requirements with the likely future shape of EDTIB capabilities to identify anticipated future strengths, gaps and excess capacity. The information to address these questions will require the expert judgment of sector specialists from the pMS, ASD and individual companies and would benefit from the input of the military at both pMS and EU level. This is a potentially large exercise in its own right and EDA will wish to consider in consultation with stakeholders the scale of this element of the study and careful consideration will need to be given to the resource implications of such a study.

24. Step 4.2: What are the competencies of the sector? To address this question, we recommended that EDA use a variety of information collection methods including: desk-based collation and analysis of publicly available information, including commercial data bases and market research reports; and meetings with sector experts from the pMS, industry and elsewhere, to consider the following questions: (1) *What are the strengths and weaknesses of the EDTIB's technology portfolio?* This requires an identification of the key, pacing and emerging technologies in the sector and an assessment of their strengths and weaknesses relative to potential military adversaries and/or other competing DTIBs. (2) *Does the EDTIB develop and sustain key, pacing and emerging technologies?* The next step could be to assess the strengths and weaknesses of those factors that contribute to sustaining and developing the technology base: European R&T programmes, the supplier base; and the skills base (3) *Does the EDTIB promote innovation from non-defence sources?* We would wish to understand whether new and innovative suppliers enter the marketplace; whether companies exhibit strong networking with the university sector and other non-defence sources of knowledge; the level of engagement of the sector in the European Commission's Framework Programme; and, whether companies compete in non-defence markets. (4) *Does the EDTIB field new technologies quickly?* In large part, time-to-fielding is linked to pMS acquisition policies but it may be legitimate to ask experts whether there are factors that could be addressed at the European level to accelerate the fielding of new technologies.

25. Step 4.3: What is the competitiveness of the sector? To address questions on the competitiveness of the sector, we again recommended that EDA uses a variety of information collection methods including: desk-based collation and analysis of publicly available information, including commercial data bases and market research reports; meetings with sector experts from the pMS, industry and elsewhere. An assessment of sector competitiveness raises a number of inter-related questions: (1) *What is the international competitiveness of the sector?* A key indicator of the

competitiveness of a sector is the balance of trade in the sector; its performance in head-to-head competitions with others in export markets and in European markets. (2) *Are companies economically viable?* A strong sector is likely to be economically viable in terms of stable or expanding markets; fair return on investment; and, relative share price. (3) *Are companies investing in the future?* Company investment in terms of capital and R&D expenditure and M&A is a measure of the health of a sector. Equally, any indicators of major shifts of investment away from Europe to the rest of the world could be a signal of weakness. (4) *Are suppliers able to effectively manage requirements peaks and troughs to maintain specialist skills?* We would expect a strong and competitive sector to be capable of effectively managing peaks and troughs in demand in a way that maintains specialist skills. (5) *Do suppliers attract cooperation with non-European partners?* We might expect a strong sector to be able to enter into balanced partnerships with non-European companies both to meet European requirements and access non-European markets. (6) *What is the contribution of the sector to overall economic growth?* A comprehensive study of the economic impact of the sector would be a complex undertaking and would require a detailed study in its own right. We recommend a more modest alternative approach that would seek to collate available information on the economic impact of the sector.

26. Step 5: Identify and evaluate alternative actions. The final step of our proposed methodology would be to identify and evaluate alternative actions to address the issues identified by the DTIB study. The study team was not asked to address this matter but we make some observations on how best to manage the process of turning the analysis contained in the study into change at the European level. We were told by several of those pMS who had undertaken DTIB studies that in their experience there is a danger that defence industrial analyses can turn into "wish lists" in which every technology becomes "critical" and every industrial capability is "key". Thus, we emphasise that any study of the DTIB in Europe should focus on the prioritization of a few key policy recommendations if study findings are to be transferred into actionable outcomes for public policy and industry.

27. We also consider how EDA could monitor the DTIB in Europe on an on-going basis. We note that there are a number of actions that Industry & Market could easily undertake to begin monitoring of the DTIB in Europe, these include: subscribing to a commercial monitoring service on defence industry and market issues; subscribing to email newswire services to receive alerts on key industry news; structured and conscious networking with industry, pMS sector specialists and other experts; and, organizing regular EDA sponsored workshops to develop a detailed overview of emerging industry topics. A complementary approach would be to develop an industry trend monitoring network to describe and analyse trends in the European DTIB drawing on a network of pMS industry experts, ASD, national industry associations and others.

HOW THE DTIB MAY CHANGE IN THE FUTURE

28. EDA also asked us to consider how the DTIB may change in the future and with it the definition of a strong DTIB. We consider how the DTIB may change by 2025 and we propose some indicators that might be used as signals that such changes are occurring. We identify some of the key trends that may drive incremental changes in the DTIB and we also identify some "wild cards" that could have more dramatic and discontinuous impacts on the DTIB in Europe.

29. By 2025, pMS and EU capability requirements are likely to have changed. The DTIB will be expected to deliver capabilities that enhance command, information, engagement, protection, deployment and sustainment. At the same time, outsourcing and services are likely to represent an increasing share of defence procurement budgets and technology insertion and upgrading existing platforms is likely to be the core business of the defence industry in many sectors. This is likely to mean that, in the future, a strong DTIB will be measured on its ability to support and upgrade platforms and rapidly insert new technologies as part of an evolutionary acquisition process as well as its ability to design and develop new equipment. A strong DTIB will also be measured by its ability to deliver services as part of the outsourcing and through-life management approaches of its customers.

30. By 2025, the role of defence R&D in delivering cutting-edge technology is likely to have changed with a shift towards an open innovation model for defence technology development, a blurring of defence, security and non-defence technology development and a change in the structure of the defence supply chain. These changes are likely to occur against a background of customer pressure to accelerate the fielding of new technologies. This means that, in the future, a strong DTIB is likely to be measured on its ability to build open innovation models and its capacity to create strong and sustainable networks of partnerships with suppliers of technological and industrial capabilities. Those suppliers are likely to come from non-traditional sectors as well as the traditional DTIB and will be geographically distributed across Europe (and the rest of the world). At the same time, the innovativeness of the DTIB may need to be measured not only on its capacity to generate new and disruptive technologies but its ability to generate new and innovative packages of outsourcing and services, new business models and innovative private financing mechanisms to meet customer requirements.

31. By 2025, the DTIB is likely to be increasingly globalised and European companies are likely to face more competition in their home markets. Multi-domestic European companies will seek to create centres of excellence and the pace at which they develop will be influenced by European initiatives and the political will of individual Member States. Whilst these centres of excellence are likely to be in the large defence industrial countries they may well be complemented by the development and

sustainment of niche capabilities and the growing engagement of suppliers from the small and medium sized pMS in the supply chains of prime contractors.

32. We identify three "wild-cards" that go beyond these trend changes and could have a more dramatic and discontinuous impact on the future of the DTIB in Europe. The first is a major change in perceptions of the international security environment such that European citizens see a direct threat to their way of life that is sufficiently severe and unambiguous that they are willing to devote more resources of defence. The second is a change of attitude towards expeditionary operations such that European governments shifted their strategies to focus primarily on the security of the European homeland. The third is an emergence of a true transatlantic defence market. In each case, we consider the implications for the DTIB in Europe.

NEXT STEPS

33. Positive and active stakeholder engagement will be critical to the success of any initiative to assess the strengths and weaknesses of the DTIB in Europe. We recommend early and detailed discussions with pMS, ASD and other stakeholders such as the European Commission to agree the objectives for the first study, its terms of reference and its link to the policy objective of maintaining a strong EDTIB as a fundamental underpinning of the European Security and Defence Policy. Positive stakeholder engagement will also require a study approach that minimizes the burden on stakeholders since stakeholders are most likely to engage in the process if it is not overly burdensome in terms of the time required and also in terms of the amount and type of data that is requested of stakeholders. Stakeholder engagement is also most likely if the EDA-facilitated process is regarded by stakeholders as authoritative and authority is a function of the credibility of the people engaged in the study process and the quality of the studies that are conducted.

34. We also recommend that EDA establish a Steering Board to manage the study process. The aim of the Steering Board should be to guide the study, determine its terms of reference and oversee the conduct of the study. The Steering Board should be comprised of interested stakeholders from pMS, industry and the European Commission. Ideally, the members of the Steering Board should be experts in DTIB analysis and have direct experience of managing or participating in such studies. In this way, the Steering Board could act as a means of transferring learning from pMS studies to the European level and ensure that the study is feasible.

35. We recommend that EDA, in consultation with stakeholders, come to an early decision on the appropriate scale and scope of the proposed study. DTIB studies can be resource intensive and there needs to be an early decision on the budget that will be allocated to the study and also the time commitment of EDA staff, pMS and industry. This will determine the study approach.

36. The successful conduct of a study will depend on access to appropriately skilled staff with the necessary expertise. EDA (Industry & Market) does not at the moment have the necessary time, skills and expertise to conduct a large and authoritative study on its own and there are several options for the staffing of such a study. A *short-study* of the kind that we described earlier would likely require a full-time project manager to coordinate the study and provide necessary staff support to the experts engaged in that study. This could be staffed from within EDA. The demands of a large *comprehensive study* could be met by a core team of seconded experts working full-time for the duration of the study. Secondees would need to have experience of managing or participating in such studies in their home countries. The team could be supported by Industry & Market in a project management role. External contractors may have a part to play in such a study although the relatively small-scale contracts that are typically let by Industry & Market are likely to be insufficient to deliver the authoritative study required by EDA. Instead, EDA may wish to use contractors to deliver specific elements of the study or use individual contractors to provide policy consultancy support.

37. We recommend that EDA conduct a small-scale pilot study to develop, test and refine the methodology before engaging in large scale studies. A DTIB study at the European level represents new territory both methodologically and for stakeholders. Thus, it is important that the methodology is tested to ensure that it is robust and to ensure that any challenges are identified and rectified before engaging in a larger and more complex study. A small-scale pilot study may also help to build confidence and trust in the process amongst industry since it any DTIB study will require companies to work together who may regard themselves as competitors. A small-scale pilot study may also help to help confidence and trust in the process amongst the pMS. The subject of the small-scale pilot study should be agreed in consultation with the pMS, industry and other stakeholders. A suitable focus of such a study would be a discrete, self-contained and relatively small sector or sub-sector. For instance, EDA may wish to consider revisiting its previous study on energetic materials and/or expanding that study to include ammunition. Alternatively, it may wish to consider a sub-sector of Future Air Systems.

38. EDA should begin the process of on-going monitoring of the DTIB in Europe by subscribing to a commercial monitoring service on defence industry and market issues; subscribing to email newswire services to receive alerts on key industry news; structured and conscious networking with industry, pMS sector specialists and other experts; and, organizing regular EDA sponsored workshops to develop a detailed overview of emerging industry topics. EDA should give serious consideration as to whether a member of staff should be allocated to such an activity on a full-time basis. In addition, EDA should convene a group comprising EDA, industry and pMS to consider the establishment of a permanent monitoring network to describe and analyse trends in the European DTIB drawing on a network of pMS industry experts, ASD, national industry associations and others.

CONTENTS

1. INTRODUCTION

In January 2008, the European Defence Agency (Industry & Market) asked a consortium led by the Manchester Institute of Innovation Research (MIoIR) at Manchester Business School to conduct a study on How to Measure the Strengths and Weaknesses of the DTIB in Europe. This document represents the final report of that study. The consortium comprised Manchester Institute of Innovation Research, UK, the Centre for Defence Economics, University of York, UK and CNRS-GREDEG, France with a sub-contractor Giovanni Gasparini of the Istituto Affari Internazionali, Italy.

1.1. Context

The maintenance of a strong European defence technological and industrial base (EDTIB) has been identified as a fundamental underpinning of the European Security and Defence Policy (ESDP). It is the EDTIB which supplies the bulk of the equipment and systems that are required by the armed forces of the Member States and which guarantees that Member States can operate with appropriate independence. The DTIB is also a valuable economic asset. However, there is agreement that a fully adequate DTIB is no longer sustainable on a strictly national basis and that Europe must press on with developing a truly European DTIB as something that is "more than the sum of the parts".

EDA functions, within the overall mission set out in the Joint Action, include creating a competitive European Defence Equipment Market and strengthening the European Defence, Technological and Industrial Base. The EDA Steering Board statement on *"Characteristics of a Strong Future European DTIB"* agreed in September 2006 and the "*Strategy for the European Defence Technological and Industrial Base"* agreed in May 2007 define the key characteristics of such an EDTIB; namely that it should be capability-driven, competent and competitive. The capability driven EDTIB should be responsive to pMS and EU defence needs and thus be capable of delivering and sustaining key military capabilities; providing complex system of systems solutions; sustaining and upgrading platforms over the long-term, and sustaining the necessary levels of European and national operational sovereignty. The competent EDTIB should be capable of delivering cutting-edge technology on time by promoting innovation also from other sources including academia; developing and sustaining key technologies (with a particular focus on disruptive technologies) and accelerating the fielding of new technologies. Finally, in business terms, the EDTIB needs to be competitive providing cost efficiency; enabling global exports; attracting cooperation with non-European partners and contributing to overall economic growth, not least amongst SMEs.

The "*Strategy for the European Defence Technological and Industrial Base"* agreed in May 2007 recognises that there is a need to determine "…which key industrial capabilities must be preserved or developed in Europe".

1.2. Questions set by the EDA

EDA asked the study team to consider four main questions as follows:

- What constitutes a strength and a weakness of a DTIB?
- What are the instruments to measure them?
- What information is needed for this exercise?
- How could/should that information be collected?

EDA asked the study team to address these questions in three work packages as follows:

- WP1: An analysis of tools and methods to assess existing DTIB capabilities.
- WP2: A methodology of how to identify and measure strengths and weaknesses of a DTIB and continuously review its status (or propose review mechanisms).
- WP3: An examination and assessment on how and why DTIB capability requirements may change in the future (and with this the criteria for what constitute strengths and weaknesses).

In addition, EDA accepted a proposal from the study team that a fourth work package should be added:

- WP+: This work package considered the implementation issues that EDA would need to take into consideration if it chose to proceed with analytical studies (and continuous monitoring) of the EDTIB.

1.3. Our approach

The study team conducted the study as follows:

WP1: An analysis of tools and methods to assess existing DTIB capabilities
The study team analysed the tools and methods used by pMS to assess the strengths and weaknesses of DTIBs using the following approach:

- **An email survey of pMS practice:** the study team sent a short questionnaire survey by email to EDA NADs points of contacts in the pMS. We sent the email survey to 23 pMS and received 16 responses (see Annex 4: Findings of the email survey).[1]

[1] This included the use of the survey instrument in a face-to-face during a meeting with one pMS (Romania).

- **Interviews with officials in 5 selected countries to generate case studies of practice:** the study team conducted interviews with officials in four pre-selected pMS (the UK, France, the Netherlands and Sweden). The four pMS were selected in discussion with EDA and on the basis of our awareness that they had engaged in studies of their respective DTIBs. In each case, the study team approached the EDA NADs PoC for the pMS and asked the PoC to identify appropriate officials who we might interview. We conducted interviews with those officials and we sent a draft summary of our country study to the pMS PoC and invited comments. Where comments were received, they were integrated into the final country study. We also conducted interviews in the United States to understand some of the practices used by the Department of Defense (see Annex 5: The country case studies).

- **A review of the state of the art in industrial and technological analysis:** the study team was also asked to take a more generic overview of tools and methods used in other sectors. We reviewed tools and methods used in economics and in the formulation of business strategy and technology strategy (see Annex 6: A short reference guide on tools and methods for industrial and technological analysis).

WP2: A methodology of how to identify and measure strengths and weaknesses of a DTIB and continuously review its status (or propose review mechanisms)

The study team developed a methodology to identify and measure the strengths and weaknesses of the DTIB in Europe as follows:

- **An assessment of existing tools and techniques:** we reviewed the tools and techniques used by the pMS and the lessons learned by pMS in conducting DTIB studies and take into account the tools and techniques used in other sectors.

- **Draft:** we took this into account in developing a draft methodology.

- **Expert Group Meeting**: we presented the draft methodology to an Expert Group Meeting comprised of experts from the pMS, representatives of ASD and independent experts to assess whether the methodology was robust and feasible (see Annex 1: Participants in the Expert Group Meeting).

- **Revision:** we revised the draft methodology to take into account the feedback from the Expert Group Meeting.

WP3: An examination and assessment on how and why DTIB capability requirements may change in the future (and with this the criteria for what constitute strengths and weaknesses)

The study team examined and assessed how and why the DTIB may change in the future as follows:

- **Collation and analysis:** we collated and analysed key public domain reports, academic studies and the results of foresight exercises.

- **Interviews:** we conducted interviews with selected experts including pMS officials, officials from European institutions (the EDA and European Commission); ASD, national industry associations and individual companies; and expert analysts from think tanks and universities.

- **Futures Workshop:** we conducted a workshop with selected expert analysts (see Annex 2: Participants in the futures workshop).

WP+: Implementation issues for a study of the EDTIB

The study considered the implementation issues that EDA would need to consider if it wished to undertake a study of the EDTIB and identified the Next Steps based on the following approach:

- **A review of the lessons learned by pMS:** these were identified from our email survey and face-to-face interviews and the feedback received from our Expert Group Meeting.

- **Meetings:** we met with officials from Industry & Market and from other EDA directorates as advised by Industry & Market.

2. AN ANALYSIS OF TOOLS AND METHODS TO ASSESS EXISTING DTIB CAPABILITIES

EDA asked the study team to begin by analysing the tools and methods used by pMS in assessing their national DTIBs and to take a more generic overview of tools and methods used in other sectors but potentially relevant for assessing DTIB capabilities. We reviewed generic tools and methods used in economics and in the formulation of business strategy and technology strategy and this is set out in Annex 6 (A short reference guide on tools and methods for industrial and technological analysis). Our email survey of all EDA pMS points of contact and face-to-face interviews with selected pMS identified the following points:

2.1. What constitutes a strength/weakness?

We found that there were subtly different views of what constitute a "strength" or a "weakness" in the DTIB and that these views differed between stakeholders and between individual pMS. Nevertheless, we also found certain common perspectives as to what constitutes a strong DTIB.

2.1.1. Different pMS views

Our email survey and face-to-face interviews found that the pMS place differing emphasis on the criteria (capability, competence, competitiveness) that they use to define a strong DTIB.

Most pMS define a strong DTIB primarily in terms of its capacity to deliver required military capabilities and the desired level of operational sovereignty. Issues of economic competitiveness are regarded as important in so far as they influence the capacity of the DTIB to deliver those military capabilities and there is recognition that in most cases the desired level of national operational sovereignty in a DTIB capability cannot be sustained by the national market alone, making international competitiveness and export performance important.

Some pMS give much greater weight to the role of the DTIB as a potentially valuable economic and technological asset in its own right and here a strong DTIB is defined primarily in terms of its international competitiveness, export performance and contribution to the national economic and technological base. In these cases, the military capability requirements of the home country are taken into account but particular weight is given to international markets because of the limited national demand for their products and services.

A number of pMS reported that they did not have an official definition of a strong DTIB since their DTIB was too small to merit particular attention and/or it was not regarded as

an important element in defence policy. Some of these pMS reported that the DTIB was assessed in the same way as other industrial sectors.

pMS views of what constitutes a strong DTIB

- **Capability:** the capability of the DTIB to meet the needs of the armed forces and guarantee security of supply in areas of desired national operational sovereignty is the critical measure of strength/weakness mentioned by many pMS.

- **Competence:** pMS identified a strong DTIB as one that was able to deliver the equipment and services that they required of the necessary quality and performance and which was able to sustain those technological capabilities necessary to guarantee the desired level of operational sovereignty. The competence of the DTIB was also regarded as important by some pMS because it would allow them to play an important role in the shaping of the DTIB at the European level.

- **Competitiveness:** pMS measured the competitiveness of the DTIB in terms of its performance in export markets and its capacity to play a role in international programmes. Some pMS characterised a competitive DTIB in terms of its ability to deliver value for money. Some pMS gave particular weight to the role of the DTIB as a valuable economic and technological asset in its own right and placed an emphasis on international competitiveness as a measure of DTIB strength.

2.1.2. Different stakeholder perspectives

We found that there are different stakeholder perspectives on what constitutes a strength or weakness of a DTIB. DTIB analyses need to recognize, implicitly or explicitly, that the definition of a strong DTIB must take a multi-dimensional approach that considers all these different perspectives and also the interaction between these perspectives. This may involve trade-offs between different dimensions and the perspectives may not necessarily, of course, be given equal weight by policy makers. Indeed, one issue is the relative weight that should be given to competing perspectives.

Four perspectives on a strong DTIB

- **The customer perspective:** pMS tend to define a strong DTIB as one that is internationally competitive and capable of delivering the equipment and services necessary to meet desired military requirements with the appropriate level of operational sovereignty. Customers are also concerned about value for money and often define a strong DTIB as one that is capable of delivering needed equipment and services on-time, on-budget and meeting agreed performance targets. In addition, the customer perspective can be influenced by political concerns about the economic benefits of the DTIB, and especially jobs.

- **The business perspective:** where a DTIB is primarily in private ownership, industry is driven by the business imperative to achieve acceptable return on its investment and sustain and grow market share through the design, development and delivery of internationally competitive products and services. Industry's view of a strong DTIB is heavily influenced by customer policies in terms of level and character of demand for industry's products and services, contractual conditions and R&T investment. Most DTIB assessments undertaken by pMS recognized these different perspectives and the importance of the business driver as an important element in sustaining a strong DTIB. DTIB studies recognized, implicitly or explicitly, that these drivers of industry behaviour may complement the customer perspective but that there can also be situations where industry and customer interests are different.

- **The innovation perspective:** those stakeholders whose primary role is to promote innovation in defence equipment and services tend to focus their attention on competence and the delivery of cutting-edge technology when considering what constitutes a strong DTIB. This focuses attention on the level of R&T investment; the capacity of the industrial base to generate cutting-edge technologies; and the strength of relationships between defence contractors and other innovators in the supply chain and universities. Those who are responsible for innovation within companies and government may have a very different view of what constitutes a strong DTIB to others within companies and government. Most DTIB studies took the particular need to promote innovation into account.

- **The industry structure perspective:** tends to focus attention on the impact of industry structure on the conduct and performance of actors and emphasizes that strong DTIB is one that is structured so that it retains a financially viable industrial base, the appropriate level of industry concentration, allows the entry of new companies (and the exit of weak companies) and attracts investment from global capital markets.

2.2. What is the focus of DTIB studies?

2.2.1 DTIB studies tend to focus on sectors

We found that pMS tend to undertake DTIB studies on an ad hoc basis as issues of policy or political concern arise. We found that a number of pMS had undertaken or were in the process of undertaking defence industrial strategy exercises.[2] We found that these DTIB studies tend to focus on the assessment of industrial sectors or sub-sectors rather than the whole DTIB and studies of national DTIBs tend to be built bottom-up from these sector studies. A sector is a group of firms producing the same principal product or service and the focus on individual sectors rather the whole of the DTIB reflects the fact that the military requirements, industrial, technological and market characteristics of individual sectors have distinctive features. Conducting a top-down study of the whole DTIB was felt by the pMS to mask these major differences between sectors and were therefore regarded as unhelpful for policy development.

2.2.2 There are a number of types of DTIB study

We identified a number of types of DTIB studies undertaken by pMS. These have different objectives and the type of study influences the tools and techniques that are selected and the information that is collected.

[2] Examples of pMS reports that focus in whole or in part on defence industrial strategy exercises include: Finland's *Defence and Security Industrial Strategy* (2007); Germany's *White Paper on German Security Policy and the Future of the Bundeswehr* (chapter 3.7 Armaments Policy); the Netherlands' *Defence Industrial Strategy* (2007); Sweden's *Defence Industrial Strategy* (forthcoming, 2008?); and, the United Kingdom's *Defence Industrial Strategy* (2005) and *Defence Industrial Strategy (version 2)* (forthcoming, 2008?). In addition, our email survey found that Latvia's MOD and Ministry of Economy plans to launch a study on the development of defence and related industries and in Portugal the MOD, in collaboration with a private firm, is conducting a study related to the development of national strategy for the DTIB.

Types of DTIB studies:

- **Programme level studies:** are often undertaken by those responsible for a particular programme to identify mismatches between DTIB capabilities and programme requirements. The studies are often undertaken during the acquisition stage of a new programme and again during the life of that programme and aim to identify any industrial capability gaps that may prevent the programme procuring at the necessary level. They typically use a gap analysis approach (see 2.3.2 below) and the information collected is specific to the programme's needs; expected rate of production; and the capacity of the DTIB to meet the rate of production demands of that programme.

- **Change studies:** are often commissioned by senior policy makers under political direction to assess the strengths and weaknesses of a DTIB with the aim of driving changes in industry structure, conduct and performance. These tend to be larger scale studies than the programme studies and focus at the sectoral level (often combining sectoral studies into a view of the whole DTIB). Change studies use a variety of tools and methods including gap analysis; SWOT analysis; scenario analysis; and, road mapping (see 2.3.2 below). The information collected for the exercise can be broad and include assessments of the future international security environment; future military capability requirements; desired level of operational sovereignty; as well as the strengths and weaknesses of the DTIB. Such studies typically mobilise a range of internal and external stakeholders including the military; the acquisition community; ministries of finance; as well as industry associations and individual companies.

- **Sustainment studies:** aim to identify critical DTIB capabilities that should be sustained and the changes in public policy and industry structure and conduct that is needed to sustain them. These studies tend to be a response to a particular issue of policy concern and typically focus on a specific sectoral issue that is regarded as important to the maintenance of the desired level of operational sovereignty in a particular area and the future economic and technological viability of the DTIB in that sector. Sustainment studies use a variety of tools and methods including gap analysis; SWOT analysis; technology audit tools; scenario analysis; economic and financial modelling; and, road mapping (see 2.3.2 below). These studies involve a very detailed analysis of the sector that typically requires very close cooperation between the pMS and industry and the sharing of very detailed and commercially sensitive information by companies.

- **Critical technologies studies:** identify new and emerging technologies that are important to meeting future military requirements and priorities for R&T funding. Critical technologies studies use a variety of tools and methods including: SWOT analysis; technology audit tools; scenario analysis; and, road mapping (see 2.3.2 below). The information collected for these exercises can typically include future military capability requirements, the identification of new and disruptive technologies and assessments of the capacity of the DTIB and the wider science and technology base to deliver these critical technologies. This information relies heavily on expertise drawn from defence research laboratories and industry.

2.2.3 Studies increasingly look beyond the national DTIB

A number of pMS noted that assessments of the DTIB were expanding beyond the national DTIB as it has traditionally been defined.

Why studies are looking beyond the national DTIB

- pMS noted that the distinction between the DTIB and non-defence sectors was increasingly blurred as a result of the growing importance of civil-origin and dual use technologies and that this was especially the case when one goes below prime contractors to consider supply chains, sub-system and component suppliers.
- Some pMS noted that the growing overlap between the defence and security sectors meant that their DTIB studies increasingly had to take into account the commercial and technological overlaps and complementarities between these two related sectors.
- Some pMS observed that changes in the structure of the defence industry and market and changes in their own acquisition policies meant that their DTIB studies were increasingly considering the European DTIB and global sources of supply. In part, some pMS noted, this growing focus on the European DTIB had been stimulated by recent initiatives by EDA.

2.3. What are the instruments used to measure strengths and weaknesses?

We found that a variety of tools and techniques are used by pMS to analyse the DTIB. These range from relatively simple tools such as SWOT analysis to sophisticated economic and financial modeling. Most of the methodologies use some form of gap analysis and follow a common logic-chain that seeks to identify important gaps between policy objectives and DTIB capabilities.

2.3.1. A common “logic chain” underpins many of the DTIB studies

We found that a common logic chain underpinned many of the DTIB studies as follows:

The logic chain underpinning DTIB analyses

- **What are the policy objectives?** Studies typically started by defining pMS policy objectives. Most DTIB studies began with a consideration of the current and anticipated future military capability requirements of the armed forces and the desired level of operational sovereignty needed to meet those operational requirements. Where the DTIB was being assessed mainly as an economic and technological asset, greater weight was given to objectives related to international competitiveness, the DTIB's capacity to engage in international programmes and supply chains and its export performance.

- **What are current DTIB capabilities?** The next step of many DTIB studies was to consider the current capabilities of the DTIB, its strengths and its weaknesses measured against pMS policy objectives.

- **What are the gaps between current DTIB capabilities and the policy objectives?** The third step was to identify any important gaps between current DTIB capabilities and pMS policy objectives.

- **What are the policy implications of the analysis?** Typically, the final step of the analytical process was to consider the policy implications of the analysis, potential policy responses, their costs and benefits. At this stage, successful DTIB studies also prioritised policy recommendations and considered mechanisms for the implementation of those policies.

2.3.2. A variety of tools and techniques are used depending on the objectives of the DTIB assessment

We found that DTIB analyses used a variety of tools and techniques that ranged from relatively simple tools such as SWOT analysis to sophisticated economic and financial modeling. The variety of these instruments and their use is illustrated by the responses to our email survey and in the country studies (see Annex 4: Findings of the email survey; and, Annex 5: the country case studies). Some of the more commonly used tools and techniques are listed here.

Commonly used tools and techniques:

- **Gap analysis:** most of the DTIB studies were based on some form of gap analysis that sought to compare current DTIB capabilities against those that may be needed to fulfil future military requirements and other pMS policy objectives. Gap analysis consists of defining the present state of the DTIB, the desired or "target" state and hence the gap between them. Thus, at the core of these gap analyses were two questions: Where are we? Where do we want to be?

- **SWOT analysis:** many studies used a SWOT analysis to assess the DTIB and its environment. SWOT stands for strengths, weaknesses, opportunities and threats. Strengths and weaknesses are factors internal to the DTIB (for instance, its technological capabilities). Opportunities and threats are factors external to the DTIB (for instance, the emergence of new competitors).

- **Technology audit tools:** a variety of tools were used to assess the strengths and weaknesses of DTIB technologies by identifying, categorising and assessing technologies.

- **Scenario analysis**: some studies sought to use alternative visions of the future (scenarios) as the basis for analysis of the implications of developments in the DTIB on its future strengths and weaknesses.

- **Economic and financial modeling:** this was used in some studies to assess the impact on the DTIB of potential future procurement decisions and the timing of programmes.

- **Road mapping:** some studies used road mapping techniques to help identify, assess and select alternative future paths for the DTIB.

2.4. What information is collected?

We found that DTIB studies collect a variety of information depending on the purpose of the study and the feasibility of information collection. The issue of feasibility is an important matter since many pMS reported that some types of information are difficult and costly to collect. We found that information was collected at the sectoral level on demand for the DTIB products and services; DTIB capabilities and competencies; supplier contract performance; DTIB financial and economic performance; and, DTIB structure. We found that the pMS used three different types of information: hard data; expert analysis; and stakeholder opinion.

2.4.1. Demand for the DTIB's products and services

Most DTIB studies collected information on the demand for the DTIB's products and services. The focus was primarily on the requirements of the national customer but some studies also collected information on international demand.

Examples of the information collected on demand for the DTIB's products and services:

- **Future customer requirements:** information was collected on future customer requirements. The source of this information was normally the internal customer in the form of acquisition agencies and the armed services. In some circumstances future customer requirements were easy to identify but in others (particularly for longer time frames) this assessment relied on expert judgement rather than hard data.

- **Desired level of operational sovereignty: s**ome pMS studies collected information on the desired level of operational sovereignty and security of supply for the DTIB capabilities. Again, the source of this information was the internal customer in the form of the military, planning staffs and acquisition agencies and this relied heavily on expert judgement and the opinion of stakeholders.

- **Future budgets:** pMS studies collected information on future budgets. Since the time horizon for the studies were typically much longer than budget planning horizons this information relied heavily on the expert judgement of budget holders and acquisition agencies to generate forecasts of likely future budgets.

- **Future programmes:** acquisition agencies and the armed forces were typically called upon to provide information on expected future military programmes based on their expert judgement of the replacement cycle for existing equipment, the likely obsolence of in-service equipment as well as anticipated future military capability requirements.

- **International demand for the sector's products and services:** some DTIB studies collected information on the anticipated future demand from export markets for the sector's products and services. Information on these international opportunities came from commercial market research data combined with expert knowledge of the sector often drawing on the views of industry and defence export organisations.

2.4.2. DTIB capabilities and competencies

DTIB studies collected information on the capabilities and competencies of the DTIB and this included:

Examples of the information collected on DTIB capabilities and competencies:

- **Products and services supplied by the DTIB:** studies collected information on the products and services supplied by the DTIB. This included the systems, sub-systems and components it produced and the services that it offered. Information came from industry associations, companies, acqusition agencies as well as expert knowledge of the sector.

- **Technological capabilities of the DTIB:** the information collected on technological capabilities took the form of descriptions of technological capabilities but also expert judgements on the strengths and weaknesses of those capabilities. Information on technological capabilities came from pMS experts from defence research agencies and acquisition agencies as well as from industry associations and individual companies.

- **R&T spending in the sector:** information was collected on government R&T budgets for the sector and where possible industry's own funded R&T in the sector. Some data on company own-funded R&T was derived from publicly available information including company annual reports although this data has severe limitations (see Annex 3: Data: strengths and weaknesses). Thus, the collection of information on industry R&T spending often depended on the willingness of individual companies to disclose that information and otherwise depended on expert judgement.

- **The characteristics of the workforce:** some studies collected information on the workforce in the sector: numbers employed; special skills; hiring rates; retention; and so forth. This included hard data where it was possible but also included expert judgement on the strengths and weaknesses of the workforce. Information on workforce characteristics came from pMS sector experts as well as from industry associations and individual companies.

2.4.3. Supplier contract performance

The contract performance of suppliers to the MOD was frequently used in assessments of the strengths and weaknesses of the DTIB. Such information was readily available from procurement agencies. Also, for non-competitive contracts some ministries have access to

the detailed costing data and firm performance for specific projects. Where access to this information was available it represented a useful source of financial and economic information on individual suppliers.

- Supplier contract performance data provided a source of information on the delivery performance; cost performance; and, technical performance of individual suppliers. This was supplemented by the opinions of acquisition programme managers.

2.4.4. Financial and economic performance

The core of most DTIB studies was financial and economic information on the sector. We were told by pMS that they found this information particularly difficult to collect. This is commercially sensitive information that companies are cautious about sharing and we found that DTIB studies therefore tend to rely wherever possible on the collection of publicly available data on the companies in a sector. This information is readily available from company annual reports and from financial databases but it has a number of important flaws (for more information, see Annex 3: Data: strengths and weaknesses).

Examples of sector financial and economic information:

- **Arms exports**: arms export data is collected by pMS in support of the EU Code of Conduct on Arms Exports and was often used as a measure of the competitiveness of the DTIB. This information is broken down by EU country of origin and by type using the EU Common Military list categories.

- **Financial and economic data for publicly quoted companies**: information was collected from annual reports and financial databases on company R&D spending, capital investment and so forth and the main financial ratios such as return on capital employed; return on assets; and, free cash flow to total debt. However, the information only tends to be available for prime contractors and large publicly quoted suppliers and is only available at the corporate level and sometimes for major divisions of the company. The information rarely allows easy analysis of the performance of the defence activities of multi-product companies nor does it allow analysis of performance in a particular sector. Another problem with this information is that information in company annual reports is subject to a lag of up to two years.

- **Stock market ratios and share prices:** some studies collected information on the stock market performance of companies in the sector. This information is easy to obtain and is being continually updated. The problem is that stock prices refer to the performance of the whole company; little in the variance in the stock price for most companies is attributable to performance in one sector of the defence market; and, the stock price reflects a variety of other factors beyond the defence sector.

2.4.5. DTIB structure

We found that pMS collected a variety of information is collected on the structure of the DTIB.

Examples of information collected on the structure of the DTIB:

- **The companies operating in the sector:** information was collected on the companies operating in the sector within the national DTIB as prime contractors; systems integrators; sub-system and components suppliers. This information was normally readily available and well known to sector experts. National industry associations often produce marketing material that provides details of their member companies and their capabilities. Some pMS conduct similar exercises for their own purposes and acquisition agencies know those companies who have contracts with the pMS. Commercial market research reports and databases (such as those produced by Jane's Information Group and others) were also used to provide background information on the sector.

- **The size of companies in terms of turnover and employees:** this information was routinely collected as part of DTIB studies and drew on the same sources described for the previous point.

- **The ownership of the companies:** some pMS collected information on the ownership of the companies that constituted the DTIB in particular to identify foreign-owned firms. Some pMS routinely collected this information but others had to generate the information specifically for the DTIB study. Information on ownership was collected from industry associations and the companies as well as from pMS sector experts.

- **Entry/exit of companies from the sector:** some pMS collected information on the entry and exit of companies from the sector as a means of identifying potential weaknesses in the DTIB (through exit) or as a measure of its vitality (through new entrants). This information was collected from a variety of sources. Procurement agencies typically monitored changes in the supplier base and were readily able to provide this information. In addition, commercial databases and email alert services provided a useful source as did industry associations.

2.4.6. Observations on the information collected

We found that pMS collected three types of information for their DTIB studies: hard data, expert analysis; and stakeholder opinion. The pMS reported that they faced major problems in getting good financial and economic data at the sector level and the engagement of experts with a deep knowledge of the sector was identified as critical to DTIB studies.

Observations on the information that was collected by pMS:

- **pMS use three different types of information - hard data; expert analysis; and stakeholder opinion:** when we think of information we tend to think of hard facts such as statistical data, budget figures or company financial details. We found that the pMS collected **hard data** in the form of facts, trends and survey information but that this data had important limitations and can be difficult and costly to collect. We found that **sector experts** were critical to DTIB studies. Not only did those experts have a great deal of knowledge of the sector but they could also draw on their own informal networks of expertise. Expert knowledge also allowed a critical evaluation of hard data which was especially important given the limitations of much of that hard data. The judgements and opinions of **stakeholders** were another important source of information for DTIB studies. Stakeholders in the military, the acquisition and R&T communities and industry are experts in their own right with detailed knowledge to contribute to the DTIB study process.

- **There is a major data gap in the form of a lack of decent financial and economic data on defence industries at the sector level:** We found that pMS faced major problems in getting good financial and economic data at the sector level. We found that the **official national statistics** published by pMS often do not identify specific defence industries. At best, there are some industrial classifications which are clearly defence (e.g. ordnance in the UK). Otherwise, official industrial classifications typically identify various defence-dependent industries, namely, aerospace and shipbuilding; but these often report aggregate data which comprises both civil and military sales. **National industry associations** often publish their own statistical information based on surveys of their members. These can provide useful overviews and typically distinguished defence from other activities (for instance, civilian aerospace) but again pMS found that they rarely disaggregated this data on the defence industry to a level that was useful for sectoral of sub-sectoral studies. **Commercial market research reports and databases** were also used as a source of information. Commercial market research reports are often written on specific sectors and defence industry and market databases can be interrogated to identify information on specific sectors. However, some pMS expressed concerns about the accuracy of some of the information since market researchers faced the same challenges as others in gathering the data. The limitations of other sources of information meant that pMS studies at the sectoral level often depended on **specially collected information on the sector**. This information was collected by surveys or meetings and relied on the willingness of individual companies to provide what they often regarded as commercially sensitive information. Industry associations were often engaged by the pMS to undertake such information collection exercises.

Observations on the information that was collected by pMS (continued):

- **Getting robust and reliable financial and economic information on defence companies at the sectoral level is a major problem for the pMS:** We found that the pMS found it difficult to get robust and reliable financial and economic information on individual companies at the sectoral level. We have already noted that financial and economic information is available for some companies at the company level for company turnover, profits, R&D and capital investment and standard financial ratios can be calculated from that information (indeed, databases of company financial information typically calculate these ratios). However, this company data is normally presented in such a way that it is difficult to disaggregate military and civil sales (and where military sales are presented it comprised both sales to national government and export sales) and military from civil R&D or capital expenditure. For almost all defence companies, the lack of financial data on their defence business means that it is difficult for outsiders to assess the financial viability of the defence component of their total business. Indeed, even where this information is available it is not presented in a way that allows ready analysis of sectoral performance. Accordingly, the pMS were dependent upon the willingness of individual companies to provide this financial and economic information on their individual business units. This is commercially sensitive information that many companies are cautious to divulge. In the absence of such information, some pMS studies used information derived from contracts data to assess the economic and financial performance of individual businesses.

2.5. How is the information collected?

We found that the collection of information presented a major challenge for pMS conducting DTIB studies. Information internal to the MOD tended to be relatively straightforward to collect although even here this depended on the availability of the information, the costs of collection and collation and the strengths and weaknesses of internal management information systems. However, external information, and in particular information on the financial performance of companies, often presented the pMS with major difficulties.

2.5.1. Information is collected in a variety of ways

We found that DTIB studies collected information in a variety of ways.

Some ways in which information was collected by the pMS:

- **Collation and analysis of available information:** an important element of the information collection process were desk-based exercises that sought to collate and analyse the available information on a sector. This may begin by a web search for existing studies on the sector or related subjects. An analysis of media coverage of the sector may be undertaken particularly focusing on industry media (*Jane's Defence Weekly*; *Defense News* and the like) as well as a review of coverage in financial media such as The *Financial Times*. Investment banks publish studies for their clients and these can be an excellent source of information on the defence industry, the prospects for individual sectors, the performance of individual companies and other matters of interest to investors. There may be reports published by commercial market research companies that can be purchased as well as information available from on-line information sources such as *Jane's Information Group*. Equally, the use of personal networking can help to identify useful sources of information.

- **Workshops with stakeholders and panels of experts:** these were a very important way of collecting information and varied from informal meetings to facilitated creativity exercises and formal hearings.

- **Surveys:** questionnaire surveys to companies and other actors in the sector were used in some DTIB studies. Surveys were a useful tool for collecting information on businesses in the sector that was not available through other sources. These surveys were sometimes conducted on behalf of the pMS by the national industry association. However, surveys faced important challenges: commercial confidentiality concerns mean that companies can be cautious about the information that they will provide for surveys; surveys can be time consuming to complete by respondents especially if the data requested is not easily to hand; and, for these reasons and others, the response rate to surveys tends to be relatively low even when they are endorsed by industry associations. Another problem of survey data is that it cannot be repeated annually without imposing a huge reporting burden on industry.

- **Databases:** we came across a number of efforts to develop databases of industry performance. The creation of an effective database presents significant problems: they are costly to develop; they experience the same information collection difficulties as other information gathering approaches; they need to be constantly updated if they are to remain useful; they need to collect data that is consistent overtime; and, the costs of maintaining the database can be high. By and large, the conclusion of those who had been engaged in such efforts was that these costs outweighed their benefits.

- **The importance of the relationship with industry:** successful studies tended to be characterised by a close working relationship with industry. Industry associations played an important role in information gathering and in some studies they sponsored questionnaire surveys of their members and other information gathering activities. Individual companies were also an important source of information particularly where there was a good working relationship between the company and the pMS already and/or where companies perceived that the benefits of participation were greater than the costs.

2.5.2. Information collection presents significant challenges

We found that information collection presented significant challenges to DTIB studies. In particular, we found that pMS experienced considerable difficulties associated with the willingness of industry to provide the financial information often required for this type of study.

Why information collection presents challenges to DTIB studies:

- **Most of the company financial information that is required for sectoral DTIB studies is not in the public domain:** sectoral DTIB studies typically require financial information at the strategic business unit (SBU) level or at the level of an individual programme. We also found that some DTIB studies required company management account data. This level of detailed information is particularly necessary for sustainability studies. In other types of study it is less critical. Where this detailed company financial and economic information is required, however, DTIB studies are highly dependent upon the willingness of companies to provide this information. We have already noted that such information is rarely available in the public domain because of the limitations of national official statistics, the information typically collected by national industry associations as well as the financial data presented in company annual reports and financial databases.

- **Commercial sensitivities:** companies are cautious about providing this information because it is commercially confidential and there are major concerns about how that information may be used and with whom it might be shared. Asking for this level of data provides an intimate understanding of the company and therefore the pMS noted that companies were concerned as to whether this was an industrial analysis or whether it might be used "against" them in subsequent contract negotiations.

- **Concerns about the cost of participating in studies:** even where the information that is requested is not commercially sensitive, companies can have major concerns about the cost of participating in studies. Internal information gathering is not costless and may take valuable company time. Equally, participation in meetings, workshops and so forth also has a considerable cost in terms of the time required.

- **The pMS find it particularly difficult to collect information on supply chains and supplying firms (many of which are SMEs):** pMS have found it particularly difficult and costly to collect information on which firms are involved as suppliers in supply chains; their location; the importance of defence in their total business; the importance of the firm in its local labour market; and, the importance of the firm in the supply chain. Many of these firms are SMEs. In contrast, the pMS tended to know more about the large suppliers in the DTIB.

2.6. How is defence industrial analysis organised?

We found that defence industrial analysis capabilities and experience differed considerably between pMS. We also found that pMS tend to undertake DTIB studies on an ad hoc basis as issues of policy or political concern arise. However, many pMS have permanent staffs responsible for industry watch or supplier relationship management.

2.6.1. Defence industrial analysis capabilities differ between pMS

We found that defence industrial analysis capabilities and experience differ considerably between pMS:

DTIB analysis capabilities differ considerably between pMS:

- pMS with sizeable defence procurement budgets and large national DTIBs tended to engage in constant monitoring of their key defence industrial capabilities. This was normally undertaken by the national defence procurement agency to support its acquisition strategy and programme monitoring. National procurement agencies in turn advised national Ministries of Defence. In addition, many of these pMS had published defence industrial strategies in recent years or said that they were in the process of producing such documents.

- In contrast, a number of pMs who responded to our email survey reported that they undertook little or no DTIB analytical activity beyond that associated with contract awards. Several pMS made the point that the size of their DTIB meant that it was assessed in the same way as other sectors of the economy.

2.6.2. Industry watch and supplier relationship management

We found that industry watch and supplier relationship management was a resource-intensive task. The Swedish procurement agency FMV has a unit of eight staff responsible for monitoring the defence industry and market. The UK Defence Equipment & Support agency has more than thirty staff working on supplier relationship management.

2.6.3. DTIB studies are undertaken by ad hoc teams supported by contractors

We found that DTIB studies tend to be undertaken by ad hoc teams who are brought together specially for that study. The DTIB analysis process is often supported by contractors who provide additional resource and specialist skills.

2.6.4. A variety of skills are needed for defence industrial analysis

We found that DTIB studies require a range of specialist skills and that matching the skills available internally and those required for an analysis of this kind presented a major challenge to many pMS. DTIB studies required the analytical skills of engineers, technologists, industrial economists, cost engineers, accountants, corporate financial analysts and military requirements specialists as well as sector experts.

2.7. Lessons learned

In discussing the lessons that the pMS had learned from conducting DTIB studies, three common themes emerged. We were told that successful DTIB studies tend to have clear policy aims and objectives from the outset; that high levels of stakeholder engagement was critical to a DTIB study; and, that DTIB studies are a major undertaking that can have demanding resource, time and skill requirements.

2.7.1. DTIB studies are a major undertaking

A key lesson learned that pMS urged us to take into account was that DTIB studies are a major undertaking that require considerable time, resources and specialized skills. This point was made repeatedly to us during our interviews with pMS and during the meeting of our Expert Group

Lessons learned (1): The resource, time and skill requirements of a DTIB study can be considerable

- **The studies conducted by pMS were often time and resource intensive:** typically, studies took at least nine months and often considerably longer. They required significant resources in terms of the time of those managing the studies; the time of internal stakeholders and experts; and, the time of individual companies. The studies were supported by significant study budgets and often required support from external contractors.
- **DTIB studies require specialist skills:** successful studies were staffed by a core of people who had detailed sectoral knowledge and required the analytical skills of engineers, technologists, industrial economists, cost engineers, accountants, corporate financial analysts and military requirements specialists.

2.7.2. Successful studies have clear policy aims and objectives

The pMS impressed upon us that successful studies tended to have clear policy aims and objectives from the outset and this point was reinforced to us during the meeting of our Expert Group. We were told that:

Lessons learned (2): Successful studies have clear policy aims and objectives

- **Successful studies begin with clear objectives and a clear link to desired policy outcomes:** we were told that it was important that those who commission studies understand how to use studies to develop a compelling case for change and that this requires a clear understanding of broader policy aims and a road map of how to get there. Those who had commissioned successful studies emphasised that this required a clear view on how to implement change and the political support that is required to achieve that change.

- **The importance of prioritization:** we were told by several of those who had undertaken DTIB studies there is a danger that defence industrial analyses can turn into "wish lists" in which every technology becomes "critical" and every defence industrial capabilities is defined as "key". Several pMS reflected that prioritisation had not been strong enough in their own DTIB studies and that this had led to a situation where: implementation was difficult because everything was regarded as equally "important"; the policy recommendations became disengaged from how they were to be implemented; and, the policy recommendations become disengaged from the cost of implementation.

- **A DTIB study must generate actionable outcomes (for public policy and for industry):** we were also told that it was important to remember that a DTIB study is only the first step and that how to use the findings of DTIB studies to leverage change requires detailed thought about: the policy levers available to stimulate change; the budget implications; and, the priorities for policy action.

2.7.3. Stakeholder engagement is critical to a successful study

Another key lesson that the pMS said that they had learned was that successful DTIB studies were characterised by high levels of communication with stakeholders on the objectives of the study and the link between the study and wider policy development.

Lessons learned (3): The importance of stakeholder engagement

- Communication to stakeholders on the objectives of the study and the link between the study and the broader policy agenda is critical for success because participation in studies can be costly and stakeholders are cautious about the release of sensitive data; how that data may be used; and the costs of their participation.

- Working closely with budget holders is critically important since the policy recommendations emerging out of such studies are likely to have important implications for funding priorities.

- Working closely with industry is vital since the implementation of many of the recommendations arising out of such studies depends on some form of strategic and behavioural change on the part of industry and thus recommendations need to be feasible in the industry context.

2.8. Summary

The aim of this section has been to analyse the tools and methods used by pMS in assessing their national DTIBs. The section draws on the information collected from our email survey of EDA pMS points of contact and our face-to-face interviews with selected pMS. In support of this activity, we also undertook a more generic overview of tools and methods to other sectors that are used in economics and in the formulation of business strategy and technology strategy. This is set out in Annex 6 (A short reference guide on tools and methods for industrial and technological analysis).

A number of important points arise from this review of the tools and methods used by pMS that we feel need to be taken into account in any attempt to develop a methodology to assess the DTIB at the European level. Those points are as follows:

- Different stakeholders have different perspectives on what constitutes a "strong" DTIB and DTIB studies need to recognise this and determine the relative weight to be given to the views of different stakeholders.

- DTIB studies tend to focus on the assessment of industrial sectors or sub-sectors rather than the whole DTIB and studies of national DTIBs tend to be built bottom-up from these sector studies. This reflects the fact that military requirements, industrial, technological and market characteristics of individual sectors have distinctive features.

- A variety of tools and techniques are used by pMS to analyse the DTIB. These range from relatively simple tools such as SWOT analysis to sophisticated economic and financial modeling. Most of the methodologies use some form of gap analysis.

- The DTIB studies conducted by pMS were a major undertaking that were resource and time intensive and required specialist skills.

- DTIB studies face major challenges in collecting information and they faced particular challenges in getting good financial and economic data at the sector level.

- Successful studies begin with clear objectives and a clear link to desired policy outcomes; they prioritise key themes and focus on the generation of actionable outcomes for public policy and industry.

- Stakeholder engagement is critical to a successful DTIB study.

3. A METHODOLOGY TO IDENTIFY AND MEASURE STRENGTHS AND WEAKNESSES OF THE DTIB IN EUROPE

The EDA asked the study team to propose a methodology to identify and measure strengths and weaknesses of the DTIB in Europe and also to propose mechanisms to continuously review the status of the DTIB in Europe. We treat these as two separate but complementary activities.[3] We begin by proposing a methodology to assess the strengths and weaknesses of the DTIB in Europe that would be common to all studies facilitated by Industry & Market. We then propose a mechanism to continuously review the status of the DTIB in Europe.

3.1. The aims of the methodology

The analysis of the DTIB at the European level is a new and ambitious project. To the best of our knowledge such an effort has not been previously undertaken and it represents uncharted territory both methodologically and for stakeholders. Accordingly, **what follows should be regarded as a food-for-thought exercise that aims to identify some possible questions that the EDA and its stakeholders may wish to address and some tools and techniques that might be suitable for the collection of the information required to address those questions.**

3.1.1. A methodology that is based on the EDA Steering Board statement

A methodology to assess the strengths and weaknesses of the DTIB in Europe needs to take into account the EDA Steering Board's statement of *Characteristics of a Strong Future European DTIB* and the *Strategy for the European Defence Technological and Industrial Base*. These two statements represent the agreed vision of the pMS as to what a strong EDTIB would look like and is thus taken as our starting point.

The methodology seeks to operationalise the vision of a strong future European DTIB set out in the EDA Steering Board's statement *Characteristics of a Strong Future European DTIB* and the *Strategy for the European Defence Technological and Industrial Base*.

[3] In our review of pMS practice, we noted that the pMS studies of their DTIBs tended to be conducted on an ad hoc basis in response to specific policy questions and that these ad hoc studies attempted to draw together teams of experts with the specific skills required for the needs of the particular study. We also noted that, separate to these individual studies, a number of pMS retained staff who were engaged in the permanent monitoring of the DTIB as part of the acquisition process. This separation between ad hoc study teams and permanent monitoring activity would also seem to be an appropriate approach for the EDA to adopt whilst recognizing that those EDA staff engaged in the permanent monitoring of the EDTIB would also most likely make a contribution to the EDTIB studies as well.

3.1.2. A methodology that is sensitive to the European context

A methodology to assess the strengths and weaknesses of the DTIB in Europe needs to be sensitive to the particularities of the European context.

- **EDTIB studies will be different to pMS DTIB studies:** the aim of studies of the DTIB in Europe should be to develop a common understanding of the strengths and weaknesses of the DTIB in Europe and build consensus between all the key stakeholders on the areas where collective action at the European level is desirable and feasible. Thus, the emphasis of any methodology must be on consensus building and the European level. Some of the tools and techniques that are used by pMS in their own DTIB studies may be useful at the European level and it is important to learn from the considerable experience of the pMS in conducting national DTIB studies. However, it is also important to recognise that the particularities of the European context may require a somewhat different approach.

- **Developing confidence between stakeholders will be a key first step:** this is a new development and conscious effort will be required to build confidence between the stakeholders. **Companies** will need to develop the confidence to speak to one another within the context of the study about their perceptions of the strengths and weaknesses of the EDTIB. This will require confidence building efforts since its is entirely understandable that companies may be cautious about discussing such matters in a detailed and company-specific way in front of their competitors. Equally, **the pMS** will need to develop confidence in the process and the potential for studies at the European level to add-value.

- **Information on the DTIB is limited at the European level and may prove challenging to collect:** one of the reasons why studies of the DTIB in Europe may be different to pMS DTIB studies is because information is limited at the European level and may be difficult to collect. A methodology that relies primarily on statistical data is likely to face considerable difficulties. The key information for a study of the DTIB in Europe is likely to lie with experts who have a deep knowledge of particular sectors. Stakeholder opinion will also play an important role given that the main aim of a European study should be to build consensus on the areas where collective action at the European level is desirable and feasible. There may also be good reason to consider the selective use of surveys to collect information from pMS and companies.

3.1.3. A methodology that uses a systematic approach common to all studies

A methodology to assess the strengths and weaknesses of the DTIB in Europe needs to provide a systematic framework that can help facilitate structured dialogue between stakeholders on the opportunities for collective action at the European level. We propose a five step methodology and each step is designed to raise key questions that stakeholders may wish to address as part of the development of a common understanding of the strengths and weaknesses of the EDTIB and the areas for collective European action. This systematic approach should be common to all studies. Designing a new methodology for each study would take time and effort. Using a common framework will allow those conducting the studies to learn from the experience of repeated use.

> A systematic methodology will facilitate structured dialogue between stakeholders. Developing an approach that is common to all EDTIB studies would allow those conducting the studies to learn from the experience of repeated use and would reduce the time and effort that would be involved in designing a new methodology for each study.

3.1.4. A methodology that is scalable

This study is part of a wider process of thinking and discussion about studies of the DTIB at the European level. Thus, the specific objectives of such EDTIB studies, their scale and scope and the resources that will be available had not been agreed between stakeholders at the time that we were designing this methodology.

Accordingly, we have designed a methodology that is scalable and can be adjusted to fit these decisions on objectives, scope and resources. **The five-steps that we identify in the methodology represent important generic stages that ought to be considered in any study irrespective of its scale.** We also wish to emphasise that it is **not** our recommendation that all the questions that we raise under each of those stages should be considered in a single study nor that all the tools and methods that we set out should be used in a single study. There are a very large number of potential indicators of the strengths and weaknesses of the EDTIB and the choice of those indicators will depend upon the specific objectives of the individual study and the scale and scope of that study.

Because it is scalable, EDA could consider the use of the five steps of the methodology as the basis for at least three different types of studies:

Three potential types of study using our proposed methodology:

- **Short studies of the DTIB in Europe:** it is feasible to consider using our methodology to structure a short study of three month duration (or less). The methodology could be used to structure a series of meetings between sectoral experts at which each stage of the methodology could be discussed in turn. For each stage, the key questions that we identify could provide an agenda for those discussions. This short study may be supported by some staff work to collate some basic and readily available information to provide food-for-thought during the expert meetings. Equally, the sectoral experts may be able to bring together relevant information from their own experience. The **strength** of such an approach is that it will provide a useful top-level and general study of a sector and may raise issues that could be subject to further more detailed analysis. The **weakness** is that it is likely to rely heavily on the existing knowledge of the experts who choose to take part in the exercise and there is the potential danger that it may lead to superficial analyses.

- **Comprehensive studies:** equally, EDA may wish to consider using our methodology to structure a more comprehensive study. We have noted that most pMS DTIB studies took nine months and often considerably longer. A nine month study could provide the opportunity for a more detailed and in-depth study of a particular sector. The methodology could be used to structure a series of meetings of sector experts as described for the short studies. In addition, a longer study would allow the opportunity for more detailed information gathering that would go beyond the basic and readily available information and begin to collect more detailed information through surveys and other mechanisms and would allow for more detailed analysis. These comprehensive studies might have a core team of seconded experts working full-time for their duration. The **strength** of such an approach is that it could go beyond the top-level and general insights of a short study to provide greater analytical depth. The **weakness** is that a comprehensive study is likely to be a great more resource intensive and more burdensome on industry and the pMS in terms of the information required of them and the extent of their participation in meetings. In addition, a comprehensive study using all the elements of the methodology might be a complex undertaking.

- **A study that focuses on one specific issue:** another way in which EDA may choose to use our methodology is as a starting point for a study that focuses on one specific issue. Our methodology seeks to operationalise all the elements of the EDA Steering Board's statement. As such, it covers a large number of issues and it will be noted that at various points during our development of the methodology, we do note that the particular issue could be the subject of a stand-alone study. Thus, EDA could choose to select a single issue for study and use the methodology to help inform the questions that would need to be addressed and the tools and techniques that could be used. The **strength** of such an approach is that it would allow EDA to focus resources to generate a detailed study of a particular issue of concern. The **weakness** of this approach is that it would not provide a comprehensive overview of the strengths and weaknesses of the DTIB in Europe.

3.2. What information is required for a study of the EDTIB and how could it be collected?

An important consideration in the development of the methodology has been the practical challenges of information collection at the European level. We have noted that the pMS are confronted with important information collection problems when they undertake studies of their national defence industries. This methodology starts by recognising that the limitations of the hard quantitative data that is publicly available at the European level means that any DTIB study at the European level will most likely have to rely heavily on expert analysts and the willingness of industry and pMS stakeholders to share information.

3.2.1. The role of publicly available data

Efforts by EDA to identify the strengths and weaknesses of the EDTIB will face significant challenges in seeking to collect hard quantitative data from public sources. In Annex 3 we review the available sources of data and assess their strengths and weaknesses for a DTIB study at the European level. We note that the data published at the European level is limited. Where data is published by national statistical authorities it is often presented on a different basis in different countries and this makes it hard to find like-for-like comparisons. The data which is collected is normally presented at the industry level and not at the sectoral level that is needed by EDA. Publicly available financial and economic information on companies has severe limitations for sectoral studies.

There are a number of sources of publicly available information that we use as a starting point for information collection in our methodology. These include:

Some useful publicly available sources of information about the DTIB in Europe

- **Commercial market research reports and databases:** There are a number of commercial market research companies such as Jane's Information Group who produce research reports on the defence industry and this includes studies of individual sectors. They also offer commercial databases that provide a variety data on the defence industry and market. The quality of studies produced by commercial market research companies varies enormously and they can be relatively expensive but they could provide useful background knowledge for a sectoral study.

- **Investment analysts' reports:** Investment banks such as Credit Suisse First Boston (CSFB) produce reports for their clients on the defence industry; individual sectors; individual companies; and particular issues that are important to the investment environment. These reports often contain very detailed data and analysis of company performance (often at the divisional or business unit level) and markets (normally broken down into individual national and market segments).

- **European Council Report on the European Union Code of Conduct on Arms Exports:** this annual report contains detailed data on arms exports by EU country of origin and country of destination and by category using the EU Common Military List categories.

- **The European Commission MEDI (Measuring the European Defence Industry) data base:** DG Enterprise has sponsored the design and development of a database on the European defence industry that is intended to include information on companies and their activities in the European defence industry including information on their products, employment, R&D and location. This represents a potentially useful source of background information although EDA will need to clarify its status since when we spoke with the Commission the form in which this data was to be published was still being considered.

- **ASD Facts and Figures:** this annual report includes data on turnover, employment, employment type and R&D but only for very broad segments.

3.2.2. The role of industry and the pMS as sources of information

Industry and the pMS will be important sources of information for the studies and EDA must be aware of the opportunities and limits of information collection from these key stakeholders.

We noted that the pMS were faced with considerable difficulties associated with the willingness of industry to provide some kinds of financial and business strategic information required for studies on a national basis. Industry is likely to be even more cautious in sharing commercially sensitive information with EDA than it is with the pMS and the sharing of information beyond that at the general level is likely to require trust building (hence our emphasis in an earlier section on the importance of building confidence amongst stakeholders). Even then there is information that companies will not be willing to disclose because of concerns of commercial confidentiality.

We also noted that the pMS collect a great deal of information. This includes information on the demand for the DTIB's products and services; DTIB capabilities and competencies; supplier contract performance; financial and economic performance; and, DTIB structure. Some of this information is published either in defence or national statistics or in White Papers and DTIB studies but much of this information is for internal use. EDA will need to explore the extent to which pMS are willing to share this information since it could play a useful role in a study of the DTIB in Europe.

Information from industry and the pMS

- During bilateral meetings and at our Expert Group Meeting, industry and pMS indicated their willingness to share some information but strongly indicated that a large data collection exercise on the part of EDA involving a large number of requests for detailed information through questionnaires and meetings would be highly costly to stakeholders and for this reason amongst others it would be unlikely to get stakeholder commitment.

- It is critically important that EDA is aware that information collection can be highly costly and burdensome for stakeholders. Stakeholders are most likely to share information where it is readily at hand, does not require a great deal of time to collate and where it is not regarded as sensitive.

3.2.3. The key role of experts

EDA has a great asset in conducting studies of the DTIB in Europe, namely the possibility of drawing on the expertise of the pMS as well as internal experts. Ultimately, studies of the DTIB in Europe are likely to rely heavily on a strong input from expert analysts who have a deep knowledge of the defence industry and the particular sector.

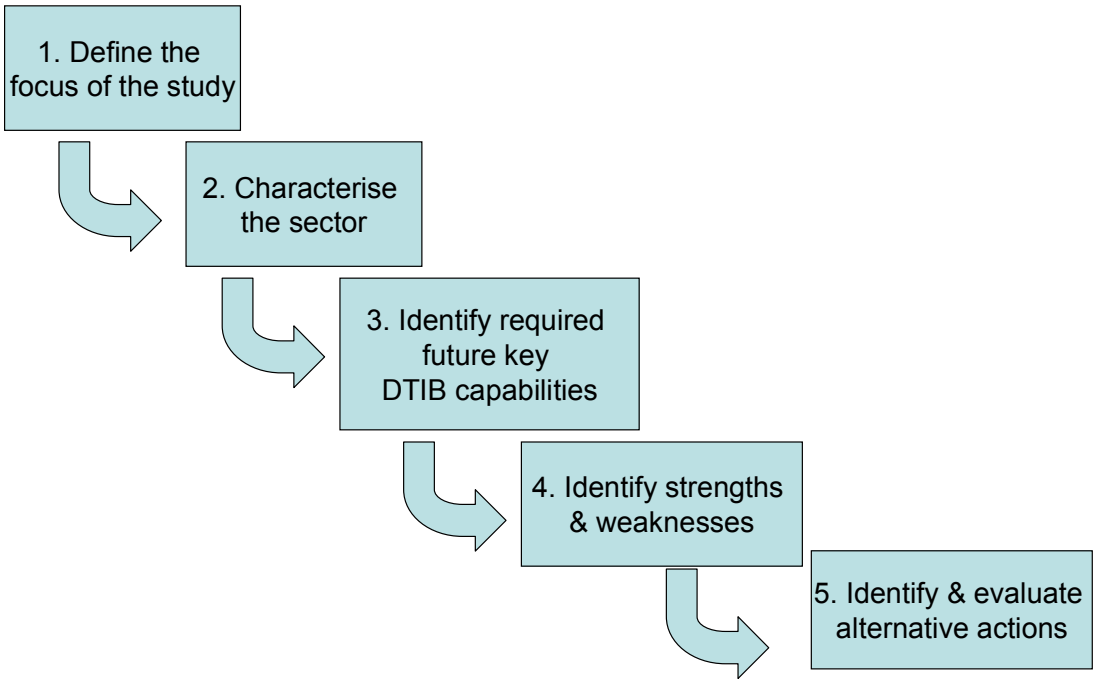
These experts are likely to come primarily from MODs, procurement agencies and defence laboratories of the pMS. Experts from industry and from the financial investment community may also be engaged as may academics with appropriate sectoral expertise.

> EDA has a great asset in conducting studies of the DTIB in Europe, namely the possibility of drawing on the expertise of the pMS as well as internal experts. Sector experts are likely to be crucial to EDA studies. Sector experts are able to draw on experience from previous studies; they are aware of the available information on the sector and how to collect it; and they are also capable of using their expert knowledge to make informed judgments on the strengths and weaknesses of the sector.

3.3. A five step methodology

We recommend a five-step approach that would be common to all studies. We believe that the five-steps that we identify represent important generic stages that ought to be considered in any study irrespective of its scale. At each step, we pose a series of questions that EDA may wish to consider although as we have already emphasised it is not our intention that all the questions need to be addressed for all studies. For each question, we identify the information that would need to be collected and the tools and techniques that could be used to collect that information. We use the EDA Steering Board's statement as our starting point. The five steps are set out in Figure 3.1.

Figure 3.1: The proposed methodology



The five steps of the proposed methodology:

Step 1: Define the focus of the study:
The first step should be to define the focus of the study and address the following questions:

- What are the aims of the study?
- Should the study assess a sector or a sub-sector?
- Will the study include an assessment of the supply chain?

Step 2: Characterise the sector:
The second step of the study should be to characterise the sector. This characterization stage should aim to establish a general understanding of the sector. The questions may include:

- Defining the sector: who are the suppliers of products and services in the sector?
- What is the demand for the sector's products and services?
- What is the structure of the sector?
- What factors are driving changes in the operating environment for the sector?
- What are competitive conditions in the sector?

Step 3: Identify required future key DTIB capabilities:
The third step of the study should be to identify the key DTIB capabilities that are necessary to support future military requirements. The questions may include:

- What is an appropriate taxonomy of EDTIB capabilities for the sector?
- What is the desired level of national and European operational sovereignty in the capabilities?
- What capabilities are needed to sustain a viable EDTIB in the sector?

Step 4: Identify the strengths and weaknesses of the identified key EDTIB capabilities:
The fourth step is to identify the strengths and weaknesses of the key EDTIB capabilities that were identified in Step 3. An assessment of the strengths and weaknesses of the EDTIB raises three main questions:

- Is the sector able to meet pMS and EU capability needs?
- Does the sector have the necessary competencies?
- Is the sector competitive?

Step 5: Identify and evaluate alternative actions
The final step is to identify and evaluate alternative actions to address the issues identified by the DTIB study. The study team was not asked to address this matter but we make some observations on how best to manage the process of turning the analysis contained in the study into actionable outcomes.

3.4. Step one: define the focus of the study

The first step of any study should be to engage with stakeholders to define the focus of the study and in particular to address the following questions:

3.4.1. What are the aims of the study?

At the very outset, there is a need to clearly define the objectives of the study, its terms of reference and its link to policy objectives. This is vital since it will drive all aspects of the conduct of the study: the questions that need to be considered; the tools and techniques that are required to gather information; and, the resources needed. To ensure stakeholder engagement, there should be early and detailed discussions of these matters with pMS, ASD and other stakeholders such as the European Commission.

> A clear definition of study aims is critical since those aims will determine the tools and techniques that are appropriate to the task. The study aims should also be scaled to fit the resources available.

3.4.2. Should the study assess a sector or sub-sector?

A key technical decision that will need to be also need to be made at the outset is whether the study will focus on a sector or sub-sector. In the case of large and complex sectors, a preliminary scoping study should be undertaken to understand the characteristics of the sector. The scoping study would need to identify the key systems, sub-systems and components that comprise the sector. In particular, it needs to identify whether the sector is comprised of distinct sub-sectors and whether the industrial and technological characteristics of those sub-sectors differ sufficiently for them to require separate analysis. The scoping study should be undertaken by EDA staff and in consultation with ASD and pMS experts.

> Where a sector is comprised of distinct sub-sectors and those sub-sectors have very different industrial and technological characteristics, it may be appropriate to consider whether a study of the whole sector is feasible or whether it might be better to focus the study on an assessment of one sub-sector.

3.4.3. Will the study include an assessment of the supply chain?

A thorough analysis of a sector (or one of its constitute sub-sectors) would include an analysis of the supply chain and the methodology that we propose assumes that key suppliers will be included alongside prime contractors at each stage of the assessment. This raises an important question for the scope of the study, namely will the analysis of

suppliers be confined to first tier suppliers (major sub-system manufacturers and suppliers of materials used directly by primes) or will it also include lower tiers of the supply chain (including manufacturers of components who supply to first-tier suppliers). A thorough analysis of the supply chain that includes all first tier suppliers and also looks at critical vulnerabilities arising from the lower tiers of the supply chain can be a complex and time consuming process. We noted in our discussion of pMS practices that few pMS have developed effective tools and techniques to assess supply chains in this way.

> The importance of considering the supply chain should be recognized and the methodology that we propose assumes that key suppliers will be considered alongside prime contractors at each stage of the assessment. One solution to the potential complexity of such a task may be to work with stakeholders to focus the supply chain element of the study on areas of particular concern to stakeholders and in particular key supply chain vulnerabilities and weaknesses.

3.5. Step two: characterise the sector

The second step of the study should be to characterise the sector. This characterization stage should aim to establish a general understanding of the sector. A number of questions may be addressed here depending on the scale and scope of the study and the existing state of knowledge about the sector. The questions may include:

3.5.1. Defining the sector: who are the suppliers of products and services in the sector?

In characterizing the sector, we might wish to identify those companies who supply products and services in this sector, both in Europe and the rest of the world. We define suppliers here as being not only prime contractors but suppliers of sub-systems, components and materials and suppliers of services that support the through-life management of equipment. Especially for services and for components, there may well be suppliers who would not necessarily be characterised as part of the DTIB as traditionally defined but these suppliers may well be important. We note that the EDA Steering Board statement (and other initiatives by EDA) emphasizes the importance attached to the geographical distribution of defence production in Europe and this also should be taken into account.

Questions on the suppliers of products and services in the sector may include:

- Who are the European prime contractors and systems integrators? Where are they located?
- Who are the European suppliers of major sub-systems? Where are they located?
- Who are the suppliers of key components, materials and services? Where are they located?
- Who are the major suppliers in the rest of the world?
- Are there non-defence suppliers of these products and services?

What information is required and how might it be collected?

- **The information could be collected through desk research supported by an expert group meeting:** gathering the information to address these questions could be a costly and complex task in itself especially if it were decided to include lower tiers of the supply chain. Therefore, we stress that this task should take the form of a general overview rather than a detailed analysis and we recommend that EDA work with stakeholders to identify critical suppliers in the supply chain and focus attention there. **The information could be gathered from:**
- **Expert knowledge:** sector experts in the pMS, industry and elsewhere are likely to have a good idea of the main suppliers of products and services in this sector.
- **Commercial market research reports and databases:** there may be market research reports on the sector that identify the main suppliers in the sector. Equally, the interrogation of commercial databases on the defence industry and market is likely to generate useful information.
- **Industry associations:** ASD and its member industry associations are likely to have some information on European suppliers of products and services in the sector, at least for the larger companies. A number of national industry associations produce marketing material that describes the capabilities of their members and analysis of this material may help identify suppliers.
- **The European Commission MEDI database:** we noted that DG Enterprise has sponsored the design and development of a database on the European defence industry that is intended to include information on companies and their activities in the European defence industry including information on their products, employment, R&D and location. If this data is published then it could provide a very useful starting point.

3.5.2. What is the demand for the sector's products and services?

In characterizing the sector, we might also want to assess demand for the sector's products and services, both in Europe and in the rest of the world.

Questions on demand may include:

- **What is the current and anticipated future pMS demand for the sector's products and services?** This would include not only new programmes but demand for upgrades, service support and so forth;
- **What is the current and anticipated future demand for the sectors products and services in major markets in the rest of the world?**
- **What is the non-defence demand for the sector's products and services?** There may be non-defence demand for the sector's products and services not least for components.

What information is required and how might it be collected?

- **The information could be collected through desk research supported by an expert group meeting:** The information could be gathered from:
- **Expert knowledge:** again, sector experts in the pMS, industry and elsewhere are likely to have a good idea of the current and anticipated future pMS demand for the sector's products and services in Europe and the rest of the world. Industry experts are also likely to be able to estimate the non-defence demand for the sector's products and services.
- **Commercial market research reports and databases:** where available, good market research reports on the sector are likely to include a detailed analysis of the demand side and the interrogation of commercial databases on the defence industry and market is likely to generate useful information.
- **Investment bank reports:** Analyst's reports often contain detailed information on the demand side at the sectoral level.
- **The pMS:** we noted in our review of pMS practice that pMS DTIB studies typically collect information on anticipated future customer requirements, budgets and programmes.
- **EDA:** the Capabilities Directorate is likely to have detailed insights into demand at the EU level through its work on the Capability Development Plan.

3.5.3. What is the structure of the sector?

In characterizing the sector, we would also want to understand the structure of the sector and this would require an assessment of features such as ownership; industry concentration and the nature of the supply chain.

Questions on the structure of the sector may include:

- **What is the ownership of the sector?** We would wish to assess the extent to which state ownership is still important in the sector; the importance of trans European defence companies and the existence of "national champions"; the extent of non-European ownership in the sector; and, the important alliances and joint ventures in the sector.
- **How concentrated is the sector?** Here we would wish to know whether a small number of companies account for a large share of sales in the sector.
- **How vertically integrated is the supply chain?** Is it typical for prime contractors to rely on internal sources for sub-systems or components or is there an extensive supply chain?

What information is required and how might it be collected?

- **The information could be collected through desk research supported by an expert group meeting:** The information could be gathered from:
- **Expert knowledge:** again, such features are likely to well known to sector experts in the pMS, industry associations, individual companies and elsewhere.
- **Commercial market research reports and databases:** again, where available, good market research reports on the sector are likely to include a detailed analysis of the structure of the sector, estimates of the market share accounted for individual companies as well as the character of ownership in the sector.

3.5.4. What factors are driving changes in the operating environment for the sector?

To begin to understand the sector, we might wish to consider the factors that are driving change in its operating environment. A wide range of factors in the operating environment are likely to drive change and performance in the sector. These factors are not independent of one another, many are linked. Such an assessment would need to consider not only the factors that are important at present but those that may be important in the future.

Questions on drivers of change may include:

- **What is the impact of the international security environment on the demand for the sector's equipment and services in Europe and in export markets?**
- **What is the impact of changing customer capability requirements on the type of equipment and services the sector will be expected to supply?**
- **Are there important political factors that will influence the sector at the pMS and EU level?**
- **What are the economic factors that will influence the sector?**
- **Are there any technological changes that will have an important impact on the sector?**
- **Are there any legal and regulatory factors that may have a particular impact on the sector?**

What information is required and how might it be collected?

- **The information could be collected through an expert group meeting supported by desk research:** whilst analysis of the drivers of change might be undertaken as an entirely desk-based study it may be more powerful if it were conducted as a group exercise that engages experts from a variety of stakeholders. This may contribute to the process of developing consensus amongst stakeholders which we regard as an important part of the EDTIB study process. The sources of information are likely to be:

- **Expert knowledge:** such features are likely to be well known to sector experts in the pMS, industry associations, individual companies and elsewhere.

- **Defence industry and financial media:** sources such as *Jane's Defence Weekly*; the *Financial Times*; and so forth are likely to provide a starting point for understanding the drivers of change impacting the sector. Most of these sources are available through searchable databases allowing for specific searches.

- **Commercial market research reports and databases:** commercial market research reports where they are available for the sector are likely to provide an explicit discussion of drivers of change.

- **Investment analysts' reports:** reports from investment banks often include an assessment of the factors driving change in particular sectors and may provide useful information from a business perspective.

- **pMS defence industrial strategy documents and foresight reports:** the defence industrial strategies of pMS as well as foresight studies of the defence sector may also prove to be a useful source of information.

3.5.5. What are competitive conditions in the sector?

Another aspect of the sector that it may be considered useful to assess is competitive conditions in the sector. The behaviour of firms in a sector are influenced in large part by the competitive conditions in that sector and an assessment of the strengths and weaknesses of the DTIB in a sector is likely to wish to take this into account if it wishes to understand company strategies and investment decisions. In strategic management, competitive conditions are assessed using Porter's five forces framework (for more details, see Annex 6: Short reference guide on tools and methods for industrial and technological analysis).

Questions on competitive conditions in the sector:

- **What is the threat of new entrants into the sector?** Where there is plausible threat that new entrants can enter a sector, existing firms are likely to set lower prices and be more innovative. Threat of entry will depend on the extent to which there are the barriers to entry. Barriers to entry are factors that need to be overcome by new entrants if they are to compete successfully. In the defence sector, barriers to exit will also need to be taken into account. Barriers to exit are those factors (such as state ownership or state subsidy) that sustain companies who might otherwise leave the sector.

- **What is the power of buyers and suppliers?** Buyers of DTIB products and services are governments and also prime contractors. Suppliers may be prime contractors who act as suppliers to pMS or may be the supply chain that sells to prime contractors. The power of buyers and suppliers is important because they interact to influence the strategic freedom of an organization and its profitability.

- **What is the threat of substitutes?** Are there potential alternatives to the products and services provided by the sector? For instance, UCAVs represent a substitute for manned combat aircraft that could have important consequences for competitive conditions in the air systems sector.

- **What is the degree of rivalry between suppliers?** Competitive rivals are companies with similar products and services that are aimed at the same customer group. Competition is likely to be more intense where there are multiple companies competing in the same sector.

Sources of information on competitive conditions in the sector:

- The same sources of information that could be used to assess change drivers could also be used to assess competitive conditions in the sector

3.6. Step three: identify the required future key EDTIB capabilities in the sector

The third step of the study should be to identify the key current and future DTIB capabilities in Europe that are necessary to support future military requirements. An assessment of required future key EDTIB capabilities needs to take into account future pMS and EU military requirements through-life.

> We define DTIB capabilities as the technologies, skills, knowledge, facilities and equipment and processes needed to design, develop, produce, repair, maintain or dispose of equipment used by the military.

3.6.1. Develop a taxonomy of EDTIB capabilities

The first stage should be to develop a taxonomy of industrial and technological capabilities for the sector. This will provide a clear basis for subsequent analysis. The WEAG Technology Taxonomy could be used as a starting point for this exercise. The WEAG Technology Taxonomy classifies underpinning technologies (A); systems-related technologies (B); and, also includes a typology of business processes (C08).[4]

Questions for the EDTIB capabilities taxonomy might include:

- **What are the DTIB capabilities needed to meet readiness and sustainment of existing equipment?** We recommend that the process begins by identifying the DTIB capabilities that will be required to maintain equipment that is already in service.
- **What are the DTIB capabilities needed for the modernization or upgrade of existing systems?** Platforms and systems have increasingly long lives, the modernization and upgrade of those systems is an important element of acquisition policy and this is likely to become even more the case in the future (see section 4 of this report). This, identification of the DTIB capabilities needed for modernization and upgrade of existing platforms and systems is important.
- **What are the DTIB capabilities needed for the design, development or manufacture of the next generation of equipment?** The taxonomy would also want to consider the DTIB capabilities needed for the next generation of equipment.

[4] *New WEAG Technology Taxonomy 2004*, Western European Armaments Group.

What information is required and how might it be collected?

- The development of the typology should be undertaken by an Expert Group comprising experts from industry, the pMS and EDA.
- The Expert Group should begin by reviewing the WEAG Technology Taxonomy and assessing its suitability.
- The Expert Group may choose to use the WEAG Technology Taxonomy or use it as a starting point for a revised taxonomy.

3.6.2. What is the desired level of European and national operational sovereignty?

After developing the EDTIB capability taxonomy, the next stage should be to use that taxonomy to identify priority DTIB capabilities for Europe. The EDA Steering Board statement emphasizes that a capability-based EDTIB should be able to sustain the necessary level of European and national operational sovereignty. Thus, it would be desirable for the study to establish the desired level of European and national operational sovereignty in the industrial and technological capabilities supplied by the sector.

Questions on the desired level of European and national operational sovereignty:

- **Is national industrial capability required?** There may be DTIB capabilities where a pMS is not willing to rely on sources outside its own national DTIB. The "national level of ambition" may vary, of course, from being: an intelligent customer/user; having the ability to define technical specifications; to, technical/manufacturing capability in industry. This national level of ambition will influence the industrial capabilities needed at the national level.
- **Is EU industrial capability required?** There may be situations where a pMS is not willing to rely on DTIB capabilities from outside Europe and where the pMS believes that EU countries must work together, to sustain or build a cross-European capability. This may assume efforts to move towards bilateral or small group collaboration or multilateral collaboration.

What information is required and how might it be collected?

- **EDA Industry & Market's key industrial capabilities exercise:** EDA Industry & Market has already undertaken an exercise to identify key industrial capabilities for preservation or development in Europe. The information gathered by EDA through its questionnaire and bilaterals with the pMS could be used as a starting point for this exercise. A first step should be to review the information gathered through that exercise.

- **EDA Research & Technology's exercise to identify key technologies:** EDA Research & Technology has engaged with pMS and ASD in the identification of key technologies. The information gathered from this exercise may be useful.

- **pMS:** where there are gaps in understanding about the desired level of European and national sovereignty in the DTIB capabilities for a sector, clarification could be sought through a questionnaire to the pMS; and, bilateral and group meetings with pMS.

3.6.3. What capabilities are needed to sustain a viable EDTIB?

The identification of the desired level of European and operational sovereignty is from the customer perspective. However, there is a complementary and interlinked question that needs to be considered from the perspective of industry, namely what capabilities are needed to sustain a commercially viable EDTIB.

Questions on the capabilities needed to sustain a viable EDTIB:

- **What capabilities are needed to maintain a presence in the sector?** There are likely to be some technological and industrial capabilities that are needed by European industry simply to compete in the sector and without which the sector may have to exit the market.

- **What capabilities are needed to achieve competitive advantage in the sector?** There may be other capabilities that are needed by European industry to provide a competitive advantage over other non-European sources of supply and without which the sector would lose competitive advantage.

What information is required and how might it be collected?

- **Meetings with industry:** this information could be collected through meetings with ASD and individual companies.

- **Industry opinion survey:** EDA might also wish to consider using an opinion survey as a means of gathering information on the opinions of a wider cross-section of companies (including suppliers and SMEs) and experts from across Europe. EDA might wish to explore whether such an opinion survey could be developed and conducted jointly with ASD and its member associations.

3.7. Step four: identify EDTIB strengths and weaknesses

The fourth step of our proposed methodology goes to our key task and assesses the strengths and weaknesses of the key EDTIB capabilities that were identified in Step 3. Following the EDA Steering Board's statement, we propose that an assessment of the strengths and weaknesses of the DTIB in Europe should address three core questions: (1) Is the sector able to meet pMS and EU capability needs? (2) What are the competencies of the sector? (3) Is the sector competitive? In the following sections, we consider how EDA might address each of these questions by identifying a number of sub-questions. We also identify the tools and techniques that EDA could use to gather the necessary information to answer these questions.

There are a very large number of potential indicators of the strengths and weaknesses of the DTIB in Europe. In the following sections we describe a selection of those indicators and note some of their strengths and weaknesses. Our intention is to set out a range of tools and techniques that could be used but we emphasise that it will be the responsibility of EDA's study team to select of those tools and techniques that best meet the specific objectives of the study; the time and resources available for the study; and the level of commitment of the stakeholders. We state once again that it is not our intention to suggest that all these tools and techniques should be used in a single study.

Is the sector able to meet pMS and EU capability needs?

To address this question, we recommend that EDA adopt a gap analysis approach that considers:

- What are the key EDTIB capabilities needed to deliver future pMS and EU military requirements?
- Will the EDTIB be able to sustain and develop the necessary capabilities to meet these pMS and EU military requirements?
- What are the implications of identified strengths and gaps between EDTIB capabilities and future pMS and EU military requirements?

What are the competencies of the sector?

To address this question, we recommended that EDA uses a variety of information collection methods including: desk-based collation and analysis of publicly available information, including commercial data bases and market research reports; and meetings with sector experts from the pMS, industry and elsewhere, to consider:

- What are the strengths and weaknesses of the EDTIB's technology portfolio?
- Does the EDTIB develop and sustain key, pacing and emerging technologies?
- Does the EDTIB promote innovation from non-defence sources?
- Does the EDTIB field new technologies quickly?

What is the competitiveness of the sector?

To address this question, we again recommended that EDA uses a variety of information collection methods including: desk-based collation and analysis of publicly available information, including commercial data bases and market research reports; meetings with sector experts from the pMS, industry and elsewhere, to address the following questions:

- What is the international competitiveness of the sector?
- Are companies economically viable?
- Are companies investing in the future?
- Are suppliers able to manage effectively requirements peaks and troughs to maintain specialist skills?
- Do suppliers attract cooperation with non-European partners?
- What is the contribution of the sector to overall economic growth?

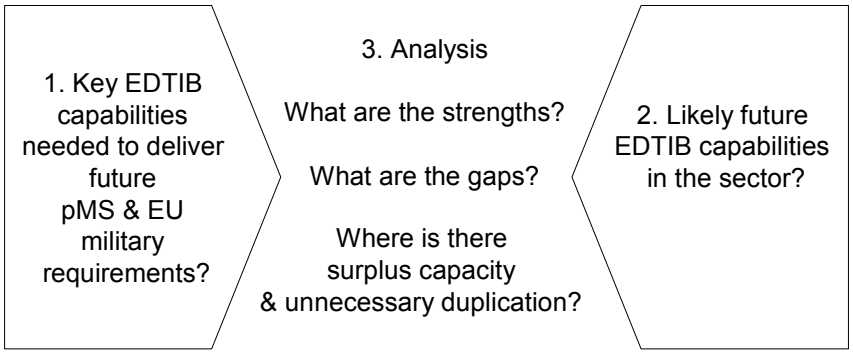
3.8. Step 4.1: Strengths and weaknesses: is the sector able to meet pMS and EU capability needs?

A key measure of the strengths and weaknesses of a sector is its ability to meet pMS and EU capability needs. The EDA Steering Board identifies a capability driven EDTIB as being responsive to pMS and EU defence needs and thus being capable of delivering and sustaining key military capabilities; providing complex system of systems solutions; sustaining and upgrading platform over the long-term, and sustaining the necessary levels of European and national operational sovereignty.

These features of a strong EDTIB are closely inter-related and we propose that they would be best considered together. To address this question, we recommend that EDA adopt a gap analysis approach that considers: (1) the key EDTIB capabilities needed to deliver future pMS and EU military requirements; (2) the ability of the EDTIB to sustain and develop capabilities to meet those requirements; (3) the future strengths as well as

potential gaps between future pMS and EU military requirements and likely future EDTIB capabilities. This gap analysis approach is illustrated in Figure 3.2.

Figure 3.2: Assessing the ability of the sector to meet pMS and EU capability needs



An assessment of the ability of a sector to meet pMS and EU capability needs should address the following questions:

3.8.1. What are the key EDTIB capabilities needed to deliver future pMS and EU military requirements?

The starting point for the assessment is an understanding of the key capabilities needed to deliver future pMS and EU military requirements. This provides a statement of where we want to be in terms of future EDTIB capabilities.

How can this information be collected?

This information will already have been collected under Step 3 of the methodology to generate a list of key DTIB capabilities needed to (1) meet readiness and sustainment of existing equipment; (2) for the modernization or upgrade of existing systems; and, (3) for the design, development or manufacture of the next generation of equipment.

3.8.2. What are the likely future EDTIB capabilities in this sector?

The next step is to consider the likely future EDTIB capabilities that will exist in this sector. The emphasis here is on developing views on what the future EDTIB capabilities are likely to be. The sustainment and development of EDTIB capabilities depends on the business decisions of companies but the willingness and ability of industry to sustain and develop these capabilities are intimately linked to the decisions of industry's customers. Thus, an assessment of this kind needs to consider not only the trajectory of industry's own strategy and investment decisions but also likely future pMS R&T and procurement budgets, R&T spending from other sources and their consequences for likely future EDTIB capabilities.

Questions on future EDTIB capabilities in the sector:

- **What are realistic scenarios for future R&T and procurement budgets and procurement programmes?**
- **What is the impact of each scenario for future EDTIB capabilities?** Each scenario will have an impact on the EDTIB capabilities that it needs to sustain and develop; the numbers of qualified scientists, engineers and technologists that it needs to employ; the facilities and equipment required; and the processes that are needed.

What information is required and how can it be collected?

We recommend a scenario-based approach that draws on the expertise of pMS and industry. The key steps of this scenario approach should be:

1. **Collate and analyse available information on future R&T and procurement budgets and programmes:** some of the information needed is likely to have been collected as part of Stage 2 of the study (Characterising the sector) and some of this information is likely to be well known to experts in pMS and industry.

2. **Develop scenarios on future R&T and procurement budgets and procurement programmes:** the creation of realistic scenarios would be most effectively done through the use of a scenario workshop comprising experts from the pMS, industry and elsewhere

3. **Consider the impact of each scenario on future EDTIB capabilities:** analysis of the impact of the scenarios on future EDTIB capabilities conducted by undertaken as a part of the scenario workshop and could be complement by follow-up analysis through desk-based work and further meetings with stakeholders.

EDA must be aware that this is a potentially large exercise in its own right. EDA will wish to consider in consultation with stakeholders the scale of this element of the study and careful consideration will need to be given to the resource implications of such a study. A scenario workshop could be conducted in one day (although two days is normally considered to be better). However, the information collation and analysis element could vary between a short desk-study and a very detailed exercise involving face-to-face interviews, questionnaire surveys and the like. It is important that EDA recognize that we are not proposing here a full sustainability study of the type conducted by some pMS. The complex and resource intensive nature of such an approach makes it impractical and this point was made forcefully by participants in our Expert Group Meeting. Instead, the intention is to use this approach as a framework for discussion between stakeholders.

3.8.3. Gap analysis: where are there likely to be strengths, gaps or excess capacity in the future?

The third stage of the process would be to compare the key EDTIB capabilities that are needed to deliver future military requirements with the likely future shape of EDTIB capabilities to identify anticipated future strengths, gaps and excess capacity.

Questions on the implications of gaps:

- **What are the likely future strengths of the EDTIB?** The gap analysis will wish to identify where the EDTIB is likely to be able to deliver future pMS and EU military requirements under the R&T and procurement scenarios. This is likely to lead to a discussion of how actions at the European level may be able to strengthen these strengths.

- **What are the likely gaps between future military requirements and future EDTIB capabilities?** The gap analysis will also wish to identify any shortfalls between what pMS and EU military requirements demand in the future and the capacity of EDTIB capabilities to meet those demands. In particular, the analysis will wish to consider whether identified shortfalls in DTIB capabilities have consequences for vulnerability to non-European sources of supply and the desired level of national and operational sovereignty**.**

- **Where is there likely to be surplus capacity and unnecessary duplication?** The gap analysis will also wish to identify EDTIB capabilities where there may be surplus capacity and/or unnecessary duplication of EDTIB capabilities in the future when compared to likely future pMS and EU military requirements. In particular, attention will want to be paid to identified excess capabilities that have consequences for the performance of the DTIB in Europe by increasing the cost base through duplication of assets and low facility utilization. Equally, however, where the pMS and EU are not the only customers exports may sustain capacity at a level above that required by the pMS and EU. Equally, some duplication may be desirable to sustain competition.

How could this information be collected?
This analysis requires the expert judgment of sector specialists from the pMS, ASD and individual companies and would benefit from the input of the military at both pMS and EU level.

3.9. Step 4.2: Strengths and weaknesses: what are the competencies of the sector?

The EDA Steering Board statement characterises a competent EDTIB as being capable of delivering cutting-edge technology on time by: promoting innovation also from other sources including academia; developing and sustaining key technologies (with a particular focus on disruptive technologies); and, accelerating the fielding of new technologies. Thus, an assessment of the strengths and weaknesses of EDTIB competencies would likely address some or all of the following questions:

3.9.1. What are the strengths and weaknesses of the EDTIB's technology portfolio?

To assess sector competencies, we might wish to begin by identifying the key, pacing and emerging technologies that are likely to be important to the sector in the future and to assess the strengths of the EDTIB in those technologies.

Questions on the EDTIB's technology portfolio:

- **What are the key, pacing and emerging technologies in the sector?** One way that EDA may classify technologies is to consider the military capability advantage that may be derived from that technology as follows: **base technologies** are essential to the functioning of the military but do not provide significant capability advantage (because the technologies are equally available to potential adversaries); **key technologies** are critical for achieving military advantage today; **pacing technologies** may have a substantial impact on capability in the reasonably near future; and, **emerging technologies** may have an impact on future capabilities but that impact remains uncertain.

- **What is the strength of the EDTIB in each key, pacing and emerging technology?** The exercise would also need to assess the strength of the EDTIB in each key, pacing and emerging technology. The strength may be relative to potential military adversaries and/or other competing DTIBs. One way that EDA might classify the technologies is as follows: **dominant** (the EDTIB leads the world in the particular technology); **strong** (the EDTIB can pursue its strategy with little consideration for the moves of rivals; **favourable** (there is no clear leader amongst strong rivals) **tenable** (the EDTIB has strengths in some niches); and, **weak** (there are critical weaknesses).

Answers to these two questions could be used to construct a matrix as set out in Figure 3.3.

Figure 3.3:
Current & future technology portfolio

Capability advantage from technology

EDTIB competitive strength

	Base	Key	Pacing	Emerging
Dominant				
Strong				
Favourable				
Tenable				
Weak				

What information is required and how can it be collected?

- **Expert meetings of pMS and industry:** this type of exercise requires the deep knowledge of experts in the field and would be best collected from meetings of experts from pMS, industry and the military. Expert judgment will be needed to seek a consensus on the technologies where European has strengths and those where it is in a weak position.

- **Work conducted during stage 3 of the methodology:** these expert meetings could be supported by the work on key EDTIB capabilities identified during Stage 3 of the study.

- **EDA R&T initiatives:** EDA's R&T Directorate may well have gathered relevant information from their activities.

- **Opinion survey:** there might be a case for conducting a survey to gather the opinions of a wider range of experts from the pMS, industry, defence research laboratories, research institutes and universities.

3.9.2. Does the EDTIB develop and sustain these key, pacing and emerging technologies?

As a next step in assessing the competencies of the EDTIB we might wish to assess the strengths and weaknesses of European programmes, the supplier base and the skills base. These all contribute to sustaining and developing the technology base.

Questions on developing and sustaining key, pacing and emerging technologies:

- **What are the main European R&T programmes in key, pacing and emerging technology areas and are these adequate?** R&T programmes may include pMS defence R&T programmes; bilateral or multilateral defence R&T programmes; programmes conducted under EDA; industry's own funded R&T programmes; and, programmes supporting generic and dual use technologies under the European Commission Framework programme or individual pMS civilian programmes.

- **Are there an adequate number of competitive suppliers in key, pacing and emerging technology areas?** In assessing the ability of the EDTIB to develop and sustain technologies, an assessment might wish to consider whether there are sufficient suppliers with capabilities in the particular technology areas. These suppliers may be existing large contractors, they may be in the supply chain or they may be SMEs or start-ups located in non-defence sectors. This analysis might also wish to identify any critical vulnerabilities to non-European sources of supply.

- **How sustainable is the skills base?** Developing and sustaining key technologies is also about the body of qualified scientists and engineers that are available to the sector and an analysis of sector competence might wish to consider the condition of the skills base, whether there is a critical mass of such skilled people and whether trend developments will sustain such a body of skilled staff. The focus of should be on both stocks and flows of QSEs where flows require consideration of the output of education and training establishments (e.g. universities; colleges; and, industry training).

What information is required and how can it be collected?

- **Expert meetings of pMS and industry:** again, this type of exercise requires the deep knowledge of experts in the field and this would best be collected from meetings of experts from pMS, industry and the military. Expert judgment will be needed to seek a consensus on Europe's ability to sustain and develop these technologies.

- **Desk research to collate existing studies and information**: this exercise would also need to be supported by desk research. Individual pMS have engaged in extensive work on these topics and there are a number of foresight studies that have assessed future defence technologies.[5] Industry & Market will wish to draw on the work that has been conducted by pMS, industry and EDA Research & Technology on identifying key technologies in Europe. This will need to consider spending by pMS, industry and at the European level.

- **European Commission:** another source of information on the technology and skills base is likely to be the European Commission. DG Research conducts work assessing the strengths and weaknesses of the European science and technology base. DG Employment conducts work on European employment and skills.

- We emphasise that **this is a potentially complex study in its own right** but the intention here is that the question would stimulate a general and top-level review, drawing on inputs from industry associations, individual companies, pMS and experts to identify key trends and potential threats.

[5] For example, the French PP30 ans; the Swedish FMV's "Future trends in defence technology – 100 experts make their predictions", Swedish Defence Materiel Administration (FMV); and, the UK's Defence Technology Strategy.

3.9.3. Does the EDTIB promote innovation from non-defence sources?

The EDA Steering Board also emphasizes the importance of promoting innovation from non-defence sources.

Questions to assess the promotion of innovation from non-defence sources:

- **Do new and innovative suppliers enter the marketplace and compete for defence business?** One way in which innovation can emerge from non-defence sources is through new and innovative suppliers entering the defence market. These new entrants may seek to sell directly to MODs or they may seek to enter the supply chain to prime contractors. These suppliers may be new companies or they may be existing companies from non-defence markets. Of course, the ability of new suppliers to enter the defence market depends in part on the acquisition processes of pMS and the supply chain strategies of the prime contractors. However, by addressing this question we would expect expert analysts to consider the extent of new entrants and - where this is low - why that is the case and whether it demands policy action at the European level.

- **Do companies exhibit strong networking with the university sector and non-defence sources of knowledge?** Another way that innovation can emerge from non-defence sources is through links with the university sector. These links may be direct through research programmes with universities or they may be indirect through multi-partner collaborative research programmes that include university partners. In addressing this question, we would expect expert analysts to consider the extent of networking with universities and - where this is low - why that is the case and whether it demands policy action at the European level.

- **What is the level of engagement in the European Commission Framework Programme and other non-defence programmes at the EU and pMS level?** A further measure could be the extent to which the sector engages in the European Commission Framework Programme and other non-defence programmes. Engagement in the Framework programme may be through the Security Research Programme but could also be through other parts of FP7.

- **Do companies compete in non-defence (dual use) markets?** The extent to which companies in the sector also compete in non-defence sectors may also be examined as a possible measure of the extent to which innovation emerges from non-defence sources. Of course, the fact that a company has non-defence business does not mean that it utilizes common technologies for its defence and non-defence businesses. Thus, the organization of companies in the sector would need to be taken into account and in particular the extent to which it draws on common technology platforms for its defence and non-defence businesses.

What information is required and how might this be collected?

- **Expert panel:** an assessment of strengths and weaknesses in this aspect would best be conducted by an expert panel comprising ASD, individual companies, pMS and the European Commission

- **European Commission assessments:** EDA could ask the European Commission (DG Research and DG Enterprise) for its assessment of the extent of engagement by the sector.

3.9.4. Does the EDTIB field new technologies quickly?

The EDA Steering Board also emphasizes that a strong EDTIB fields new technologies quickly. Examining time-to-fielding of new technologies is problematic since the time that it takes industry to field new technologies is only in part a function of industry's own processes. In large part, it is linked to pMS acquisition processes and the willingness of the pMS to fund the demonstrators and new procurement programmes that act as the platforms for those new technologies. Nevertheless, as part of the study it would legitimate to ask experts for their judgment on this matter.

Questions to assess the speed of technology adoption:

- **What are the barriers to fielding new technologies quickly in this sector?** An assessment of this issue may wish to consider the barriers to fielding new technologies quickly. Since the focus of the study is on the DTIB at the European level, it is most appropriate that the assessment focuses on barriers that are clearly at the European level rather than concern itself with issues that relate to the acquisition practices of individual pMS.

- **How could actions at the European level help the fielding of new technologies in this sector?** Again, the focus of the assessment should be on actions that could be undertaken at the European level, rather than by individual pMS.

What information is required and how might this be collected?

- **Expert panel:** this information would be best collected through an expert panel comprising pMS, ASD and individual companies.
- **Survey of pMS and industry:** in addition, a survey of pMS and industry could be used to identify barriers to the rapid adoption of new technologies and how actions at the European level might help the fielding of new technologies in the sector.

3.10. Step 4.3: Strengths and weaknesses: what is the competitiveness of the sector?

The EDA Steering Board statement characterises a competitive EDTIB as one that, in business terms: provides cost efficiency; enables global exports; attracts cooperation with non-European partners; and, contributes to overall economic growth, not least amongst SMEs. Thus, an assessment of EDTIB competitiveness would likely address some or all of the following questions:

3.10.1. What is the international competitiveness of the sector?

A key indicator of the competitiveness of the sector is its performance against non-European competitors both in European and rest of the world markets.

Questions on the international competitiveness of the sector:

- **What is the balance of trade in the sector?** The balance of trade is the difference between the value of exports by the sector to the rest of the world and the value of imports into the EU defence market. A sector with a positive trade balance (value of exports exceeds value of imports) is likely to be more competitive than one with a negative trade balance.
- **How does the sector perform in head-to-head competitions with others in export markets?** We would expect a strong EDTIB to be able to win competitions for contracts in the rest of the world when faced by competitors from other exporting nations.
- **How does the sector perform in head-to-head competitions with others in European markets?** We would expect a strong EDTIB to be able to win most competitions for contracts in the European market when faced by competitors or teams with a strong non-European element.

What information is required and how might this be collected?

1. **European Council Report on the European Union Code of Conduct on Arms Exports:** this annual report contains detailed data on arms exports by EU country of origin and country of destination and by category using the EU Common Military List categories.

2. **Expert assessments:** experts from ASD, companies and the pMS are likely to have views on the international competitiveness of the sector.

3. **Commercial market research reports:** commercial market research reports where available for the sector are likely to include assessments of its international competitiveness.

4. **Investment analysts' reports:** reports from investment banks typically contain SWOT analyses of key companies and this may help in an assessment.

3.10.2. Are companies economically viable?

An assessment of the strengths and weaknesses of the EDTIB must as a matter of critical importance take into account the economic viability of the companies that constitute the EDTIB. The EDTIB is comprised of companies who are increasingly shareholder owned albeit with minor state holdings in some cases. This means that the stock market evaluates defence companies using the same criteria as for other sectors of the economy. Sectors of the EDTIB that are attractive to companies and their shareholders will receive private investment whilst sectors that are unattractive from a business perspective are likely to see companies exit the sector in favour of more financially attractive alternatives. This is important for an assessment at the European level since such changes may have a direct impact upon the capacity of the EDTIB to deliver needed capabilities and for the sustainment of the necessary levels of European and national operational sovereignty.

Questions on the economic viability of companies:

- **Do companies have a stable or expanding market for their products and services?** All other things being equal we would expect companies with a stable or expanding market for their products and services to be more economically viable than those facing a declining market.

- **Are companies receiving a fair return on investment?** The return on investment (ROI) that a business receives is an important measure of its long-term viability and is a standard metric used in the financial analysis of companies and their business units. However, it is open to differing interpretations. First of all, the ROI from a defence contract may depend to a large extent on the profit formula set by the defence customer. At the same time, what is deemed a reasonable ROI by one business may be regarded as poor by another business. Indeed, this is particularly the case where a business faces high barriers to exit and is unable to move its capital to other uses - in those circumstances; such a business may accept a low ROI absent an alternative.

- **What is the relative share price performance of the companies?** Another potential measure of economic viability that could be considered is the share price of companies. This metric also has significant weaknesses (see section 2.4.4 and Annex 3 for a discussion) nonetheless in an environment where shareholder value plays an increasingly important part in the strategic behaviour of companies this metric is worth reviewing, at least as part of a "basket" of financial and economic performance measures.

What information is required and how might it be collected?

- **Expert assessments:** experts from ASD, companies, the pMS and the financial investment community are likely to have views on the economic viability of the sector.

- **Commercial market research reports:** commercial market research reports where available for the sector typically include assessments of its international competitiveness.

- **Investment analysts' reports:** reports from investment banks typically include detailed assessments of market demand, the financial performance of individual companies and so forth.

- **Share price data:** the study might also wish to look at share price data as an indicator of economic viability although the weaknesses of this measure will need to be taken into account. Share price data is readily available from a variety of on-line sources or from the web sites of individual companies.

3.10.3. Are companies investing in the future?

Given the difficulties of interpreting standard corporate financial metrics, alternative measures of DTIB competitiveness have been developed by some pMS and they may be useful for a study of the EDTIB. One measure of the competitiveness of the EDTIB is whether companies are investing in the future since this is a strong indicator of whether those companies think that the European industry is viable and attractive as a place to do business.

Potential questions on company investment behaviour:

- **What is the trend in capital expenditure of companies in the sector?** CAPEX is the clearest indicator of investment by a company or one of its constituent business units and an examination of CAPEX in a sector would be a useful measure of future intentions.

- **What is the trend in company funded R&D expenditure in the sector?** The limitations of R&D expenditure data has been noted but again it would be useful in giving some sense of company willingness to invest in the sector.

- **What is the extent of European merger and acquisition (M&A) and joint venture activity in the sector?** The extent of M&A and joint venture activity in Europe in a sector might also be an indicator of company willingness to invest in the future. If defence companies (or venture capitalists) are willing to invest in a sector through mergers, acquisitions or equity based joint ventures then it suggests that they regard the sector as having potential for the future. Again, the existence of M&A is open to different interpretations but is a worthwhile indicator to include in a "basket" of measures.

- **Are there indicators of a shift in investment from Europe to the rest of the world?** A further indicator of the perceived health of a sector could be signs of a shift of investment from Europe to the rest of the world. Thus, evidence that European firms have a preference for investment in acquisitions in the United States or in Asia rather than in Europe could be interpreted as a signal that those European companies regard the European industry as a relatively poor investment opportunity.

What information is required and how might it be collected?

5. This information could be collected using a mixture of desk-based research and meetings with experts.

6. **Investment analysts' reports:** reports produced by investment banks typically include assessments of sectoral trends in investment and M&A activity and company level assessments of R&D and capital investment.

7. **Commercial market research reports:** commercial market research reports where available for the sector are likely to include assessments of its international competitiveness.

8. **R&D Scoreboard:** http://www.innovation.gov.uk/rd_scoreboard/ provides information on the R&D expenditure of selected companies.

9. **Value Added Scoreboard:** http://www.innovation.gov.uk/value_added/

10. **Expert assessments:** experts from ASD, companies, the pMS and the financial investment community are likely to have views on the economic viability of the sector.

3.10.4. Are companies able to manage effectively requirement peaks and troughs to maintain specialist skills?

We would expect a strong and competitive sector to be one that was capable of effectively managing peaks and troughs in demand in a way that maintains specialist skills. Again, the nature of the defence sector means that this is also a product of pMS acquisition policy. Nonetheless, it is an issue that would merit exploration.

Questions on the management of changes in demand:

- **How have companies or individual business units responded to demand shifts?** The best measure of whether businesses are able to manage peaks and troughs in demand is through their demonstrated ability to do so in the recent past.
- **How dependent are companies or individual business units on the defence market?** All other things being equal, businesses who are highly dependent on the defence market are likely to be more vulnerable to downturns in that market although this depends on how diversified their customer and programme portfolio is.
- **How dependent are companies or individual business units on one defence customer?** Dependence on one defence customer is likely to make a business more vulnerable to downturns in demand.
- **How dependent are companies or individual business units on one or few defence programmes?** Equally, dependence on one or a few defence programmes is likely to make a business potentially vulnerable to the cancellation, delay or reduction in that programme.

What information is required and how might it be collected?

- **Expert assessments:** experts from ASD, companies and pMS are likely to be able to provide an assessment of the sector's ability to manage changes in demand.

3.10.5. Do companies attract cooperation with non-European partners?

A further measure of a competitive EDTIB emphasised by the EDA Steering Board is whether European companies attract cooperation with non-European partners. Once again, this measure is open to a wide variety of interpretation. Cooperation with non-European partners may be sign of strength but it may equally be a sign of weakness. Thus, this would need careful interpretation by experts.

Questions on cooperation with non-European partners:

- **Are foreign companies seeking to team with European companies to address specific procurement requirements?** Where foreign companies seek to partner with European companies to address procurement requirements in the foreign company's home country or in a third country this may be an indicator of the strength of the European industry in a particular sector.

- **Are foreign companies establishing alliances or joint ventures with European companies?** The extent to which foreign firms are establishing alliances or joint ventures with European companies may also be seen as a measure of the strength of the sector.

- **Are foreign investors acquiring European companies?** Again, foreign acquisitions of European companies may be seen as an indicator that European firms (and the European market) are sufficiently attractive to merit investment.

What information is required and how might it be collected?

- **The information could be collected through desk research supported by an expert group meeting:**

- **Expert knowledge:** such features are likely to well known to sector experts in the pMS, industry associations, individual companies and elsewhere.

- **Defence industry and financial media:** sources such as *Jane's Defence Weekly*; the *Financial Times*; and so forth are likely to provide information on transnational alliances. Most of these sources are available through searchable databases allowing for specific searches.

- **Commercial market research reports and databases:** commercial market research reports where they are available for the sector are also likely to provide useful information.

- **Investment analysts' reports:** reports from investment banks often include an assessment of key industry relationships.

3.10.6. What is the contribution of the sector to overall economic growth?

The EDA Steering Board also emphasizes that a competitive EDTIB contributes to overall economic growth, not least amongst SMEs. The EDTIB may contribute to the overall economy in a variety of ways: creating and sustaining jobs, including high-wage and technically skilled jobs; contributing to technology and spillovers; as well as exports and import-savings benefits.

Once again, however, this is a challenging characteristic to assess. The subject of the economic benefits and costs of the defence industry has been the subject of countless studies in its own right and a comprehensive study of the contribution of the EDTIB to overall economic growth would be a complex and resource intensive undertaking. Also, detailed studies of this kind have faced considerable methodological problems. In particular, economists argue that it would be necessary to show that the EDTIB makes a net economic contribution by comparing the performance of the EDTIB with the average performance for the economy (i.e. focusing on the alternative use value of resources). Net economic benefits arise where defence industries make a greater contribution to output than the alternative use of resources and many studies have argued that defence spending has negative economic consequences through the crowding-out of other economic activity.

> We recommend that, if EDA and its stakeholders consider this question a priority, a specific study is conducted into this matter. Alternatively, if EDA wants a top-level overview, we recommend a more modest approach that would seek to collate available information on the economic impact of the sector.

Potential questions for a simple assessment of the economic benefits of the sector

- **How many people are employed in the sector in Europe?** How many high skilled workers (QSEs) are employed in the sector? What is the regional distribution of employment? This information is not available at the sectoral level and EDA will need to rely on pMS, industry associations and individual companies.

- **What is the value of exports and import savings for the sector?** We have noted that there is some data available for arms exports at the European level

- **What are the number of qualified scientists, engineers and technologists trained by the sector?** Industry associations and individual companies may be able to provide some information on the contribution of the sector to the European skills base although - unless specific studies of this have taken place - this data is likely to be patchy and anecdotal.

- **What are the wider technology benefits including spin-offs?** Again, the information is patchy although EDA may be able to gather individual examples using expert knowledge of the sector.

What information is required and how might it be collected?

- **Collation and analysis of previous studies:** this is a topic that has been the subject of considerable attention and an important element of any exercise should be the collation and analysis of these previous studies. These include studies by pMS and by or on behalf of regional governments in defence dependent regions.

- **pMS:** a survey of pMS might be considered as a means of identifying existing information on this topic.

- **Industry associations:** equally, some of this information is collected by industry associations

- **Expert group meetings:** desk research could be supported by meetings with experts from pMs, industry and elsewhere who are likely to be able to use their detailed sectoral knowledge to provide an assessment of its economic contribution.

3.11. Step five: identify and evaluate alternative actions

The final step of our proposed methodology would be to identify and evaluate alternative actions to address the issues identified by the DTIB study. The study team was not asked to address this matter but we make some observations on how best to manage the process of turning the analysis contained in the study into change at the European level. We were told by several of those pMS who had undertaken DTIB studies that in their experience there is a danger that defence industrial analyses can turn into "wish lists" in which every technology becomes "critical" and every industrial capability is "key". Thus, we emphasise that any study of the DTIB in Europe should focus on the prioritization of a few key policy recommendations if study findings are to be transferred into actionable outcomes for public policy and industry.

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3.12. How could EDA monitor the EDTIB on an on-going basis?

The discussion so far has focused on the development of a methodology suitable for a study to identify and measure the strengths and weaknesses of the DTIB in Europe. EDA also asked the study team to consider how EDA Industry & Market could monitor the EDTIB on an on-going basis.

Of course, the answer to this question depends on the aim of such a monitoring activity and the resources that would be made available. In our review of pMS practice, we noted how pMS engage in on-going monitoring of industry performance and trends and that this is a resource intensive process that involves the monitoring of company performance at programme and contract level. Clearly, such an approach is impractical at the European level and we assume that EDA's aim is to monitor key trends at the European level that may have implications for the ESDP and may that, as they are identified, may merit specific study using the methodology proposed above.

3.12.1. What EDA can do itself

There are a number of actions that Industry & Market can undertake easily to allow it to monitor the EDTIB on an on-going basis. We will return to this point when we discuss Next Steps (Section 5, below) but here it is sufficient to note that EDA may wish to consider some or all of the following actions:

- **A subscription to a monitoring service:** there are a variety of fee-based services available that are tailored to key issues of concern to EDA. For example, Jane's Information Group provides a Defence Industry and Markets service that provides a consolidated view of all Jane's defence industry content including organisation profiles and contact details, defence budget data and market overviews.

- **Subscriptions to email newswire services:** there are a number of email news alert services provided by the Financial Times, Defense Daily Network (http://www.defensedaily.com) and others that provide subject-based email alerts on key industry news.

- **Structured and conscious networking**: a number of pMS officials emphasised the importance to effective industry watch activities of networking. EDA already engages in an extensive programme of meetings with stakeholders and can get considerable benefit from networking with pMS experts, industry associations, individual companies, financial analysts and individual experts, attend industry conferences.

- **Regular EDA sponsored workshops on specific topics:** EDA may complement other industry watch activities through conducting a regular series of workshops on specific emerging themes. Such workshops that draw together selected experts are a time-efficient way of developing a detailed overview of emerging topics.

3.12.2. A trend chart process

A complementary and potentially more resource-intensive approach to support EDA's own activities would be to develop an industry monitoring network to describe and analyse major trends in the DTIB in Europe drawing on a network of pMS industry experts, ASD, national industry associations and others. Such an initiative would require consultation with the pMS to judge whether pMS experts would have the time and resources to devote to such an initiative. An alternative would be to engage independent experts and/or ASD and national industry associations but again this should be the subject of detailed consultation.

3.13 Summary

This section has proposed a methodology to identify and measure the strengths and weaknesses of the DTIB in Europe. The methodology has been designed to be scalable to the objectives and resources available and could be used to support short studies, more

comprehensive studies of longer duration or studies focused on a specific sub-set of the issues contained within the methodology.

In designing the methodology and considering the information that might be needed and how it could be collected, we have taken into account the specificities of the European context, the limitations of available information at the European level and stakeholder concerns about the high cost and burden of an extensive and detailed data collection exercise. We anticipate that a study of the DTIB in Europe would rely heavily on the contribution of expert analysts who have a deep knowledge of defence industry and the particular sector. This would be complemented by the collection of hard data as a means of ensuring a robust analytical base for the studies.

EDA also asked the study team to consider how EDA Industry & Market could monitor the EDTIB on an on-going basis. We propose some relatively simple steps that EDA could take that would help it monitor key trends at the European level that may have implications for ESDP and may merit specific study using our proposed methodology.

4. HOW THE DTIB MAY CHANGE IN THE FUTURE

EDA asked us to consider how the DTIB may change in the future and with it the definition of a strong DTIB. We consider how the DTIB may change by 2025 and we propose some indicators that might be used as signals that such changes are occurring. We identify some of the key trends that may drive incremental changes in the DTIB and we also identify some "wild cards" that could have more dramatic and discontinuous impacts on the future of the DTIB in Europe. This section draws on our collation and analysis of public domain reports, interviews and a futures workshop with selected experts.

4.1. Trends in the operating environment for the DTIB

By way of background, we begin by noting a number of trends in the environment in which the DTIB will operate in the future. These trends have been discussed in the *EDA Long-Term Vision* but deserve to be emphasised here since they provide the context in which changes to the DTIB will occur.

The European Union is likely to become a global security actor by putting in place the vision set out in the *European Security Strategy*. The EU will increasingly utilise a comprehensive approach combining its hard and soft power instruments and coordinating civilian, military, governmental and non-governmental bodies to collectively achieve the necessary political effects. This will have implications for the capabilities that pMS and the EU require and shape the European demand for equipment and services from the DTIB.

The trend towards "hybrid wars" is likely to continue with conflicts combining conventional warfare, counterinsurgency and humanitarian aid and reconstruction efforts and the breakdown of the distinction between defence and security and war and politics. The distinction between "defence" and "security" will become increasingly blurred and civilians are likely to carry out a wide range of activities traditionally undertaken by military personnel as more comprehensive approaches are adopted. Military personnel may find themselves increasingly deployed in essentially non-military roles as the first response to natural disasters or civil contingencies. We could expect novel types of warfare, including cyber attacks, biological attacks, attacks on the critical infrastructure and attacks on resources. Some of these attacks will be designed to cause economic or political damage, rather than mass casualties.

Europe's population will be older and its working age population will have declined. There will be intense competition amongst employers for workers in the 18-35 age group that has traditionally been the core of the armed services. At the same time, there is likely to be a decline in the number of science, engineering and technology graduates from European universities meaning that the defence sector will face intense competition from other sectors for skilled labour.

With European citizens more inclined to favour "security" over "defence" spending and, with public finances under pressure from a growing pension burden and declining work age population, defence spending will have to compete with welfare spending for political attention. At the same time, we expect that defence inflation (both from rising labour costs and the increase in costs of defence equipment and services) will continue to grow at a faster rate than inflation in the wider economy. In such a budgetary environment, European Member States are likely to attempt to minimise their defence burden and this may lead to cuts in defence spending and may also increase the willingness of Member States to consider cooperative equipment solutions and common procurement to meet their defence needs. The growing cost of new equipment combined with constrained defence budgets is likely to mean that there is a continued trend towards procurement models that emphasise pooled purchase of military off-the-shelf equipment, jointly-owned capabilities and role specialization as a ways of spreading the high costs of defence equipment across a number of pMS.

4.2. How pMS and EU capability requirements may change

By 2025, pMS and EU capability requirements are likely to have changed and the DTIB will be expected to deliver capabilities that enhance command, information, engagement, protection, deployment and sustainment. At the same time, outsourcing and services are likely to represent an increasing share of defence procurement budgets and technology insertion and upgrading existing platforms is likely to be the core business of the defence industry in many sectors.

4.2.1. There will be an emphasis on military capabilities that enhance command, information, engagement, protection, deployment and sustainment

There was general agreement amongst those that we talked to that, in the future, the needs of European armed forces will mean that the DTIB will be expected to deliver capabilities that enhance command, information, engagement, protection, deployment and sustainment. This view is in line with statements in pMS Defence White Papers and also the *EDA Long-Term Vision.* The *Long-Term Vision* notes how pMS and ESDP operations are likely to be expeditionary, multinational and multi-instrument reflecting the broad and challenging set of potential missions for European forces envisaged by the Headline Goal and European Security Strategy. Military requirements are likely to emphasise synergy (beyond jointness to include also coordination of effects with non-military actors), agility (the ability to achieve rapidity of reaction and deployment and also the ability to reconfigure for optimum force size and balance and move quickly at the tactical level), selectivity (meaning a wide range of capabilities and the means to ensure an informed and appropriate choice at each stage of the operation) and sustainability (emphasising logistic support and theatre access) placing an emphasis on capabilities that enhance command, information, engagement, protection, deployment and sustainment.

The trend towards joint and network enabled capabilities is likely to continue with an emphasis on forces composed of land, air, space and maritime elements using precision firepower, intelligence and focused logistics in order to deliver military effects in a more discriminate way. However, recent experience in stability operations suggests that such a "high tech" approach is likely to need to be complemented with a larger number of "boots on the ground"; in particular in semi-permissive environments and that this trend will also involve police-type forces, to complement the military presence in permissive environments. This trend towards expeditionary, multi-national operations with strong interaction with civil instruments is likely to place a strong emphasis on interoperability within national forces, between national forces and with civilian actors.

The DTIB will also be expected to meet pMS and EU requirements for detailed, unambiguous, persistent and timely information is likely to grow as European militaries are increasingly called upon to engage in asymmetric operations in difficult environments against irregular forces and individuals. At the same time, peace enforcement and peace keeping operations will require persistent surveillance in a more benign environment. This is likely to require a broad range of sensors and systems, including satellites, manned aircraft, UAVs and land systems.

Unmanned technologies are likely to make further advances allowing their increased use for defence applications in all environments with a correspondingly reduced risk to military personnel and an expanded range of capabilities. Equally, space-based systems are likely to become increasingly important and are also likely to become accessible for many more nations as advances in enabling technologies, cheaper launch techniques and platforms are likely to allow spaced-based programmes to operate at lower cost.

At the same time, in an environment of uncertain threats, rapid change and constrained defence budgets, military customers are likely to place a high premium on military capabilities that are flexible and capable of adaptation to a variety of tasks and operational requirements. The trend towards the convergence of defence and security capability requirements in fields such as intelligence, command and control and border surveillance is likely to continue and with greater political support for security rather than defence it is likely that there will be a growing emphasis on military capabilities that are able to support the security of the European homeland.

What will be the indicators of change in this direction?

- An increased share of defence procurement budgets allocated to command, information, engagement, protection, deployment and sustainment
- An increased number of contracts let by pMS for equipment and services in support of these capabilities
- A continued shift of investment by companies into business areas that meet these emerging customer capability requirements such as C4ISTAR; UAVs; and protection systems

4.2.2. Outsourcing and services are likely to represent a growing share of defence procurement budgets

The trend for European defence procurement spending to shift from equipment to services is likely to grow as pMS place an increasing emphasis on through-life management of equipment and increasingly seek to outsource non-operational activities that have previously been undertaken by the military such as training, repair and maintenance and logistics. We may also see the increased use of commercial manpower and security solutions in the operational environment, especially for deployed or enduring tasks although this is likely to continue to be contentious and raise important issues about the blurring of the responsibilities of military and private industry and issues of accountability. This growth in outsourcing and services is likely to be driven by military over-stretch and efforts to reduce personnel costs as continuing pressures on defence budgets and the prospect of a declining labour force increase customer requirements for solutions that reduce directly employed manpower numbers and costs whilst providing for "boots on the ground".

At the same time, new service-oriented models of provision may become more widespread including forms of public private partnership in which governments pay private companies for equipment and services on the basis of availability and usage and the through life risks of ownership lie with industry. The trend towards through-life management of defence equipment is likely to encourage such developments. At the same time, pressures on defence budgets are likely to increase government efforts to use government finance more efficiently. This may include the use of private finance instruments especially to enhance the affordability of projects involving significant capital expenditure. There may well be efforts to use such approaches as part of the trend towards procurement models that emphasise the pooling of assets between pMS and the development of jointly-owned capabilities. However, the widespread adoption of private finance will require governments and industry to develop effective models to share costs and risks and overcome the high up front costs of establishing such programmes.

The growth in outsourcing and services is likely to provide new business opportunities for defence companies who are able to develop appropriate business models that offer services solutions to their customers. This trend is also likely to present opportunities for new entrants from non-defence service industries.

What are the indicators of change in this direction?

- pMS issue an increasing number of calls for tender for outsourcing and service contracts
- pMS issue requests for information and/or requests for tender that require private finance solutions
- Outsourcing and services become an increasing proportion of pMS defence procurement budgets
- Outsourcing and services become a larger share of the revenues of established defence companies
- Non-defence service companies signal that they intend to enter the defence market, perhaps through teaming and alliances with established defence companies

4.2.3. Technology insertion and upgrading existing platforms is likely to be the core business for the defence industry in many sectors

The trend towards fewer, more capable platforms with very long service lives is likely to mean that the future business for the defence industry in many sectors will be in supporting and upgrading these platforms and rapidly inserting new technology to meet emerging threats, rather than moving to design new requirements for new national or European equipment programmes. The growing sophistication, efficiency and lethality of weapons systems in an increasingly networked environment mean that there is likely to be a need for fewer platforms in the future. At the same time, these more capable platforms are likely to have an increasingly long in-service life as customers seek to upgrade those platforms rather than acquire new platforms. This is likely to reinforce the trend towards the growing importance of electronics, sensors and IT in the defence industry and also place an increased emphasis on COTS (Commercial Off the Shelf) solutions. The rapid pace of non-defence origin technological change and the growing emphasis on incremental upgrade and technology insertion for existing platforms is also likely to see the defence sector embrace open systems architecture principles, spiral development and incremental acquisition approaches.

What are the indicators of change in this direction?

- A growing share of pMS procurement spending is accounted for by technology insertion and upgrades to existing platforms
- A growing number of pMS contracts for technology insertion and upgrades
- A growing use of spiral development by pMS as part of the acquisition process

4.3. How DTIB competencies may change

By 2025, the role of defence R&D in delivering cutting-edge technology is likely to have changed with a shift towards an open innovation model, a blurring of defence, security and non-defence technology development and a change in the structure of the defence supply chain. These changes are likely to occur against a background of customer pressure to accelerate the fielding of new technologies.

4.3.1. A shift towards an open innovation model in the defence sector is likely

The role of defence R&D is already shifting from the development of new technologies to partnerships that can access and exploit technologies that are the product of commercially-funded research. This trend is likely to continue. The rapid pace of non-defence origin technological change and the likelihood that defence R&D spending in Europe will continue to decline (or at best remain stable) is likely to impact the way that governments and industry conduct defence R&D.

Governments are likely to develop R&D programmes that draw on the increasingly diverse global science and technology base in industry, SMEs and universities and adapt and apply that knowledge for military use. Similarly, industry is likely to pursue "open innovation" approaches that emphasise the role of networks of external suppliers of industrial and technological capabilities. These external sources of technology are likely to include defence-specific suppliers, suppliers of civil-origin technologies, SMEs, research institutes and universities.

The trend towards an open innovation approach reflects the growing importance to defence of non-defence origin scientific and technological knowledge. Most of the technologies that may be the key determinants of military capabilities in 2025 are already

known about today. Advances in microsystems, nanotechnology, unmanned systems, communications and sensors, digital technology, bio- and material sciences, energy and power technologies and neuro-technologies have all been identified as important for the defence sector. There is likely to be an increasing convergence between different science and technology areas, leading to novel applications such the combination of nanotechnology and informatics. In general, there may be more impact will be through novel applications of technology rather than new scientific discoveries. Many of these critical technologies for the future are not of defence origin but are emerging from commercial R&D activity taking place in civilian sectors, SMEs and start-ups and in universities throughout the world. At the same time, established civil-origin technologies are likely to continue to become cheaper and the pace of civilian technological advance will continue to increase thus making it increasingly important for satisfying defence needs, in particular in the IT sector but in other fields as well.

Shortages of suitably skilled labour in the defence technological and industrial base may also cause governments and industry to pursue an open innovation approach as they seek skills from elsewhere. A decline in the number of science, engineering and technology graduates from European universities has been projected, defence is facing intense competition for skilled labour and the skills shortages that are already being experienced in some parts of the DTIB are likely to increase.

The pace of this move towards an open innovation approach is likely to depend in part on the willingness of those non-traditional sources of scientific and technological knowledge to engage with the defence sector. There are major cultural differences between universities and the defence sector in some countries. At the same time, despite efforts to reform defence procurement processes and encourage dual use technology sourcing, defence procurement regulations and processes are likely to mean that significant barriers will remain to new entrants into the equipment market. Thus, it is likely that non-defence suppliers of dual use technologies will continue to act as suppliers to large defence specialised prime contractors. Specific national government R&D investment in in-house expertise and technology development is likely to continue where there is no civilian equivalent and where there are particular concerns about the need to retain national operational sovereignty, for example in some critical defence and security technologies, such as cryptography, nuclear, counter-terrorism and CBRN defence.

What are the indicators of change in this direction?

- Defence companies team with non-traditional suppliers to bid for R&T and procurement contracts
- Defence companies signal a growth in their relationships with non-defence technology suppliers, SMEs and universities
- pMS seek to engage with universities and SMEs as part of their defence innovation strategies

4.3.2. There will be a blurring of defence, security and non-defence technology development

The move towards a more open innovation approach to defence research and technology development is likely to be part of a wider blurring of the distinction between the DTIB and the security and civilian sectors in the future. The blurring of these boundaries means that, at least at the margins, the defence innovation system is likely to open-up to new actors and will become less distinct from its surrounding environment.

Dual-use and COTS (commercial off the shelf) technologies will continue to grow in importance blurring the distinction between defence and civilian technology. The pace of technological change in non-defence sectors will continue to accelerate and commercial companies and the scientific community will drive technological change in a globalised environment that is in large part out of the control of governments.

At the same time, it is likely that defence and security technology development will increasingly be considered together from a technological standpoint. Defence and security equipment is likely to draw on an increasingly common platform of core technologies. These technologies are likely to often be supplied by different (or in some cases the same) business units within the same company and they are likely to draw on common sources of development funding, not least from the security research programme of the European Commission's Framework Programme as well as complementary programmes at the pMS level.

What are the indicators of change in this direction?

- Dual-use and COTS technologies play a growing role in defence equipment
- Companies signal to the market that they are exploiting common technology platforms for defence and security applications

4.3.3. The structure of the defence supply chain is likely to change

The structure of the defence supply chain is likely to change. Systems integration is likely to become an even more important competence in the future as defence systems are required to bring together a complex variety of components and sub-systems, many of

them of commercial origin, to be integrated within military platform technologies from a variety of sources. This is likely to increase the role of "architecture systems integrators".[6]

Large defence contractors are increasingly focusing on system-of-systems or lead system integrator roles and this trend is likely to continue in the future. They are likely to continue to outsource responsibility for sub-system and component design and manufacture to their suppliers. At the same time, prime contractors who are facing pressures from customers to cut costs and pressures from shareholders to increase return on investment are likely to seek sources of inputs from lower cost countries within the European Union providing opportunities for suitably qualified suppliers from the newer Member States but increasing competitive pressures on existing suppliers.

There is also the possibility that we will see the specialist architecture systems integrators increasingly challenge the traditional platform manufacturers for the role of prime contractor and system integrator. These are engineering consulting firms whose strengths lie in the definition of systems able to respond to military requirements, and which have knowledge of a diversity of technologies that allows them to assess trade-offs and make decisions selecting among a diversity of technologies but which have traditionally limited themselves to expert advisory roles. In the future, prime contractors may not necessarily be the big manufacturing groups in charge of building large platforms but specialist architecture systems integrators supplied by increasingly large and complex networks of manufacturers.[7]

What are the indicators of change?

- Statements from large defence contractors signaling to the market their strategic intent to focus on systems integration
- Suppliers from the small and medium pMS win contracts from large prime contractors
- Prime contractorship and systems integration roles are won by specialist architecture systems integrators against competition from the traditional prime contractors

[6] Gholz, E. (2003), Systems Integration in the US Defense Industry, in Andrea Prencipe, Andrew Davies and Mike Hobday (eds), *The Business of Systems Integration*, Oxford: Oxford University Press

[7] Jordi Molas-Gallart "From closed to open: the defence innovation system in transition?" in James, AD (ed) *The Role of Defence in the Innovation System* (forthcoming)

4.3.4. The pressure to accelerate the fielding of new equipment is likely to continue to increase

In the future, customers are likely to place even more pressure on all actors in the procurement process to shorten the time from requirement specification to the fielding of equipment.

Customers are seeking to reduce the time from concept to fielding of equipment as they attempt to meet the urgent requirements of deployed and high readiness forces. The frequency with which European forces are deployed for humanitarian, peace keeping and peace enforcement operations and the emphasis on force readiness is likely to continue in the future. This is likely to mean that customers place increasing emphasis on equipment that is "good enough" to meet urgent operational requirements rather than wait for optimal design solutions to their requirements. In such an environment, Military Off the Shelf purchases rather than specific design and development programmes for new equipment may be attractive and where suitable MOTS equipment is not available in Europe cooperation or Military Off The Shelf procurement from the United States is likely to remain an important part of the procurement strategies of many European governments.

The continued pace of technological innovation combined with the globalization of technology and knowledge is likely to place an emphasis on the ever more rapid exploitation and insertion of technology if military equipment is to avoid rapid obsolescence. This is likely to place pressure on defence companies and defence procurement organisations to quicken the pace at which technological opportunities are transferred into fielded equipment. There is likely to be a growing emphasis on evolutionary acquisition models such as incremental or spiral development to deliver capability in increments, recognizing, up front, the need for future capability improvements, balancing needs and available capability with resources, and to put capability into the hands of the user quickly. At the same time, however, budget constraints may mean that defence companies find it difficult to transfer new technologies into new equipment or existing platforms.

What are the indicators of change in this direction?

- pMS acquisition strategies indicate a growing willingness to use Military Off The Shelf purchases
- A growth in the use by pMS of evolutionary acquisition models such as incremental or spiral development

4.4. How competitive conditions may change

By 2025, what constitutes a competitive DTIB is likely to have changed. The DTIB is likely to become increasingly global; European companies are likely to have developed new business models with an emphasis on "centres of excellence"; and, competition in European and export markets is likely to be more intense.

4.4.1. The DTIB is likely to become increasingly global

The trend towards the globalisation of the European defence industry is likely to continue in the future with companies seeking to establish a greater presence in the United States and also increasingly in Asia.

The globalization trend will continue to be driven by the desire of companies to reduce their dependence on individual national customers and seek new growth opportunities. Industry believes that European defence procurement budgets are likely to remain flat in the future and that government defence R&D spending may well fall. Industry is likely to "follow the money" and this will lead it to the United States which will remain an attractive market because of its size and its defence R&D spending - even if US defence budgets fall as has been predicted. Asia is likely to become a focus for the European defence industry given its steadily increasing defence spending. The Euro Dollar exchange rate is also likely to be an important factor in the location decisions of aerospace and defence companies.

There is no doubt that accessing the US market is likely to continue to be difficult and costly for European companies as a consequence of the Buy America Act and the Berry Amendment; onerous controls on companies under foreign ownership, control or influence; and, US arms export regulations (most particularly ITAR). Nevertheless, even if the US defence procurement budget falls from its current high level, the size of the US market opportunity combined with the high level of defence R&D spending is likely to act as a continuing draw for European investment.

European companies will continue to develop close cooperative relationships with US companies as a means to access the US market and as a means of transferring US technologies for European programmes. US and European companies are likely to continue to explore the creation of transatlantic defence companies and joint ventures but this is only likely to happen if there is a strong business case as well as unambiguous political support.

Globalisation and further privatization are likely to further reduce direct political control over defence companies although this may lead to growing political concerns to retain operational sovereignty, maintain strategic controls over critical capabilities, assure security of supply and protect jobs and these concerns are likely to continue to represent

an important barrier to industry restructuring. The buyer power of individual Member States is likely to decline as they face large global and multi-domestic defence companies who are likely to be less and less dependent on a single "home" market. However, securing a launch contract from the "home" country is likely to remain important to companies for export success and development funding for programmes and a shift towards more common European procurement would substantially increase the power of buyers.

What are the indicators of change in this direction?

- European defence companies make acquisitions in the United States
- European defence companies make acquisitions in Asia or enter into alliances with Asian defence companies

4.4.2. European companies are likely to develop new business models that allow them to work effectively across national borders

The trend towards the creation of transnational European defence companies is likely to continue although this may be slowed in the land and naval systems sectors by the desire of governments to create "national champions" as a prior step to European mergers. There is likely to be a new wave of consolidation and restructuring amongst the largest European defence contractors as multi-domestic companies seek to specialise their activities around "centres of excellence" as a way of increasing operational efficiencies by reducing duplication and increasing economies of scale and scope. There is also likely to be further consolidation amongst first and second tier suppliers as those firms seek to achieve economies of scale and scope and respond to the demands of prime contractors.

The emergence of effective Security of Supply and Security of Information provisions and simplified procedures for intra-Community transfer of defence goods is likely to increase the pace at which such developments occur and encourage European defence industry consolidation, work-sharing and interdependencies. At the same time, a lack of political support from Member States could limit the development of a European Defence Equipment Market, reduce the scope for achieving economies of scale in European procurement and further reduce the relative attractiveness of the European market to European defence companies.

The opening-up of national defence markets to create a more transparent, open and non-discriminatory European Defence Equipment Market would be likely to accelerate the speed at which the new wave of industry restructuring takes place. If Member States

make the European Defence Agency's *Code of Conduct on Procurement* and its *Electronic Bulletin Board on Government Contract Opportunities* a routine part of their procurement processes then this has the potential to bring more open, non-discriminatory and transparent processes to those items covered by Article 296. The Commission's draft *Directive on Defence Procurement* could open up those markets in Europe that remain protected but its impact will depend on its proper and fair enforcement throughout Europe to ensure a level playing field for all. These initiatives are only the first step and but ultimately they may have the effect of improving efficiency by driving the restructuring of the European defence industry. At the same time, however, the implementation of such initiatives depends on political will and the concerns of Member States to retain operational sovereignty, security and supply, technology and jobs is likely to continue to represent an important barrier to industry restructuring and exit.

In the future, the creation of centres of excellence and other moves to restructure the European defence industry are likely to concentrate defence industrial activity in a decreasing number of Member States not least because those centres of excellence are most likely to be located in Member States with large and established defence industries. This may well be complemented by niche capabilities developed and sustained in other Member States and we have also noted how suppliers from the small and medium sized pMS may increasingly be engaged in the industry supply chain. The extent to which this happens will depend on the extent to which open market access is assured for SMEs and also for suppliers from the newer Member States.

What are the indicators of change in this direction?

- Transnational European defence companies establish centres of excellence that concentrate their activities in particular locations
- There are move towards the creation of a European Defence Equipment Market signaled by a growing number of cross-border contracts resulting from the EDA's *Electronic Bulletin Board on Government Contract Opportunities*
- SMEs and suppliers from the newer Member States are increasingly engaged in the defence industry supply chain

4.4.3. Competition in European and export markets is likely to become more intense

In the future, competition in European and export markets is likely to become more intense.

In the European market, the opening-up of national defence markets to create a more transparent, open and non-discriminatory European Defence Equipment Market would be likely to increase competition. "National champions" who have been protected by discriminatory procurement practices may face cross-border competition. At the same time, in the newer Member States, the privatisation of state owned defence firms is likely to continue and the privatised companies are likely to either exit the defence market or seek to establish a stronger role as suppliers to prime contractors either in Europe or elsewhere. The prospect of an end to rapid defence budget growth in the US is causing US defence contractors to pay renewed attention to defence markets in Europe

In export markets, the end of rapid US defence budget growth is also causing US defence contractors to pay greater attention to exports to the rest of the world (especially Asia Pacific). We are also likely to see the emergence (China and India) or re-emergence (Russia) of new competitors in defence industry markets.

What are the indicators of change in this direction?

- A growing number of cross-border contracts resulting from the EDA's *Electronic Bulletin Board on Government Contract Opportunities*
- An increase in the number of bids for European contracts by US defence contractors teamed with European companies
- An increase in the number of head-to-head competitions in overseas markets between European companies and companies from China, India or Russia

4.5. Wild cards

The discussion of how the DTIB may change in the future has focused on the projection of current trends into the future. However, we also identified some "wild cards" that could have a more dramatic and discontinuous impact on the future of the DTIB in Europe.[8]

4.5.1. A major change in perceptions of the international security environment

The first wild card is a major change in perceptions of the international security environment. We noted at the outset that European citizens are more inclined to favour

[8] We have not included the emergence of a new disruptive technology here since the general view is that those technologies that are likely to have an impact on military capability by 2025 are already well known.

"security" over "defence" spending and that there is little political appetite for a substantial increase in defence budgets in Europe. This has direct consequences for the demand for the DTIB's products and services and the level of investment in defence R&D by government.

This situation could alter dramatically if European citizens saw a threat to their way of life that was sufficiently severe and unambiguous that they were willing to devote increased resources for defence and security. These resources may be in terms of public spending but might also include a willingness to commit people, accept casualties and forego social welfare spending in favour of enhanced defence and security spending. A direct attack on Europe by a state actor involving traditional state-on-state conventional forces appears improbable. Conceivably, a catastrophic terrorist attack might be the trigger for such a change in public opinion especially given the continued proliferation of nuclear, biological and chemical capabilities. The European neighbourhood is likely to become increasingly unstable and threats from state actors may grow as a result of conflicts over natural resources and in particular energy and, by 2025, this may be heightened by the effects of global warming. These "resource wars" may lead to instability in the European neighbourhood and threaten European interests in other parts of the world.

The consequences for the DTIB of such a development would be complex. If defence budgets remain flat or decline, it is likely that political support for an EDEM and EDTIB will gradually increase as Member States struggle to match their aspirations to their available. In contrast, an increase in real defence spending might have the effect of reducing the pace of change towards an EDEM and EDTIB and may encourage efforts to sustain national DTIBs.

What are the indictors of change in this direction?

- EuroBarometer and other opinion poll evidence shows a significant change in attitude towards defence spending amongst European citizens

4.5.2. A change in attitudes towards expeditionary operations and a focus on security of the European homeland

The second "wild card" that was identified was a dramatic change in attitudes towards expeditionary operations in favour of a focus on the security of the European homeland. This change might be triggered by a negative experience with expeditionary operations especially of the long endurance type that was sufficiently dramatic to cause Europe to fall back on security of the homeland and the protection of direct vital interests. Such a

development might cause Europe to focus on soft power and a reliance on civil security forces. The consequences for the DTIB would be dramatic since current expectations are that European capability requirements and thus the demand for the DTIB's equipment and services will focus on the requirements of expeditionary operations. A focus on the security of the European homeland would be likely to increase security budgets and would provide opportunities for that part of the DTIB that was able to meet security requirements. The remainder would be faced by the need to export or downsize.

What are the indictors of change in this direction?

- European governments withdraw from expeditionary or peacekeeping operations
- European governments announce major defence reviews indicating a shift in security posture and cuts in defence programmes associated with equipment for expeditionary operations

4.5.3. The emergence of a true transatlantic defence market

The third wild card would be the emergence of a true transatlantic defence market. This would be characterised by greater openness of the US market to European companies combined with a change to the US ITAR (International Traffic in Arms Regulations) of a kind that was sufficiently great to reduce European concerns about the operational sovereignty consequences of using ITAR controlled components or systems.

Attempts to create a transatlantic armaments market and to reform ITAR have been on the agenda of NATO for decades. There have also been bilateral reform initiatives of which the UK-United States Defense Trade Cooperation Treaty is the latest effort to reform export licensing arrangements between the two countries. Whether the United States proves willing to widen this to other European countries is an open question but such a development could have important implications for the DTIB in Europe. The opening of the US market would be likely to have a more dramatic impact on the economics of the DTIB in Europe.

What are the indictors of change in this direction?

- United States selects teams with a significant European component for major procurement contracts
- United States begins negotiations of Defense Trade Cooperation Treaty-like provisions with other European governments

4.6. Summary

This section of our study has considered how the DTIB in Europe may change in the future and with it the definition of a strong DTIB. We considered how the DTIB may change by 2025 and we proposed some indicators that might be used as signals that such changes are occurring. We identify some of the key trends that may drive incremental changes in the DTIB and we also identify some "wild cards" that could have more dramatic and discontinuous impacts on the future of the DTIB in Europe.

The main message to EDA from our futures exercise is that the definition of what constitutes a strong future European DTIB will need to be periodically revisited and revised. We identify a number of trends changes that may have a particular impact on how we define a strong DTIB in the future.

Defining a strong DTIB in the future

- **Capability-driven:** in the future, a strong DTIB will be measured on its ability to support and upgrade platforms and rapidly insert new technologies as part of an evolutionary acquisition process as well as its ability to design and develop new equipment. A strong DTIB will also be measured by its ability to deliver services as part of the outsourcing and through-life management approaches of its customers.

- **Competent:** in the future, a strong DTIB is likely to be measured on its ability to build open innovation models and its capacity to create strong and sustainable networks of partnerships with suppliers of technological and industrial capabilities. Those suppliers are likely to come from non-traditional sectors as well as the traditional DTIB and will be geographically distributed across Europe (and the rest of the world). At the same time, the innovativeness of the DTIB may need to be measured not only on its capacity to generate new and disruptive technologies but its ability to generate new and innovative packages of outsourcing and services, new business models and innovative private financing mechanisms to meet customer requirements.

- **Competitive:** in the future, the DTIB is likely to be increasingly globalised and European companies are likely to face more competition in their home markets. Multi-domestic European companies will seek to create centres of excellence and the pace at which they develop will be influenced by European initiatives and the political will of individual Member States. Whilst these centres of excellence are likely to be in the large defence industrial countries this may well be complemented by the development and sustainment of niche capabilities and the growing engagement of suppliers from the small and medium sized pMS in the supply chains of prime contractors.

- **Less distinct from the rest of the economy:** in the future, the distinction between the DTIB and other sectors of the economy is likely to become increasingly blurred as a consequence of the growing role of dual use suppliers in the defence industry supply chain and the diversification of some defence companies into the security and defence services sectors. The future DTIB will be comprised of a greater variety of companies, including new entrants from civilian service sectors.

5. NEXT STEPS: THE IMPLEMENTATION ISSUES

At our suggestion, EDA also asked us to consider the implementation issues that EDA would need to take into consideration if it chose to proceed with analytical studies (and continuous monitoring) of the DTIB in Europe. This section sets out some "Next Steps" that EDA may wish to consider. We base our recommendations on a review of the lessons learned by pMS identified from our email survey and face-to-face interviews and the feedback received from our Expert Group Meeting. We also conducted meetings with officials from Industry & Market.

5.1. Engage stakeholders in the process of defining the studies of the DTIB in Europe

Positive and active stakeholder engagement will be critical to the success of any EDA-facilitated DTIB study. This requires early and detailed discussions with pMS, ASD and other stakeholders such as the European Commission.

5.1.1. Clarify the objectives of studies of the DTIB in Europe and the desired impact on policy

In conducting this study, stakeholders sought clarification of EDA's objectives for the proposed studies of the DTIB in Europe. On the one hand this can be regarded as strange given the EDA Steering Board statement and subsequent discussions with pMS and others. Nevertheless, it is clear that there is a need for EDA to clarify its objectives as a first step to ensuring stakeholder engagement in the process.

5.1.2. Minimise the burden on stakeholders

In conducting this study, both pMS and industry stakeholders expressed the view that for such an exercise to be successful it must minimize the burden on stakeholders. Stakeholders are likely to engage in the process if it is not too burdensome in terms of the time required and also in term of the amount and type of data that is requested of stakeholders.

5.1.3. Deliver authoritative studies

The EDA initiative to facilitate studies of the DTIB in Europe will get authority through the credibility of its people and the studies that it conducts and raises issues about study budgets. EDA has to deliver something that individual pMS cannot do alone. pMS and industry are unlikely to be satisfied with a superficial analysis but would expect a high quality and in-depth analysis of a particular field – this suggests that depth rather than breadth is important in determining the scope of studies of the DTIB in Europe.

5.2. Establish a Steering Board for each study

We recommend that the EDA establish a Steering Board to manage the study process. The aim of the Steering Board should be guide the study, determine its terms of reference and oversee the conduct of the study. The Steering Board should be comprised of interested stakeholders from pMS, industry and the European Commission. Ideally, the members of the Steering Board should be experts in DTIB analysis and have direct experience of managing or participating in such studies. In this way, the Steering Board could act as a means of transferring learning from pMS studies to the European level and ensure that the study is feasible.

5.3. Agree the scale and scope of the studies

EDA, in consultation with stakeholders, needs to decide on the desired scale and scope of the proposed study. DTIB studies can be resource intensive and there needs to be an early decision on the budget that will be allocated to the study and also the time commitment of EDA staff, pMS and industry. This will determine the study approach.

We have already noted that we believe that EDA has at least three options if it wished to use the methodology that we have proposed (see Table 5.1).

Table 5.1: Three types of studies that EDA may wish to consider

Type	Scale	Scope	Strengths & weaknesses
Short studies	3 month duration (or less)	Series of expert meetings at which each stage of methodology is discussed. For each stage, the key questions that we identify could provide an agenda for the discussion. Some staff work to collate basic and readily available information to provide food-for-thought during the expert meetings.	**Strength:** a useful top-level and general study of a sector. **Weakness** is that it is likely to rely heavily on the existing knowledge of the experts who choose to take part in the exercise.
Comprehensive studies	9 months	Detailed & in-depth sectoral study The methodology could be used to structure a series of meetings of sector experts as described for the short studies. Information gathering beyond the basic and readily available to begin to collect more detailed information and analysis.	**Strength:** could go beyond the top-level and general insights of a short study to provide greater analytical depth. **Weakness:** a great more resource intensive and more burdensome on industry and the pMS in terms of the information required of them and the extent of their participation in meetings. Potentially complex. .
Issue specific	3-9 months	Select a single issue for study and use the methodology to help inform the questions that would need to be addressed and the tools and techniques that could be used.	S**trength:** would allow EDA to focus resources to generate a detailed study on an issue of particular concern. W**eakness:** would not provide a comprehensive overview of the strengths and weaknesses of the DTIB in Europe.

5.4. Decide how to staff the studies

The successful conduct of a study will depend on access to appropriately skilled staff with the necessary expertise. EDA (Industry & Market) does not at the moment have the necessary time, skills or experience to conduct a large and authoritative study on its own. There are several options for the staffing of such a study. A *short-study* would likely require a full-time project manager to coordinate the study and provide necessary staff support to the experts engaged in that study. This could be staffed from within EDA. The demands of a large *comprehensive study* would require a full-time project manager dedicated to the study with demonstrated project management skills and experience of DTIB studies and this task could be undertaken by Industry & Market. Comprehensive studies might have a core team of seconded experts working full-time for the duration of the study. Secondees would have experience of managing or participating in such studies in their home countries. The team could be supported by Industry & Market in a project management role. External contractors may have a part to play in such a study although the relatively small-scale contracts that are typically let by Industry & Market are likely to be insufficient to deliver the authoritative study required by EDA. Instead, EDA may wish to use contractors to deliver specific elements of the study or use individual contractors to provide policy consultancy support.

5.5. Conduct a pilot study to test the methodology

We recommend that EDA conduct a small-scale pilot study to develop, test and refine the methodology before engaging in large scale studies. Conducting a DTIB study at the European level is a new initiative that has not been done before. Thus, it is important that the methodology is tested to ensure that it is robust and to ensure that any challenges are identified and rectified before engaging in a larger and more complex study. A small-scale pilot study may also help to build confidence and trust in the process amongst industry since it any DTIB study will require companies to work together who may regard themselves as competitors. A small-scale pilot study may help to help confidence and trust in the process amongst the pMS. The subject of the small-scale pilot study should be agreed in consultation with the pMS, industry and other stakeholders. A suitable focus of such a study would be a discrete, self-contained and relatively small sector or sub-sector. For instance, EDA may wish to consider revisiting its previous study on energetic materials using the methodology set out in this study and selected questions from the options set out in section 3. Alternatively, EDA might wish to consider a sub-sector of Future Air Systems.

5.6. Begin the on-going monitoring of the DTIB in Europe

We recommend that EDA should begin the process of on-going monitoring of the DTIB in Europe by subscribing to a commercial monitoring service on defence industry and market issues; subscribing to email newswire services to receive alerts on key industry news; structured and conscious networking with industry, pMS sector specialists and other experts; and, organizing regular EDA sponsored workshops to develop a detailed overview of emerging industry topics. EDA should give serious consideration as to

whether a member of staff should be allocated to such an activity on a full-time basis. In addition, EDA should convene a group comprising EDA, industry and pMS to consider the establishment of a permanent monitoring network to describe and analyse trends in the European DTIB drawing on a network of pMS industry experts, ASD, national industry associations and others.

5.7. Summary

This section has set out some "Next Steps" that EDA may wish to consider as follows:

Next steps:

- Engage stakeholders in the process of defining the studies of the DTIB in Europe
- Establish a Steering Board for each study
- Agree the scale and scope of the studies
- Decide how to staff the studies
- Conduct a pilot study to test the methodology
- Begin the on-going monitoring of the DTIB in Europe

ANNEXES

Annex 1: Participants in the Expert Group Meeting on the draft methodology

Name	Organisation
INDUSTRY	
1. Peter COLLINS	SELEX
2. Marian GILCEAVA	ROMARM SA, Romania
3. Jean-Bernard PAUL	Thales
4. Olympios RAPTIS	ASD
pMS	
5. Susanne ANDERSSON	FMV, Sweden
6. John CLARK	MOD/DE&S, UK
7. Sylvain DAFFIX	MOD, France
8. Tuija KARANKO	MOD, Finland
9. David MOHEIM	FMV, Sweden
10. Christophe SERRAT	DGA, France
11. Catalina TEODORESCU	MOD, Romania
12. Kristine VENSAVA-GOLDMANE	MOD, Latvia
13. Nicusor VISAN	Ministry of Economy & Finance, Romania
EUROPEAN COMMISSION	
14. Pierre-Philippe BACRI	DG Enterprise
INDEPENDENT EXPERT	
15. David VERSAILLES	CReA, France
PROJECT TEAM	
16. Andrew JAMES	Manchester Business School, UK
17. Keith HARTLEY	University of York, UK
18. Nathalie LAZARIC	CNRS-GREDEG, France
19. Giovanni GASPARINI	Istituto Affari Internazionali

Annex 2: Participants in the workshop on the future DTIB

Name	Organisation
1. Lars AJAXSON	Saab
2. Thomas BAUER	CAP, University of Munich, Germany
3. Frank BEKKERS	TNO, The Netherlands
4. Fabrizio BRAGHINI	Finmeccanica
5. Jean-Christophe ESCULIER	Thales
6. Bill GILES	BAE Systems
7. Thomas GOTTSCHILD	EADS
8. Martin LUNDMARK	FOI, Sweden
9. Helene MASSON	Fondation pour la recherche stratégique, France
10. Jean-Bernard PAUL	Thales
11. Olympios RAPTIS	ASD
12. David VERSAILLES	CReA, France
PROJECT TEAM	
13. Andrew JAMES	Manchester Business School, UK
14. Keith HARTLEY	University of York, UK
15. Giovanni GASPARINI	Istituto Affari Internazionali
16. Ian MILES	Manchester Business School, UK

Annex 3: Publicly available data on the DTIB in Europe: strengths and weaknesses

This annex identifies some readily available sources of data on the defence industry and market. The focus is on publicly available data rather than data held by pMS or industry. We review the data and its strengths and weaknesses and we conclude by stating the data problem that will need to be overcome by any study of the DTIB in Europe.

A. INDUSTRY DATA

1. **ASD Facts and Figures:** the latest version is available at http://www.asd-europe.org/

Notes on data:

i) Data includes turnover, employment, employment type, R&D and exports some of which is split between defence and civil.

ii) Some of the data is divided into broad categories (aeronautics; space; and land and naval systems).

iii) Some of the aeronautics data is divided into major system categories: aircraft systems and frames; aircraft engines; and, aircraft equipment.

iv) The data is collected from a statistical survey (for aeronautics and space) and land and naval data is based on company annual reports and estimates (although a complete statistical survey for this sector is to be launched)

v) The ASD Facts and Figures provides a good starting point for an overview of the aeronautics, space and land and naval sectors in Europe. However, it does not provide the detailed sectoral level data that would be required for a study of the DTIB in Europe.

2. Commercial market research reports:

i) There are a number of commercial market research companies such as Jane's Information Group, DataMonitor and Frost & Sullivan (mainly from a US perspective) who produce research reports on the defence industry.

ii) These studies can be detailed and can focus on individual sectors; equipment types; markets. Take as an example a 2006 report by market research company VisionGain The UAV Market Report 2006 which contains detailed analysis of: UAV history; UAV technologies and typology; UAV market overview (for US; Europe; rest of the world); UAV missions; UAV emerging technological requirements.

iii) There are specialist websites that provide search facilities for available market research reports and sell those reports. For instance: http://www.reportbuyer.com/

iv) The quality of studies produced by commercial market research companies varies enormously and they can be relatively expensive (€750-€3000) but they could provide useful background knowledge for a sectoral study.

3. **European Council Report on the European Union Code of Conduct on Arms Exports:**

i) This report is produced annually by the European Council and is available at http://consilium.europa.eu/

ii) Contains data on arms exports by EU country of origin and country of destination and by category using the EU Common Military List categories.

4. (a) **EU Defence Industry Employment** data annually from 1990 to 2003
Source: BICC Annual Conversion Survey (but series ended in 2005 with latest data at 2003).

Notes on data:

i) Data show total employment in arms industries by nation.

ii) Data are derived from variety of official sources with preference given to figures from national bodies.

iii) There are differences in the definition of the relevant industry and in the methods used to estimate employment.

iv) For many countries, the figures are own estimates based on a variety of methods. Up to 1993, most of the data were from Wulf (1993). The estimates are sent to a number of correspondents for suggestions and comments.

v) Preferably, both direct and indirect employment have been included. Indirect employment does not refer to the multiplier effects from spending by defence industry workers.

vi) Nations not shown in the Table have either no or only minor arms production.

vii) As an example of data discrepancies, consider the UK. For 2003, the BICC data shows UK defence industry employment of 200,000; the UK official data

show total employment of 310,000 personnel (reflecting different definitions of the defence industry).

(b) **SIPRI . Tables of National Arms Production** published in SIPRI (2003)
Source: SIPRI Yearbook 2003

Notes on data:

i) Published in 2003 only showing data for 1991 to 2000

ii) Data for France, Germany, UK and USA

iii) Data are for industry sales, exports and employment

iv) There are also data on expenditure on military equipment and military R&D in Western Europe and USA for 1991 to 2002.

v) There are data on Russian military output and employment for 1991 to 2002 and for arms procurement, R&D and arms exports for 1996 to 2003.

B. COMPANY DATA

5. **SIPRI The 100 largest arms producing companies: annually.** Series was originally for OECD and developing countries; but more recent data for the world's largest arms producing companies, including Russia but excluding China. Also, more recent series includes companies supplying military goods and services to military customers (i.e. military outsourcing).

Source: SIPRI Yearbook: Armaments, Disarmament and International Security, OUP and SIPRI, Sweden.

Notes on data:

i) For each company, there are data on arms sales, country of location and main sector of arms activity. Companies are ranked by arms sales.

ii) Other data are for total sales, employment and profitability for the entire company, not for its arms-producing division.

iii) The sources of data include company annual reports; internet sites; a SIPRI questionnaire; newspapers; military journals; and other associated data sources. In the absence of data, estimates have been made by SIPRI.

iv) A detailed explanation of sources and methods is provided in an accompanying section on selection criteria, definitions and calculations.

6. **DTI/BERR, The 2007 R&D Scoreboard: annually.**

Source: Originally published by DTI; now published by BERR (Department for Business Enterprise and Regulatory Reform, London).

Notes on data:

i) Data for top 850 UK companies and top 1250 global companies ranked by R&D spending. The data are obtained from the annual reports and accounts received by Company Reporting Ltd.

ii) Within the totals for UK and global companies, there are company data for the Aerospace and Defence sector showing annual R&D investment by total; by employee; and as share of sales and profits. There are also data on total company sales (including sales outside the home region), total employment, labour productivity and profitability.

iii) Within the Aerospace and Defence sector, details are shown for 24 UK and 31 European and US companies. Comparisons can be made with companies in other sectors.

iv) The R&D data are based on that disclosed in the annual company reports and accounts and as defined by UK or international accounting standards, based on the Frascati manual.

v) There are two major limitations of the data. First, all data refer to total company sales embracing both civil and defence: there are no separate published company defence data. Second, the R&D data are for privately-funded R&D, much of which is for civil R&D. Thus, the R&D data excludes a major component of defence R&D, namely, R&D funded by government (which is the dominant component of defence R&D).

7. **DTI. The Value Added Scoreboard 2007: annually.**
Source: The Value Added Scoreboard 2007, Department of Trade and Industry, London)

Notes on data:

i) Similar to DTI/BERR R&D Scoreboard but for value added. There are two volumes dealing with Commentary and Analysis (volume 1) and Company Data (volume 2).

ii) Company data are presented for the top 800 UK companies and the top 750 European companies ranked by value added. Comparisons can be made with companies in other sectors.

iii) There are company data for the Aerospace and Defence sector. Within this sector, there are data on 15 UK companies and 12 European companies.

iv) There are data on total sales, employment, profitability, market capitalisation, R&D and R&D plus capital expenditure as a share of sales.

v) The distinctive feature of the Scoreboard is the provision of data on value added productivity (i.e. value added per employee compared with the typical labour productivity measure of sales per employee where sales include bought-out parts and components).
vi) Again, a major limitation of the Scoreboard is that it reports data on *total* company activities embracing both civil and military business.

8. **Company Annual Reports and Accounts: annually**.

Source: Major companies publish their Reports and accounts on the internet (e.g. BAE Systems; Finmeccanica).

Notes on data:

i) The size and content of annual company reports differ markedly. Their statistical data also vary ranging from the minimum required by law and accounting requirements to more substantial data by various divisions of the company. Two examples are reported below, namely, BAE Systems and Finmeccanica..

ii) *BAE Systems* annual reports are detailed and comprehensive documents with a range of useful data:

a) There are Group data on total sales, employment and profitability and other financial ratios can be derived from the accounts.
b) There are also financial data by company divisions (and by location: UK; USA).
c) There are divisions for Electronics, Intelligence and Support (HQ in USA); Land and Armaments (HQ in USA); Programmes (HQ in UK); Customer Support and Solutions; Integrated Systems and Partnerships; and HQ and Other Businesses. Each Division provides data on sales, employment, earnings before tax and profits as a share of sales. Also, from sales and employment data, it is possible to estimate labour productivity for each Division. **Also, the Divisions identify the Group's defence business so that performance indicators are for various defence activities, such as land, electronics and air and sea systems.**
d) There are also sections on Key Performance Indicators; a Financial Review and a review of non-financial performance indicators; together with a section on The principal risks of the Group (e.g. its dependence on fixed price contracts, especially for risky design and development work).

iii) *Finmeccanica* annual reports are not as detailed and informative as BAE reports:

a) There are Group data on sales, employment, earnings before interest and tax, and profits on investment. Total employment is shown by regional location in the world and for Italy, total employment is shown by region.

b) The company is divided into sectors: helicopters; defence electronics; space; defence systems; Energy; Transport; and Others. There are only two defence-specific sectors. For each sector, there are
data on sales, earnings before interest and tax and orders (an indicator of future viability of each sector of the business).

iii) Whilst company reports are available for large defence companies, there are problems in identifying suppliers, especially in supply chains which contain large numbers of SMEs. See Appendix for further details.

9. Investment analysts' reports:

i) Investment banks such as BNP; Credit Suisse First Boston (CSFB), Deutsche Bank and so forth produce reports for their clients on the defence industry; individual sectors; individual companies; and particular issues that are important to the investment environment.

ii) These reports often contain very detailed data and analysis of company performance (often at the divisional or business unit level) and markets (normally broken down into individual national and market segments).

iii) For instance, Credit Suisse First Boston produces an annual Global Aerospace and Defence Outlook and Directory. The 2008 Outlook and Directory includes a review of over 300 pages that provides detailed information on such aspects of the defence sector as: global defence spending overview; major programmes in the United States; Europe; defence emerging markets; and, profiles of major defence companies (including a description of their main business activities; a SWOT analysis; and key financial data).

iv) These studies are available directly from the investment banks.

10. Share price data:

i) Share price data is available from a variety of courses including from internet websites and the websites of individual companies.

ii) The share price is an important driver of company strategy and management behaviour and an indicator of investor sentiment towards the firm and its sector.

iii) The most obvious problem of share price data is that it is only available for companies that are quoted on the stock market. Share price data also presents a number of technical challenges. Most companies are comprised of a number of businesses and this makes it difficult to assess the portion of the share price accounted for by the performance of the defence business. Where it is possible to identify the influence of defence business performance on share price it is rarely possible to assess the impact of performance in a particular sector therefore making share price problematic as a metric for sectoral studies. There is also the question of what the share price performance of a defence company (or the defence industry) should be compared against to assess whether the sector is doing "well" or "poorly". Equally, the share price of a company is also influenced by a variety of factors beyond the performance of the company and its management and these include wider "market sentiment" towards the sector, the economy and so forth.

11. **The European Commission MEDI (Measuring the European Defence Industry) data base:**
DG Enterprise has sponsored the design and development of a database on the European defence industry that is intended to include information on companies and their activities in the European defence industry including information on their products, employment, R&D and location. This represents a potentially useful source of background information although EDA will need to clarify its status since when we spoke with the Commission the form in which this data was to be published was still being considered.

Conclusion: Data Problems

12. There is a major data gap in the form of a lack of decent economic data on defence industries and defence companies. Typically, official national statistics do not identify specific defence industries. At best, there are some industrial classifications which are clearly defence (e.g. ordnance in the UK). Otherwise, the official industrial classification identifies various defence-dependent industries, namely, aerospace and shipbuilding; but these report aggregate data which comprises both civil and military sales.

13. Similar problems arise with company data where military and civil sales are aggregated; and military sales comprise both sales to national government and export sales. Moreover, the published company data often focus on the top 100 firms (e.g. Flight; SIPRI) to the neglect of supply chains and supplying firms many of which are SMEs. **There are major gaps in our knowledge of defence industry supply chains for air, land and sea systems within the EDTIB**. We lack data on which firms are involved as suppliers in supply chains; their location; the importance of defence in their total business; the importance of the firm in its local labour market; the importance of the firm in the supply chain (e.g. is it a key supplier and the only one in its national market; are their rivals elsewhere in the EU or is it an European monopoly?). Many of these firms are SMEs and little is known about their financial viability and hence their long-run

presence in the EDTIB. In contrast, we know more about the large suppliers in the EDTIB. Examples include firms such as SNECMA(Safran) and Rolls-Royce as aero-engine suppliers; Smiths Aerospace (acquired by GE in 2007) as an avionics supplier and Cobham involved in supplying air refuelling, avionics and defence electronics.

14. For almost all defence companies, the lack of financial data on their defence business means that it is difficult for outsiders to assess the financial viability of the defence component of their total business. Nonetheless, for privately-owned defence companies, the standard signalling mechanism of a company's financial fortunes is reflected in its capital market performance. Here, the standard performance indicators are profitability and the associated share prices. Relatively poor profitability compared with other firms and industries is reflected in falling share prices, management and board changes, sales of unprofitable parts of the business, mergers and take-overs and ultimately, bankruptcy. These are important signals about the financial viability of the EDTIB. Overall, the best single source of *published* data on defence companies is the SIPRI Top 100 arms producing companies.

15. **Thus**, **efforts by EDA to identify strengths and weaknesses of an EDTIB encounter major data problems. The available published data are useful but no substitute for actual data on company defence sales, productivity and profitability. The position is further complicated because most national defence ministries are confronted with precisely the same data problems in relation to their national defence industries.** However, national defence ministries usually have access to contract data for firms. Also, for non-competitive contracts some ministries have access to the detailed costing data and firm performance for specific projects (which allows procurement staff to assess a firm's performance and efficiency).

Annex 4: Findings of the email survey

The objective of the email survey was to establish which pMS conduct formal assessments of the strengths & weaknesses of their DTIBs and (amongst those that do) what methods they use to make that assessment. The email survey sent was sent to EDA NADs PoCs on 3 March; a first email reminder sent on 12 March; a second email reminder sent on 17 March; and a third reminder to selected pMS on 27 March.

We received 16 responses as follows: Austria; Belgium; Bulgaria; Cyprus; Czech Republic; Estonia; Finland; Italy; Germany; Greece; Latvia; Lithuania; Portugal; Romania[9]; Slovak Republic; and, Slovenia.

[9] The survey instrument was used face-to-face during a meeting with Romanian officials.

1. What is your government's definition of a strong national defence technological and industrial base (DTIB)?

pMS	Definition of a strong DTIB
Estonia	The industry can deal with some of the defence forces needs. Defence industries products are successful also abroad.
Finland	According the Finnish Defence and Security Industrial Strategy (2007) the importance of the Finnish DTIB lies in its capability to support and guarantee domestic integration and maintenance capacities as well as crisis repair expertise and hence contribute to the security of supply. The domestic market alone cannot maintain the national DTIB. In order for it to be strong and successful, it needs to be internationally competitive as well as meet the needs of the domestic market.
Germany	In order to meet the demands of its role as a security partner of equal rank in future, Germany needs to maintain a modern, competitive and strong defence industry. Only the preservation and improvement of defence technology capabilities and capacities at a qualitatively and quantitatively high level and geared towards the necessary and long-term capabilities for modern armed forces that are fit for the future will ensure that Germany has a say in European and transatlantic affairs and the capability to both shape developments and engage in cooperation. The White Paper 2006 on German Security Policy and the Future of the Bundeswehr (Chapter 3.7 "Armaments Policy") states: "It means having indigenous defence technology capabilities in order to co-shape the European integration process in the armaments sector. These will guarantee cooperability and assure an influence in the development, procurement and operation of critical military systems. Only nations with a strong defence industry have the appropriate clout in Alliance decisions."
Italy	The DTIB needs to be capable of delivering and sustaining key military capabilities, providing complex system of systems solutions, sustaining and upgrading platforms over the long-term, by promoting innovation also from other sources, developing and sustaining key technologies and accelerating the fielding of new technologies.
Portugal	By 'strong national DTIB' we mean a consolidated group or cluster of industries, companies, institutes and universities that, all together, have a relevant and decisive role and share as defence suppliers (of goods, equipment, technologies and services), at national and international levels (markets). The definition given above is in accordance with all the guidance received from EDA, namely the document "A Strategy for the European Defence Technological and Industrial Base", Brussels, 14 May 2007". In addition, we consider that some sectors of our DTIB are no longer sustainable on a strictly national basis, therefore we are implementing measures to develop the DTIB in order to play a role in a truly European DTIB environment.

1(a) Other responses

pMS	Response
Austria	There is no official definition. The question to ask is what could the definition of the DTEB be? A possible definition: "The Defence Technological Industrial Base includes all enterprises/ R&T/D facilities from different industrial branches, which are able to offer/ develop and/or produce and supply products, services, technologies or act as a system-house or as a supplier of sub components in the field of Defence/ Security."
Belgium	In Belgium our DTIB is not considered as a strategic element and therefore is no part of the Belgian Security & Defence Policy. The Federal Public Service for Economy is monitoring the different industrial sectors in Belgium but the government has today not given enough priority to the sector of the defence industry so that it could be monitored in detail. As a consequence the Strengths & Weaknesses of the DTIB are not formally assessed,
Bulgaria	There is no common view within the Bulgarian government bodies on defining a strong national DTIB.
Cyprus	Cyprus Republic has no defence industry therefore we can´t reply the above mentioned questionnaire.
Czech Republic	There is no government's definition of DTIB in the Czech Republic
Greece	It could be mentioned, that all domestic industrial potential, as well as the Research Institutes & Universities which are involved with defense programs during their various phases (Research, Development and Manufacturing) constitute the National DTIB.
Latvia	There is no official definition of DTIB in Latvia. There is very limited direct defence industry presented in Latvia. Thus, DTIB in Latvia should be defined in a broader way and include upstream and related industries. It should include a range of SMEs that act or can act as subcontractors for defence industry, as well as research institutions whose research can be applied for defence and military purposes.
Lithunia	We do not use such a definition like strong DTIB in our country. The main reasons for that are as follows: Lithuanian defence industrial part is quite small; Enterprises participating in defence business mainly work for civilian market and just approximately 5-10 % of their products are devoted for defence purposes. Defence industrial part with few exceptions is private and is not governed by Government or MOD.
Slovakia	There is no formal definition of a strong national DTIB. The Slovak defence industry is taken as any other industry under the governance of the Ministry of Economy. In relation to the question, special attention is paid to the support of our defence industry in the Manifesto of the Government of the Slovak Republic.
Slovenia	There is no definition of a strong DTIB in Slovenia. Slovenia does not have neither capabilities nor possibilities to sustain or develop national DTIB. Slovenia has a private civil industry with some defence production. Our defence forces are equipped on the basis of the procurements from abroad. The defence industry is tailored to participate to fulfil domestic needs partially. There is some defence production for the armed forces going on in Slovenia (clothes, boots, personal equipment, telecommunication equipment and installation, software production, maintenance and services, production of vehicles) but the development or production is not a long lasting - launched on demand.

2. What data on your DTIB do you (a) collect? (b) publish internally? (c) publish externally?

pMS	DTIB data collected
Austria	The email survey reply indicated that a number of studies have been produced in this field by outside contractors.
Bulgaria	a) MoD and Ministry of Economy and Energy collect data on a regular basis with regard to analysing and assessing the readiness of the industry to support the defence and home security in time of crises. b) MoD and National Statistical Institute have started within 2008 a project for issuing an Register for the potential capabilities of the Bulgarian suppliers for delivering military and civil products and services. The register will be published internally for government use only, because of the sensitivity of the data included. c) On biannual basis MoD publishes a Catalogue for the Bulgarian defence industry capabilities and the defence industrial policy of MoD. The catalogue encompasses thorough information for the activities of the Bulgarian companies and it is published externally. It might be found in Internet on the site of BU MoD.
Czech Republic	a) Production and sale data of defence equipment (monetary specifications); incomes (equipment and services sale) as a whole; incomes (as above) on behalf of MoD, MoI and export. Production and sale volume on behalf of MoD, MoI and export, (for some selected defence equipment only) b) Complex data are for internal purposes of MIT (Ministry of Industry and Trade) only and are held as classified information c) Total data on production of small and light arms are published in Annual Report on Export Control of Military Material and Small Arms for Civil Exploitation in the Czech Republic Selected data can be released on demand
Finland	Most of the Finnish defence companies are members of the Association of Finnish Defence industries. The Defence Establishment has an open and ongoing dialogue with the Association. The size of the country and the industry also encourages direct contacts between the companies, the Association and the officials. Having said that, there isn't such "official data" on our DTIB that we would collect or publish. Most of the information we need can be acquired from the companies and their Annual Reports. The data that we do collect is the information needed for the Annual Report According to the EU Code of Conduct on Arms Exports. This data gives us good information on exports of defence materiel. The data is delivered to the EU and published in our website www.defmin.fi
Germany	The Federal Ministry of Defence is constantly monitoring the national Key Defence Industrial Capabilities and it does keep records about the national DTIB, by recording all contracts awarded to Industries and keeping close contact to the National Industries Association. The statistics about the awarded contracts are regularly published.
Italy	We are publishing data both internally and externally, as follows: internally, the guidelines for the Technical General Directorates, factories strategy, macro-economic data and reports concerning the evolution of national and international markets; externally, the National Defence Procurement Update and the Secretariat General of Defence & National Armaments Directorate (SGD/NAD) Annual Report.
Greece	We collect data about Defence Industry's details and capabilities, such as: i.Organization; ii.Personnel; iii.Infrastructure - equipment; iv.capabilities; v.contracts – defence programs; vi.co-operations - co-productions. The use of the above data by the responsible MoD's departments, assist during the bidding, evaluation and selection

	processes b) Not published, but internally available upon request c) Not published, upon request and after the company's permission taking into account National security reasons
Latvia	At the moment there is no such data collections and publications that are specifically oriented to DTIB on regular basis. In 2008 first such study will be carried out. Data collection on industry in general and main industry branches is performed on permanent basis. There have been several studies on the competitiveness of main sectors of manufacturing industry. Several of these sectors have or potentially may have connection to DTIB like electronics, chemical, mechanical engineering, etc.
Lithunia	The following data of national DTIB are being collected, published internally and occasionally published externally: Company (enterprise) title, profile, activities, type of production, main data and specification of the products, annual turnover, defence products percentage of the total amount, exports amount, quality assurance data and other indicators.
Portugal	(a) We have been collecting on a regular basis data from the universe of defence or defence related companies, in terms of areas of business, spectrum of activities and nature of offer, so as to build an updated data base (which includes all the firms, private and defence owned, legally authorised to do business with the MOD (commerce and development of defence products, equipment and goods) allowing for guidance in business opportunities and alternatives. A recent assessment of the national R&T capabilities has been made in order to get a better picture of the potential of our industry and academia and thus be able to design an R&T Strategy at national level. (b) In addition to the DTIB database, which is edited in hard copy and CD on a biennial basis, the MOD has been publishing internal directives, brochures and regulations aiming at facilitating an enhanced dialogue between the two sides of the defence market – demand and supply. (c) Externally, a hard copy and a CD with the relevant data of our companies have been circulated in specific fora that might be interested in getting in touch with specific sectors of our industrial capacity. The Portuguese AICEP (Portuguese Agency for Overseas Business and Investment) has an important role in disseminating defence business opportunities where foreign countries and NATO agencies are customers, by promoting the direct involvement of Portuguese trade and industry. The CD Database of national companies is just one of the tools for that purpose.
Slovakia	There are no standardized forms/ patterns for an industrial defence data (information) collection. We only collect selected data for our internal needs, not being published internally or externally and it varies according to the subject collecting data.
Slovenia	In accordance to our legislation company which wish to produce defence goods must be registered for the defence production. We therefore collect data of registered companies (name of the company, data of the registration, any changes in the registration). The data is published internally – for the export/import control purposes, for enforcement and for the procurements. We collect data on exports too. The data of the Slovenian DI exports is published externally.

3. Do you conduct formal assessments of the strengths and weaknesses of your DTIB?

pMS	Response
Austria	Yes, for example in the above listed studies.
Czech Republic	We do not conduct formal assessments of our DTIB at the present. Firstly, keeping track on the industrial performance in the Czech Republic fall under the responsibility of the Ministry of Industry and Trade. Secondly, Czech defence industry is still considered to be at its transition. Liberal feeling prevails amongst the society. The Security of Supply is mostly ensured by a condition in the delivery contracts of the main equipment. If there is not such an article in the contract, then the competition is launched for ensuring the supplies and services. From this point, it has not been considered necessary to maintain an assessment of the DTIB. This situation is changing lately. Together with the Defence Industry Association and with the Ministry of Industry and Trade, by using the activity of the EDA, the collection of necessary data has started. The assessment, nevertheless, is not performed yet.
Finland	As said before we have good and open contacts with the defence industry in Finland. An example of this is the Finnish Defence and Security Industrial Strategy that was prepared in cooperation with the industry. The industry executes the strategy on its behalf in cooperation with the Defence Establishment. In that work certain assessments of our DTIB has been made.
Germany	As far as the national Key Defence Industrial Capabilities are concerned, yes.
Greece	We conduct formal assessments of the potential contractor's current technical capabilities, just before the award of a Defence supply contract.
Italy	Yes
Latvia	In 2008 Ministry of Defence and Ministry of Economics jointly will launch study on development of defence and related industries in Latvia. There have not been such studies and assessments regarding DTIB before. One of the key objectives of the study will be to assess the capacity of Latvian defence and related industries, to assess the impact they have now on the national economy and possibilities to improve their competitiveness.
Lithuania	There is no rationale to conduct formal assessment of National DTIB for above mentioned reasons and due to not adequacy of the proportion of the products for defence needs and for other customers.
Portugal	In a systematic way, we do not conduct formal assessments because we are in a process of developing a national strategy for the DTIB as part of the transformational process going on in the defence sector. Moreover, the universe of firms working for defence is relatively small thus the MOD is fairly aware of their strengths and weaknesses. The MOD/Armaments Directorate is monitoring and evaluating the projects related to the defence owned firms in development through different methods, such as: visits, periodic surveys, reports, etc. The MOD, in collaboration with a private firm, is conducting a study related to the development of the national strategy for the DTIB.Furthermore a survey on the potential of the R&T sector (research centres, companies, institutes, laboratories and universities) has been conducted in order to build the grounds for a newly conceived defence R&T Strategy and Plan.
Slovakia	We only assess the Slovak DTIB internally within our Defence Planning and Armaments Processes in view of possible contribution to the Slovak defence capability development and Slovak Armed Forces capabilities enhancement and/or in developing of government/ MoD documents.
Slovenia	We do not conduct formal assessments of our DTIB. We do not have basis for conducting such formal assessments and we do not have methodology developed. The impact of the DTIB to the fulfilment of the defence needs and to the Slovenian economy is very small.

4. What criteria do you use to measure strengths and weaknesses of the DTIB?

pMS	Criteria used
Austria	The question for the assesment criterias can be answered with Checklists: "Branch analysis" and "Business/Firm Analysis" (developed from Prof STRUNZ/AUT). It is possible to make "Benchmarking" and "SWOT /Portfolio-analysis". A draft is enclosed (in German). The are from the STRUNZ book: „Sicherheitspolitik und Wirtschaft". In total STRUNZ has developed ca. 20 checklists with different content a depth.
Finland	In the work described above i.e. the following criteria has been used: structure (industrial, operational); international competitiveness; financial state; R&D resourses and investments; commitment to the development of the defence forces
Germany	The national Key Defence Technology Capabilities are based on the evolving Military Operational Requirements and the current and predicted Military Capabilities. The data about awarded contracts are continuously analysed, to see which industries capabilities exist on the national and international market and to see the participation of Small and Medium Enterprises. The DTIB is based on defence technology capabilities. Indispensable national key defence technology capabilities have been defined by the Federal Ministry of Defence and the Defence Economics Committee of the Federation of German Industries in order to: assist Germany's defence industry in maintaining its strength and competitiveness, with the aim of also ensuring the preservation of the identified key defence technology capabilities in the European context; give Germany's defence industry a reliable basis for planning and so assist it in the making of its decisions about current and future investments; safeguard jobs in Germany by preserving innovativeness for the promotion of cutting-edge technology; and, to provide stimulus for a defence industry and a defence market where equal conditions of competition can be created – also with a view to maintaining the freedom of entrepreneurial activities from state interference.
Greece	Evaluation criteria are based on the specific MoD's requirements.
Italy	To this aim, we believe it's necessary to provide a valuable commentary on where the main challenges and opportunities for the DTIB lie and which technologies deserve particular priority.

5. What tools and methods do you use?

pMS	Tools and methods used
Finland	In this work the SWOT method was used
Germany	Comparison of current and future military demand with existing and future Defence Industrial Capabilities.
Greece	Assessments are conducted by means of an internal "experts committee".
Italy	To this aim, we make the recourse to data analysis, priorities identification and development of areas of interest.
Latvia	The study will include interviews and gathering data from companies, research institutes and innovation support institutions like technology transfer offices and centres. Development trends in Latvian industry, in Europe and globally will be analysed. Detailed methodology will be elaborated in the inception part of the project.
Slovakia	Expert evaluation

Annex 5: The country case studies

The study team conducted interviews with officials in four pre-selected pMS (the UK, France, the Netherlands and Sweden). The four pMS were selected in discussion with EDA and on the basis of our awareness that they had engaged in studies of their respective DTIBs. In each case, the study team approached the EDA NADs PoC for the pMS and asked the PoC to identify appropriate officials who we might interview. We conducted interviews with those officials and we sent a draft summary of our country study to the pMS PoC and invited comments. Where comments were received, they were integrated into the final country study. We also conducted interviews in the United States to understand some of the practices used by the Department of Defense.

It ought to be emphasized that the aim of the country studies is not to provide a comprehensive description of all defence industrial analysis efforts undertaken in the country. Such an aim would have been unrealistic given that the larger countries that we studied adopt a diverse variety of tools and techniques across a variety of different parts of the organization. Instead, the aim of the country studies is to provide nothing more than a flavour of the tools and techniques that are used. We have consciously selected a variety of tools and techniques for illustrative purposes.

> Since this study is only the beginning of EDA's process of developing a methodology we strongly suggest that EDA use these country studies as the starting point for further discussions with experts in the pMS.

France

1. INTRODUCTION

This note describes some of the tools and methods used by the French government to assess the strengths and weaknesses of the French defence technological and industrial base. The DGA is the key actor in defence industrial assessment. The Ministry of Defence's Observatoire Economique de la défence (OED) also undertakes some relevant activities and these are also considered. In addition, it should be noted that at the time of writing we were awaiting the publication of the *Livre blanc* which will be critical for having a complete panorama of future changes concerning DTIB and was anticipated to have important consequences for the perimeter of this industry and the critical skills to develop in the future but also the specific agenda for European cooperation.

2. CRITERIA USED TO ASSESS STRENGTHS/WEAKNESSES OF THE DTIB

Concerning the DTIB, the French position is largely summarized by the official position of the *Conseil Economique de la défense (CED).* According to the CED:

> "The objective of the defence industrial policy should be to respond to France's need for independence, i.e. to ensure it has access to the industrial capabilities and competencies required to satisfy requirements of French forces in terms of equipment in the long term. This independence influences not only military effectiveness, but also margin for diplomatic manoeuvring, decision making and action. France must be able to rely on an industrial base whose degree of autonomy enables it to guarantee the security of supplies for the armed forces**,** the freedom to use equipment at their disposal and the option to export arms to friendly countries and allies" (Philippe Ester *et al.*, Report Défendre la France et l'Europe, CED, 2007).

At the same time, the definition of a strong DTIB has shifted towards the European level in some areas if France is to retain the capabilities that it regards as important. Thus, the CED notes:

> "an integration and rationalisation of the industrial base must be sought at European level: they involve the acceptance between states of mutual dependencies on industrial competencies, ensuring fair recognition and reciprocal consideration of existing centres of excellence(…) To this end, Europe must be seen as the relevant perimeter for most defence acquisitions and the implementation of joint bi or multilateral programmes (…) The objective of competitiveness of industrial fabric includes a rationalisation of the European DTIB around centres of excellence, possibly transnational, able to handle international competition".

3. TOOLS & METHODS USED TO ASSESS THE DTIB

We were told that DGA had developed a specific tool in the form of a handbook for conducting having sectoral analyses and that this was similar to the approach used by UK Defence Industrial Strategy (version 1). However, this tool was confidential and consequently could not be discussed. However, we were able to develop an understanding of some other tools and methods that are of importance.

DGA: Politique Technologique Sectorielle
The DGA's Politique Technologique Sectorielle (PTS) process seeks to identify priorities for R&T activity and funding. The PTS process is conducted within the context of the PP30 (Plan prospectif à 30 ans) and translates the findings of the PP30 to specific sector, firms, research institutes the budgets and research contracts required to make it consistent with defence objectives.

Technologies identified by the PP30 as important are allocated to a Politique Technologique Sectorielle (PTS). There are 20-25 PTS and, in general, the PTS process is undertaken annually for each PTS although this may differ between the PTS depending on the particular characteristics of the sector.

The PTS panels analyse the technologies and typically address a number of questions, including: What is the potential of the technologies? What constraints need to be overcome to maximize the opportunities from the technology? What kinds of actors need to be involved to develop these technologies and how can industry in particular be orientated to focus on these technologies? Depending on the objective, the studies can be relatively short - reviewing a PTS may simply be one meeting to check whether anything has changed - or a broader exercise that draws on specific experts, including panels of industry representatives and panels of military representatives.

The aim of the process is to promote interaction between industry and the DGA to develop a collective view of the technological domain and its resource requirements that will lead to what is needed to write requests for proposals.

DGA: the role of D4S
Within the DGA, there is a service responsible for working with the defence industrial base called D4S (Direction de System de Force et des Strategies Industrielles, Technologiques et des Cooperations). D4S is responsible for collecting information on the health of defence contractors, their capabilities and their strategic direction, including suppliers and SMEs. A variety of tools are used to collect and analyse this information but DGA was keen to emphasize the importance of direct contact and regular discussion as the key "tool" needed to judge the evolution of the skills and competencies of the industrial base.

OED: SANDIE database

The Ministry of Defence's OED (*Observatoire Economique de la défence*) seeks to provide an overview of the defence industry with the building of a specific tool called SANDIE: Statistiques Annuelles sur la Défense, son Industrie et ses Entreprises (Annual Statistical on Defence Industry and database). This initiative is distinct from the activities of the DGA but relies on the collaboration of the DGA for much of the information to populate the database.

SANDIE is a database produced and maintained by OED which includes information on the suppliers of the Defence Ministry (more than 12 000 firms) over the period 1998-2007. SANDIE compiles supplier information from a variety of sources, including:

- FIDGI (Fichier de données de gestion industrielle) database updated and maintained by the DGA (in this field DGA and OED are working in close cooperation),
- GIFAS's database (called 'BD-STAS') for having a list of the main subcontractors in the aerospace industries;
- Data from the Ministry of Defence concerning all firms that have contracts with this government agency.

The SANDIE database has proved to be a useful tool for academics and researchers seeking to assess the particular characteristics of the DTIB and the distinctive features of defence firms (innovative capacities, characteristics of firms belonging to the defence industry…). However, it has had more limited value for operational purposes. The main reason is that SANDIE database is unable to provide comparable year-on-year information. There are also questions over the quality of the data that is inputted into the databases upon which SANDIE draws. At the same time, it has proved resource intensive to maintain the SANDIE database. Nevertheless, despite these limitations, SANDIE has proved useful for judging the development of specific characteristics present in the French DTIB and for identifying important general trends. At the same time, OED staff are frequently engaged by the Conseil Economique de la défense (CED) in the analysis of various dimensions of the DTIB.

The Netherlands

1. INTRODUCTION

In August 2006, the Dutch Ministers of Economic Affairs and Defence jointly began a process to develop a strategic vision concerning the Netherlands defence related industry in an international context in order to inform the Parliament. This note describes the process that was used to produce the Defence Industrial Strategy (DIS) published in 2007. The Dutch process is noteworthy for a number of reasons: (1) the analysis is strongly international in its orientation and considers the role of the Dutch DTIB in Europe and transatlantic industry; (2) alongside its concerns with the needs of the Dutch military the study also placed a strong emphasis on the potential economic benefits of the DTIB for the Dutch economy; and (3) there is an explicit connection between defence, the emerging market for security-related products and services and civil sectors.

2. CRITERIA USED TO ASSESS STRENGTHS/WEAKNESSES OF THE DTIB

In considering the strengths and weaknesses of the Dutch DTIB, the Defence Industrial Strategy (DIS) process evaluated:

- *Capabilities* - the fit between the DTIB and the ambitions of the Netherlands armed forces;
- *Competitiveness* - the capacity of the Dutch defence related industry to share structurally in international supply chains;
- *Broader benefits to the economy/technology base* - the capacity of the Netherlands to share in the economic effects of the DTIB, security-related industry and related dual use technologies. The technological aspects concerning spin-off and applications beyond the military realm were underlined.

It ought to be emphasised that the focus of the DIS process was much wider than the national DTIB and that the focus was wider than those companies that were suppliers to the Dutch Ministry of Defence:

(1) The analysis was strongly international in its orientation and considers the role of the Dutch DTIB in Europe and transatlantic industry and in serving a customer base that was much wider than the Dutch government alone. There was a view that that the relatively small size of the national industry required a broader vision and that assessing the European and global DTIB was essential to determine the posture of the Dutch DTIB vis-à-vis potential cooperation and competition.

(2) Alongside its concerns with the needs of the Dutch military, the study also placed a strong emphasis on the potential economic benefits of the DTIB for the Dutch economy; and there was an explicit connection between defence, the emerging market for security-

related products and services and civil sectors. A basic principle of the DTIB analysis was that most companies already served multiple markets an that they would continue to be active in the military as well as on the civil market.

3. TOOLS & METHODS USED TO ASSESS THE DTIB

The study considered: (1) Geopolitical International Developments; (2) DTIB Strengths and Weaknesses, Needs and Opportunities; (3) an evaluation of International Cooperation Programs Evaluation; (4) the possible Dutch contribution to the industry.

The TNO study
The analysis of DTIB strengths and weaknesses, needs and opportunities was supported by an outside contractor: TNO's Innovation Policy Group. A three step process was used:

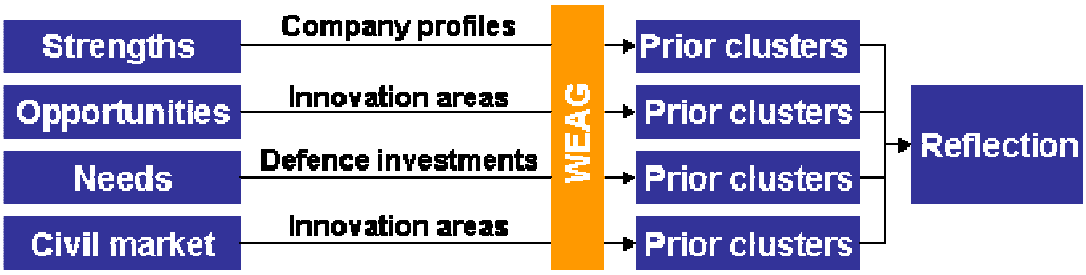


Figure A5.1: The methodology

Step 1: Data collection
Data was collected on each of the questions, as follows:

- What are the current **strengths** of the Dutch defence industry? Information on the current strengths of the Dutch defence industry was gathered through a questionnaire sent to relevant companies; information collection by the Dutch industry association NIDV; and a computer aided workshop with the industry organized by TNO.

- What are international **opportunities** for innovation in the defence market? Information on innovative opportunities were identified using desk research and interviews with leading parties;

- Which technologies and innovations meet the future **needs** of the Dutch Ministry of Defence? Information on the future needs of the military forces were identified and weighted based on already planned investments by the Ministry of Defence;

- What are opportunities for the **civil market**? Information on civil market opportunities was assessed using an expert panel.

Step 2: Identification of technological clusters
The next step was to use the Western European Armaments Group (WEAG) technology taxonomy to identify technological clusters. This was used to order the information that had been gathered on DTIB strengths, international opportunities, future MOD needs and civil market opportunities.

Step 3: Analysis of the clusters
In the final step, an expert panel scored each technology cluster against the four dimensions. The clusters were characterised as being (1) A broadly represented technology cluster (++); (2) A cluster that is strong in niche areas; (3) Potential of cluster has different views (+); (4) Less important, fragmented cluster (=)

The analysis is described in the following table:

	Technology clusters	Perspective			
		Strengths	Opportunities	Needs	Civil market
Type 1	C4I	++	++	++	++
	Sensor systems	+	++	++	++
Type 2	Integrated system design and development	+	+	+	+
	Simulation, training and artificial environments	+	(+)	+	+
	Electronics and mechatronics	(+)	(+)	+	+
	Advanced materials	(+)	(+)	+	+
Type 3	Propulsion and energy systems	+	=	(+)	=
	Mechanics and hydraulics	+	=	=	=
	Protection and weaponry	=	=	+	=

Type 1 clusters can be regarded as broad, strong clusters, with a good industry base and market potential in domestic, international and civil markets. Type 2 clusters cover a couple of interesting niche markets. Finally, type 3 clusters are fragmented but might have some niches.

4. ORGANISATION OF DTIB ANALYSIS

The development of the 2007 Defence Industrial Strategy was a one-off exercise although there has been some discussion about making it a regular document to be updated every two years. The DIS was led jointly by the Ministry of Defence (MoD) and the Ministry of Economic Affairs (MoEA) and involved a wide range of government Departments and stakeholders. The DIS process was led by a high-level Steering Group, heading four different Working Groups. The Steering Group was comprised of senior figures from the policy directorate of defence material (NAD); the directorate of the defence staff (military); the R&D directorate; and the finance department

The DIS involved some 50 people part-time (10%) and lasted some 9-10 months. The DTIB analysis within the DIS was led by TNO lead and involved four people for six months. A number of different skills were required.

The DIS process has been viewed as a successful intergovernmental exercise that is having a direct impact on public policy. The strategy was discussed in Parliament and will be part of the national policy on the defence industry. The DIS is also likely to form the core of a proposed defence innovation policy that will direct future R&T investments and define innovation programmes in the area of security as well as defence.

Sweden

1. INTRODUCTION

This note focuses primarily on the tools and methods used by the Swedish Defence Materiel Administration (FMV) to provide on-going monitoring of the DTIB for the Swedish Ministry of Defence and the Swedish armed forces. FMV market- and business analysis are also utilized in FMV strategy and policy work, etc. The Swedish defence research agency (FOI) also undertakes some DTIB analyses through its FIND programme and this is also described. In addition, it should be noted that the Swedish government is currently preparing a Defence Industrial Strategy and this has included inputs from both FMV and FOI. The Defence Industrial Strategy process is not considered here.[10]

2. CRITERIA USED TO ASSESS STRENGTHS/WEAKNESSES OF THE DTIB

The SWEDISH GOVERNMENT BILL 2004 / 05:5 *Our Future Defence – The focus of Swedish defence policy 2005–2007* set out the factors that the government regarded as important when making assessments of the strengths and weaknesses of the Swedish DTIB. This statement made clear that a strong DTIB would be characterized by:

- *A strong fit with military capability requirements:* The Swedish Armed Forces shall have modern military equipment that supports the development towards a network-based defence and that satisfies both the national and international needs of the future operational defence force. The modified needs of the operational defence force must have a greater impact on military equipment planning. Traceability must improve, i.e. it must also be easier to see how the demands for operative capability affect equipment supply.
- *International competitiveness:* the DTIB must be focused more on specific areas or 'niches' and Swedish authorities and the country's defence industry must develop skills based on the equipment needs of the Armed Forces, where Sweden can gain an internationally competitive edge, in turn creating scope for greater international cooperation.
- *Engagement in international cooperation;* There has to be more cooperation on RTD between different countries to ensure our equipment is in line with international development and can function together with the materiel of other countries in international operations.
- *Use of dual technologies:* It is also necessary to make better use of civil RTD in military equipment systems.
- *Achievement of synergies between actors within the DTIB:* we need to identify areas in which the defence authorities, civil authorities, universities, Swedish industry and research institutes, all have the opportunity to cooperate to create more synergy effects and make better use of research findings.

[10] We approached the Swedish Ministry of Defence to request a meeting to discuss the process being used to develop the Defence Industrial Strategy. We were told that it would not be possible to share information on the content or the process of the strategy until there was a formal position from the Government.

3. TOOLS & METHODS USED TO ASSESS THE DTIB

FMV is expected to monitor the DTIB on an on-going basis in order to provide advice and support to the Ministry of Defence and the Swedish armed forces on defence industrial issues. In addition to responding to these questions, every six months, FMV conducts an analysis of the Swedish defence industry for the Ministry of Defence. FMV analyses also have an international dimension reflecting the emphasis on international cooperation in Swedish government policy.

FMV's bi-annual DTIB studies

Every six months, FMV undertakes a study of the defence industry and market for the Ministry of Defence.

The industry analysis includes, among other aspects, an evaluation of:

- Business performance (including export performance)
- Technology (including companies' own R&D spend)
- Project performance
- Financial health

The market analysis includes, among other aspects:

- Identification of the companies that are operating in the market;
- Market developments in individual capability areas;
- Developments in selected countries and in particular developments in their procurement programmes and R&T programmes that may open up opportunities for mutually beneficial cooperation.

FMV emphasised the importance of expert knowledge and networks of expertise both within FMV, the armed forces, but also from outside government in its DTIB analyses and that most of the value-added in such analyses comes from the knowledge and analytical capabilities of FMV experts. The data used in DTIB studies comes from both open and confidential sources.

FMV emphasized that it believed that there was a need for frequent (six monthly) analyses since company investment decisions alter continuously and so does the performance of the companies on individual projects.

4. ORGANISATION OF DTIB ANALYSIS

FMV

FMV has core of business- and market analysts with support from relevant experts within the organization. These analysts bring a mix of knowledge on international relations/strategic issues; industry; legal; and military. The knowledge and experience has been developed through working on materiel programmes, working in the procurement commands and so forth.

Resource limitations mean that FMV stressed the importance of effective networking. FMV noted that knowledge is distributed and that those who are responsible for DTIB analyses are dependent upon expertise that resides in many departments within FMV; in the armed forces; Strategic Materiel Command; research and technology community; procurement commands; as well as in companies and consultancies.

The FOI FIND Programme

FOI (the Swedish defence research agency) also conducts some defence industrial analyses for the Swedish Ministry of Defence and the armed forces. FOI's FIND programme has conducted a number or projects over the last fifteen years, either on its own or jointly with external contractors. These include assessments of the Swedish defence industry and broader competitiveness issues. FIND conducts studies at the initiative of the Ministry of Defence, FMV or the Armed Forces. FIND has also undertaken research and analysis projects for the European Commission and the European Defence Agency. The FIND programme comprises two full-time staff with a background in the social sciences and it draws on other expertise from within FOI as and when necessary. The FIND programme is part of FOI's Defence Analysis Division which researches and works in areas such as security policy, civil and military crisis management, command systems as well as defence economy.

United Kingdom

1. INTRODUCTION

In December 2005, the United Kingdom published its Defence Industrial Strategy. This note focuses on the tools and techniques used by the UK Ministry of Defence (MOD) to develop the Defence Industrial Strategy and the studies subsequently undertaken as part of its implementation. Since this has been a complex process and the tools and methods used have differed between industrial sectors, this note focuses in particular on the Complex Weapons sector as an example.[11] At the time of the interviews conducted for this study (March 2008), the UK was preparing Defence Industrial Strategy Version 2. The MOD were unable to discuss it although MOD officials close to the process said that the methodology being used for DIS v2 was broadly similar to that used for DIS v1.

2. CRITERIA USED TO ASSESS STRENGTHS/WEAKNESSES OF THE DTIB

The MOD emphasises that the Defence Industrial Strategy was a capability-driven process that was designed to contribute towards the overriding aim of ensuring that the capability requirements of the Armed Forces can be met, now and in the future. The Defence Industrial Strategy identifies the ways in which the DIS can contribute to that over-arching aim and these can be seen as the UK's definition of what it considers to be a strong defence industrial base:

> "The contribution that a DIS can offer towards that overriding aim [of ensuring that the capability requirements of the Armed Forces can be met, now and in the future] is in promoting a sustainable industrial base, that retains in the UK those industrial capabilities (including infrastructure, skills, tacit knowledge, Intellectual Property (IP) and capacity) needed to ensure appropriate sovereignty and/or contribute to co-operation with allies, to ensure our national security, but allows us to benefit from products on the broader international market where appropriate to maximize our Armed Forces' cost-effectiveness. Our interaction with this industrial base must provide good value to the taxpayer and good returns to shareholders based on delivery of good performance, and be consistent with broader security and economic policy…."

3. TOOLS & METHODS USED TO ASSESS DTIB STRENGTHS/WEAKNESSES

Since the Defence Industrial Strategy was a complex process and the tools and methods used have differed between industrial sectors, this note focuses in particular on the Complex Weapons sector as an example. We begin by providing a top-level description

[11] The UK also undertook a process that led to the development of the Defence Technology Strategy (2006). We focus this note on the Defence Industrial Strategy process only.

of the Defence Industrial Strategy process, before considering the Complex Weapons sector study that was undertaken as part of the DIS and we then consider the Complex Weapons sustainability study.

3.1 The Defence Industrial Strategy process

The defence Industry Strategy was a four step process as follows:

STEP 1: Agree sectors to be studied
The DIS was constructed sector-up. Sectors were agreed along what were judged to be the industry structure and there was a focus on key sectors which had a direct impact on defence outputs and where it was anticipated that potential restructuring would need to take place and/or which were strategic priorities for future capabilities.

STEP 2: Conduct sector studies
Each sector was expected to address the same core questions:

- What is in your forward programme?
- What do you need to sustain your industrial capabilities?
- What is your acquisition strategy to achieve that?
- How will you drive industry change and efficiency?

At the same time, acquisition reform policies were developed.

STEP 3: Consider trade-offs
The sector studies were brought together and trade-offs were debated to identify where priorities should lie and what was achievable.

STEP 4: Publication of the Defence Industrial Strategy
In their published form, each of the DIS sector studies considers:

- Strategic overview (relationship to military capability requirements)
- Current and future equipment programmes
- Indicative planning assumptions (i.e. future budgets)
- What is required for retention in the UK industrial base?
- Overview of the global defence market
- Overview of the UK defence market
- Sustainment strategy

3.2 The Defence Industrial Strategy: Complex Weapons sector study

Each sectoral team developed their own methodologies and here we focus on the approach used for the Complex Weapons (CW) sector study. The purpose of the study was to identify critical technologies and the industrial capabilities needed to support them as an input to the DIS process. The CW team used a four step process:

Step 1: Identification of critical technologies

Starting from an agreed defence industrial taxonomy, the defence acquisition community for CW in the form of the IPTs (Integrated Project Teams) were asked to classify CW technologies into Red (critical); Amber (willing to collaborate) and Green (suitable for open competition).

Step 2: Company workshops
Workshops with individual companies were organized at which the companies were asked what technologies it was critical that the UK retained for military reasons and - if they were the supplier of choice - what technologies would they invest in?

Step 3: Analysis and testing
The findings from Step 1 and Step 2 were analysed to identify areas of overlap/consensus. At the same time, the CW study team had to convince companies to provide their management accounts for staffing for 10 year time frame to get an assessment of staff planning. This was assessed against known future budgets and the Supplier Engagement Team's understanding of future contracts. The preliminary findings from the analysis were tested with experts in DSTL; RAO; the IPTs; and the Equipment Capability Customers.

Step 4: The findings were put to the senior-level DIS Board
At this stage, the CW lead had to justify what he was recommending and why.

3.3 Complex Weapons Sustainability Study
The implementation of the Defence Industrial Strategy required a number of further studies including several studies of CW sustainability. We focus here on the first of these CW sustainability studies and how it was conducted. The objective of the study was to assess the sustainability of CW sector technological and industrial capabilities against a number of procurement scenarios. The study was conducted by the Directorate of Supplier Relations for the DIS Implementation team. The sustainment analysis was one part of a wider process of developing a business case for the CW sector. The study used a four-step methodology as follows:

STEP 1: Investigate the impact of a number of procurement scenarios for sustainment of the enabling skills necessary for the CW sector
The CW sector was defined along a series of skills that were required for CW and that resided in companies. For a range of procurement scenarios, the impact on staff numbers in each category was estimated for each year between 2006-2015. The estimates were produced by each company. This was supported by detailed consultancy work contracted by DE&S that explored the organisation of each company.

STEP 2: Consideration of impact on sovereign capabilities
The next step was to consider the impact of the procurement scenarios on the sovereign capabilities set out in the DIS and DTS.

Step 3: Assessment of the impact on technologies

The sovereign capabilities were disaggregated into their constitute technologies using a systems engineering approach and an assessment was undertaken of the impact of each scenario on the sustainment of each technology.

Step 4: Assessment of the critical mass to sustain the technologies, capabilities and skills necessary to sustain the CW sector

The next step sought to assess how many people were required in each company to sustain a critical mass. A "traffic light" indicator was developed:

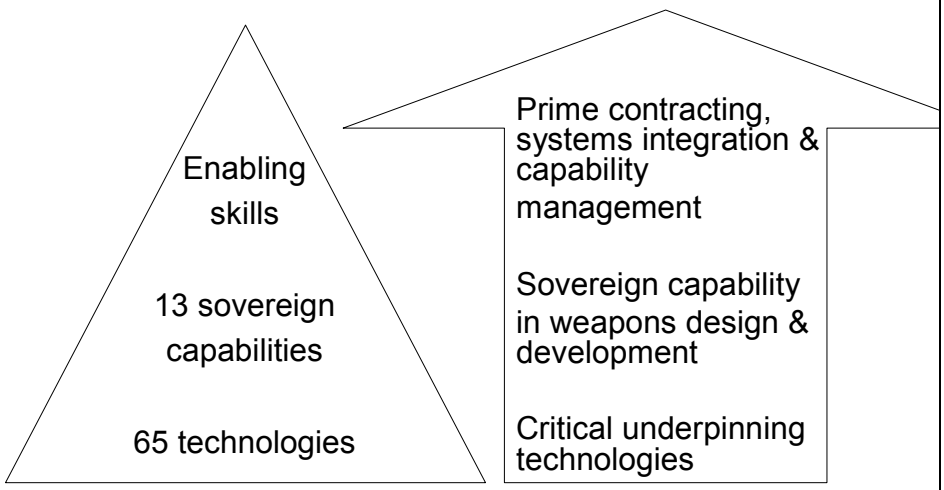
GREEN: high confidence that existing capability can be sustained without changing the industrial construct (i.e. business model)

AMBER: indicated an increasing level of certainty in delivering a constant capability as manning approaches the critical mass; minimum level of staffing to rebuild a full current capability in a realistic contractual cycle; allows sufficient manning to allow succession planning of deep experts and other critical specialists; and, statutory and regulatory obligations can be met

RED: indicates with a high probability that: the current capability is likely to be lost under the scenario and that there is no certainty that it could be addressed by organic growth and that this is likely to force structural change (e.g. market exit; alternative industrial construct).

Critical mass was calculated at three levels: *enabling/company skill* (essential prime contracting, enabling and management skills to ensure a company can discharge its statutory and regulatory obligations of a minimum number of staff); *sovereign capability* (number of staff needed to sustain sovereign capability in the company); and, *technologies* (number of staff needed to sustain technologies in the company).

Figure A5.2: Sustainment analysis



The assessment was time and resource intensive. There were two staff in the Supplier Relations Directorate who lead the process and worked approximately 25% of their time on the study; in industry there were 15 staff in the five companies who worked 50% of their time on the study over 12 months. The MOD emphasised that he level of resource put into investigating the companies concerned and the level of skills and expertise required to carry out that work was considerable. The Complex Weapons Implementation Team (CWIT) for instance also called upon the services of the Pricing and Focus Group (now the Cost Assurance Service (CAS) and Supplier Engagement Team (SET)). This support included one member from SET assigned to CWIT for 18 months and a further 3 Cost Engineers and 3 Accountants working part-time.

The sustainment analysis required the development of scenarios (including indicative funding data) and these were supplied by MOD. The sustainment analysis also required detailed information from companies and the calculations were undertaken by the companies using their expert judgment. One company was unwilling to provide these calculations (except at the enabling skills level) and this reflected that: (a) the assessment required a lot of work on the part of the companies; (b) the company felt that the assessment was not relevant arguing that it was difficult/impossible to distinguish staff who worked in different project/skill areas because they were all essentially transferrable; (c) the information required was commercially sensitive.

4. ORGANISATION OF DTIB ANALYSIS

Responsibility for DTIB analyses is distributed and there is no one team in the UK involved in this area of work. Within the MOD, those with an interest in this area are: the MOD lead for the Defence Industrial Strategy; the teams within DE&S responsible for each DIS sector; the Supplier Relations Group; and the Supplier Engagement Team.

The Defence Industrial Strategy was comprised of a series of activities. The DIS Board and the DIS sectoral teams were established to conduct the DIS. After the completion of the DIS, implementation teams were then established to operationalise and implement the recommendations of the DIS. DIS1 took two and a half years of effort with Ministerial support. The DIS process (and particularly implementation) required a range of skills including deep engineering knowledge of the particular sectors but critically financial and business analytical skills to understand the business operating environment and the dynamics of industry. This was a highly resource intensive process. The resources required for the Complex Weapons sustainment study has been noted. In the case of the fixed wing sector as a further example, UK MOD and the major companies concerned have been engaged for the best part of 5 years and there is an Integrated Project team that supports this work.

The process engaged a range of stakeholders within the MOD including the Integrated Project Teams; Equipment Capability Customers; Directorate of Supplier Relations (and its predecessor organisation), the Defence Science and Technology Laboratory (DSTL). Elsewhere in government, HM Treasury has played an important role with respect to the budget implications of recommendations and Value for Money issues. Externally, companies have been heavily engaged in the process.

Permanent monitoring of the defence industrial base is undertaken by the sectoral DGs and by the Directorate of Supplier Relations. The Directorate of Supplier Relations is responsible for the Key Supplier Management initiative which is seeking to develop a framework that will improve and develop DE&S knowledge, understanding and relationships with key suppliers throughout the supply chain. This focuses on 33 of MOD's key suppliers and is a resource intensive activity: it employs thirty staff to oversee relationships with the thirty three key suppliers.

United States

1. INTRODUCTION

Responsibility for defence industrial analyses in the United States reflects the fragmented nature of the U.S. procurement process and is distributed between the military services, defence agencies and the Office of the Deputy Under Secretary of Defense (Industrial Policy). The tools and techniques used differ between organizations making it difficult to generalize about practice. Accordingly, this country profile selects representative examples of practices and studies.

2. CRITERIA USED TO ASSESS STRENGTHS/WEAKNESSES OF THE DTIB

The U.S. Department of Defense (DoD) regards a strong industrial base as one that is reliable, cost-effective, and sufficient to meet strategic objectives:

- A "reliable" industrial base is one in which suppliers ship contracted products and services on time. Additionally, reliable firms are likely to be those who are viable and healthy for the long-term.

- A "cost-effective" industrial base is one in which suppliers deliver contracted products and services at or below cost targets.

- A "sufficient" industrial base is one in which suppliers deliver contracted products and services that meet DoD performance requirements.

3. TOOLS & METHODS USED TO ASSESS DTIB STRENGTHS/WEAKNESSES

The tools and techniques used differ between organizations making it difficult to generalize about practice. This section discusses several different tools and methods that have been used.

3.1 ODUSD(IP) monitoring of defence industrial capabilities

The mission of the Office of the Deputy Under Secretary of Defense (Industrial Policy) (ODUSD(IP)) is to sustain an environment that ensures the industrial base on which the Department of Defense (DoD) depends is reliable, cost-effective, and sufficient to meet DoD requirements.[12]

[12] ODUSD(IP) employs seven full-time staff in its Industrial Base Assessments Directorate. These are mainly engineers. Recently, a service sector analyst has been added in recognition of the growing importance of the procurement of services. ODUSD(IP) has a $1.5 million per annum study budget for external contracts with consultants and Federally Funded Research and Development Centers like the Institute for Defense Analysis (IDA)..

One way in which ODUSD(IP) does so is by monitoring industry readiness, competitiveness, ability to innovate, and financial stability amongst key system, subsystem, component, and/or material providers that supply many programmes, and affect competition, innovation, and product availability. Sector experts in ODUSD(IP) produce a monthly summary of industry performance in their sector and an annual report that is included in an Annual Industrial capabilities Report submitted to Congress by the Secretary of Defense.

The desired attributes of reliability, cost-effectiveness and sufficiency have been expressed in a number of measures:

- A "reliable" industrial base is characterised by the DoD as one in which suppliers deliver contracted products or services to DoD on time; at or below cost targets and meeting performance requirements. Equally, a reliable industrial base is characterised as one where firms have a stable or expanding business base, earn fair operating margins for owners, and invest in internal research and development and capital equipment such that long-term viability, innovation, and competitiveness is likely.

- A cost-effective industrial base maintains an adequate number of competitive suppliers in key and emerging technology areas. In addition to the number of suppliers in a given product area, another indicator of competitiveness (and cost-effectiveness) is the extent to which suppliers participate in non-defense (dual-use) U.S. markets and export products overseas. In fact, a positive trade balance within a market segment is a solid indicator that firms within that segment are world-class and provide cost-competitive products.

- Suppliers with sufficient industrial capabilities are flexible and react positively and quickly to changing requirements and priorities within the Department, particularly during times of conflict—indicative of the adaptability of both production lines and technology. They can effectively manage their way through requirements peaks and valleys while maintaining the ability to hire, train, and retain the specialized skills required to meet these dynamic requirements. They also have technology or technology development programs planned and/or in place to meet current and projected DoD needs.

These desired attributes have been converted into a series of metrics as follows:

Metric	Measure
DoD funding level/stability	Current/projected DoD budgets
Delivery performance	Earned value management data (e.g. schedule performance index)
Cost performance	Earned value management data (e.g. cost performance index)
Technical performance	Progress in meeting key performance parameters
Company viability	Business base, return on investment, cash flow, market

	valuation, earnings-per-employee, IR&D, capital expenditures
Workforce	Employment/workforce data (to include hiring, retention, special skills, etc)
Competitiveness	Number of suppliers, non-defence (dual use) sales, export sales, etc
Problem areas	Sick suppliers, capability gaps, capacity shortfalls (peacetime-surge)

In addition, specific financial and economic metrics are used are as follows:

Measure	Metric
Profitability	Return on Invested Capital (ROIC) Earnings Before Interest & Taxes (EBIT) Return on Assets (ROA)
Financial risk	Free cash flow to total debt
Market value	Market valuation based on EBIT
Productivity	EBIT-per-employee
Innovation	Independent R&D investment
Viability	Industry capital expenditures

The easy availability of data has been a key concern in developing the monitoring process. ODUSD(IP)'s aim is to collect repeatable top-level data and the data that is used comes either from DoD contracts data bases or from a commercial data base of company financial data. Data is not collected directly from the companies as there was a concern that this would impose excessive burden on the companies and that some companies would be unwilling to release commercial data. When more detailed and fine-grained data is required ODUSD(IP) may then go to companies or to DoD's Defense Contracts Management Agency. All DUSD(IP) studies are voluntary and companies can choose not to take part if they so wish. DUSD(IP) finds that anything data that is proprietary tends not to be released.

3.2 DOD Handbook Assessing Defence Industrial Capabilities

DoD Handbook 5000.60-H "Assessing Defense Industrial Capabilities" was published in 1996 and established the policies, procedures, and circumstances under which the DoD will take action to preserve endangered industrial capabilities. The Handbook was published at the height of US defence industry consolidation during which time ODUSD(IP) was receiving frequent approaches from DoD programme managers and companies who were concerned that key industrial capabilities were under threat. ODUSD(IP) published the Handbook to make its decision making process transparent and to help guide programme managers and companies in their decision making.

Although the Handbook was developed with a specific policy issue in mind and is now more than a decade old it remains a template for ODUSD(IP) defence industrial analyses where there is an indication that an important and unique industrial capability could be lost. The Handbook also provides some useful guidance of a more general kind for those like EDA who are considering undertaking industrial analyses.

The handbook uses a four step process as follows:

Step 1: Decide if an analysis is warranted:
Step 1 considers whether an analysis is warranted by considering the following questions:

- Does another supplier exist?
- Is a substitute available?

Step 2: Define the problem:
Step 2 defines the problem by addressing the following questions:

- Is there a national security requirement for the capability?
    - Is the product or service necessary to meet planned military missions?
    - Is the product or service needed to meet readiness or sustainment requirements? Will its absence affect the DoD's ability to support defence systems, assemblies or other components over the life cycle?
    - Is the product or service needed to support the design, development or manufacture of next generation defence equipment? Would its loss limit DoD ability to develop or field new systems? Is it needed to modernise systems or make make mission-driven upgrades?
- Do others use this product or service?
    - DoD demand: What is the total DoD demand for the products or services in terms of total quantities required, quantities on order, dollars and development or production timelines?
    - World-wide demand: What is the DoD's share of the global product or service market? Who are the non-DoD users?
- Is the capability truly unique?
    - What type of capability (Skills? Knowledge? Facilities and equipment? Processes? Technologies?)are needed to provide the product or service?
    - What kind of activity does the capability support (design, develop, produce, repair or maintain defence products)
    - Does the capability exist in a single product line or in a single or limited set of suppliers?

  - Are there related products, services or capabilities that could act as a substitute?
  - Is the capability so unique that defence needs or missions cannot be met without them?
- Will the capability be lost?
  - Will the capability be lost due to supplier financial performance or product line profitability?
  - Will the capability be lost if development or manufacturing is reduced or interrupted?

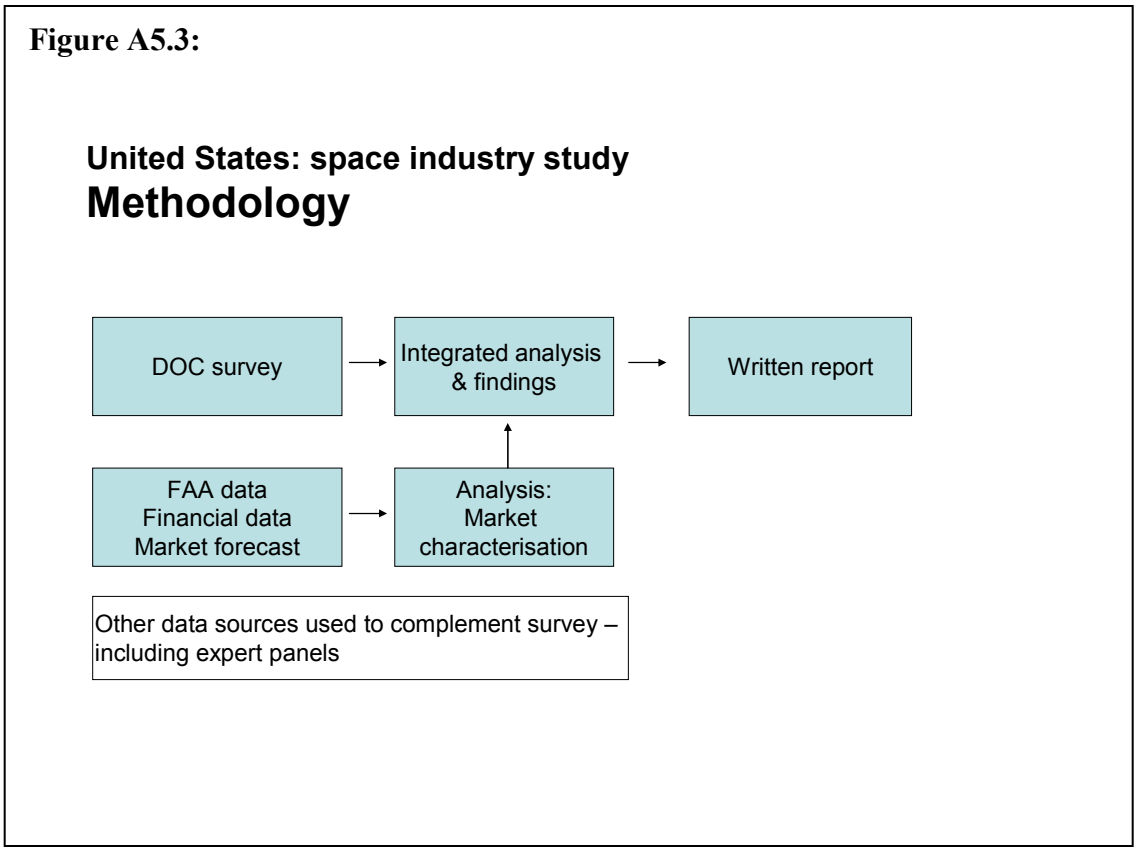
Step 3: Identify and evaluate alternative actions:
Step 3 identifies the alternatives available to DoD and evaluates those alternatives by determining and comparing the cost, lead-time, consequences and risks of pursuing each option.

3.3 Defense Industrial Base Assessment: U.S. Space Industry

Illustrating the diversity of agencies that undertake defence industrial base assessments is the U.S. Space Industry Defense Industrial Base assessment study. In October 2006, the National Security Space Office initiated a study to evaluate the industrial, economic and financial factors affecting the US space industrial base and to assess the impact of U.S. export controls and procedures. The study was published in August 2007.

The study was undertaken by a team comprising the U.S. Air Force Research Laboratory and the Department of Commerce and was supported by the Center for Strategic & International Studies. The methodology is described in Figure A5.3

Figure A5.3:



Several data sources were used for the study. The primary source was a survey of U.S. companies with space-related business. The survey was conducted by the U.S. Bureau of Industry and Security within the Department of Commerce to provide employment, financial, production, R&D, and other data. This information was not available from any other source. The questionnaire was comprehensive - it was 52 pages long - and it was estimated that it would take individual respondents 11 hours to collect the data and complete the questionnaire. Nevertheless, the response rate was high (over 80%) - in part because the Department of Commerce has the legal power to demand a response to such surveys and failure to respond can result in a maximum fine of $10,000, imprisonment of up to one year, or both. To complement the survey data, the study collated existing company and space industry data to characterize the global and U.S. space markets.

The two data sources were analysed separately and then brought together to assess: the global marketplace and the competitiveness of the U.S. space industry; the health of the U.S. space industry in terms of financial status, R&D and workforce; and the impact of export controls on the U.S. space industry.

In addition, a panel of experts were brought together to advise on the direction of the study, provide expert analysis on its preliminary findings; and comment on its conclusions.

3.4 DOD Defense Industrial Base Capabilities Study (DIBCS) series

The Defense Industrial Base Capabilities Study (DIBCS) series is of note for those like EDA who are considering undertaking industrial analyses because the studies focused explicitly on military *capabilities* rather than industrial *sectors*.

In February 2003, ODUSD(IP) published a report entitled *Transforming the Defense Industrial Base: A Roadmap.* The report argued that efforts aimed at the transformation of the U.S. military also required a transformation of the U.S. defence industrial base, including access to new technologies and the need to engage with non-traditional suppliers of technological and industrial capabilities, many of whom may have not worked with the Pentagon before. The report argued for the need for systematic evaluation of the ability of the defence industrial base to develop and provide functional operational effects-based warfighting capabilities.

The Defense Industrial Base Capabilities Study (DIBCS) series undertook studies on, for example, focused logistics, force application and protection. DIBCS had ambitious objectives and aimed to:

- Develop a capabilities-base industrial framework & analytical methodology as a foundation for programmatic & investment decision-making
- Identify technology critical to enabling the new Joint Staff functional warfighting capabilities
- Conduct industrial base capability assessments on priority critical technologies to identify deficiencies
- Develop a systematic methodology to craft industrial base strategies to remedy industrial base deficiencies; and encourage proactive, innovative management of the industrial base

The DIBCS study approach is set out in the following diagram (Figure A5.4). There were three main steps:

Step 1: Identifying U.S. leadership goals for capabilities
The first step was to use research and analysis teams of subject matter experts to identify U.S. leadership goals for particular military capabilities that establish the degree of innovation desired in the industrial base. These goals were categorized as: Neutral; Equal; Be Ahead; Be Way Ahead. A Senior Advisory Group composed of retired senior military and civil DoD officials and selected industry experts guided this process.

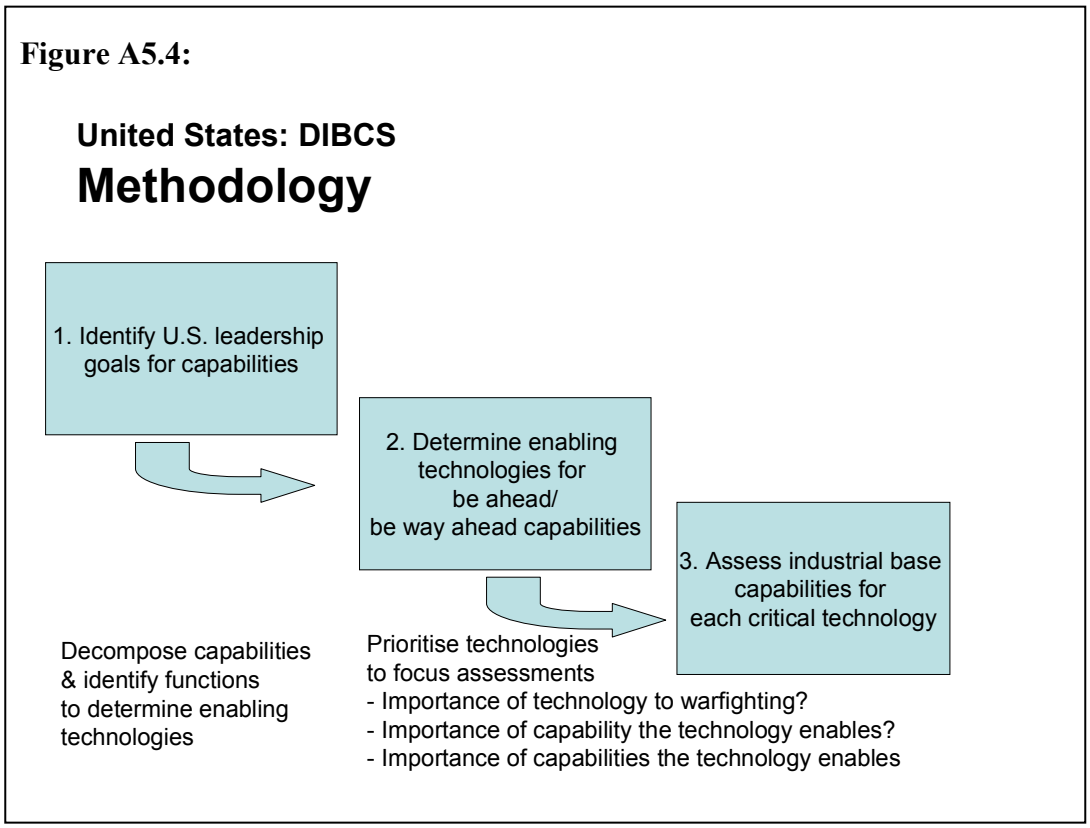
Step 2: Determine and prioritise critical technologies for be ahead/be way ahead capabilities

The second step was to identify the critical enabling technologies needed for be ahead/be way ahead goals. A warfighting capability that is mature and available to all countries was classified as Neutral and was judged to require minimal innovation and could be sourced from global markets. In contrast, Be Way Ahead capabilities were judged to have the potential to bring key advantages to the U.S. military. Technologies associated with such capabilities must lead by multiple technology generations, must be highly innovative and require effective competition between multiple suppliers. The Senior Advisory group oversaw a team of subject matter experts and established the priority o a technology using three factors. First, the importance of the technology in enabling warfighting impact on a breakthrough, transformational or critically essential manner. Second, the importance of the specific capability the technology enables. Third, the span of impact of the technology (i.e. its ability to enable multiple capabilities)

Step 3: Assess industrial base capabilities for each critical technology

The third step was for the study team to examine the industrial capabilities necessary to supply these critical technologies. This involved identifying the major domestic and foreign suppliers and examining them for sufficiency and suitability (using published sources). Sufficiency was defined in terms of two factors: an adequate number of sources; and suppliers with sufficient innovation to maintain U.S. technological leadership over likely adversaries.

Figure A5.4:



The DIBCS were challenging studies to undertake because focusing on military capabilities rather than a discrete sector hugely increased the number of technologies and companies that required assessment. Consequently, the studies were very expensive to conduct (in terms of person time and monetary cost). The studies highlighted some important policy issues for the U.S. but because they were snapshots there was a feeling that for the capabilities based assessment process to be successful it would have to be undertaken on an on-going basis. In addition, it was felt that the studies had been done in a vacuum and had not been very well integrated with the work of the military capabilities community and the S&T community. The studies were also felt by some to be highly subjective and overly dependent upon expert opinion.

Annex 6: Short Reference Guide on Tools and Methods for Industrial and Technological Analysis

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Introduction

1. Our study requires a methodology to measure the strengths and weaknesses of the DTIB in Europe. The methodology requires an assessment of what constitutes a strength and weakness; how can such features be measured; what information and data are needed for such an assessment; and how can the data and associated information be collected?

2. There is a substantial literature on the tools and methods for analysing industries and technologies with contributions from economics (including business and management economics) and innovation perspectives. This short reference guide assumes no prior knowledge of these perspectives and will show their relevance to the study of defence industries and the development of the methodology used in this study. Much of the literature focuses on how industries can be analysed and assessed. It is the task of this reference guide to show these analytical frameworks can be used to determine whether firms and industries are successful, what are their strengths and weaknesses, how can performance be measured and what are the implications for measuring the strengths and weaknesses of the EDTIB.

I. ECONOMICS PERPECTIVES:

i) The Industry Structure Perspective

3. A starting point for analysing an industry is the industry structure-conduct-performance model of industrial economics (SCP paradigm: Lipczynski, *et al*, 2005). Using this approach, an industry is analysed in terms of its:

> i) ***Structure*** comprising the number of firms and their size together with entry and exit conditions for the industry. The number and size of firms will reflect the opportunities for achieving economies of scale and learning which lead to lower unit production costs as the scale of output rises. These are known as decreasing cost industries and are typical of the defence sector (e.g. aerospace which is characterised by learning economies: Hartley, 2006). Where there are substantial scale economies in both R&D and production, firms have incentives to expand

either internally or via mergers and acquisitions so creating large firms of the size seen in defence industries (e.g. Boeing; BAE Systems; EADS; Lockheed Martin; Thales).

ii) ***Market Conduct*** reflected in price and non-price competition where non-price competition comprises advertising, marketing, political lobbying, research and development (R&D) and product differentiation. In defence industries, competition is often based on non-price factors such as the technological features of equipment (e.g. speed, range and weapon load of a combat aircraft): hence, defence firms are often R&D-intensive companies. Moreover, defence R&D might lead to beneficial 'spin-offs and spillovers' to the rest of the economy (e.g. jet engines, composite materials and avionics for military aircraft applied to civil airliners).

iii) ***Market Performance*** which is reflected in efficiency and profitability, growth and technical progress. Efficiency has two aspects comprising technical efficiency and allocative efficiency. Technical or productive efficiency requires that firms use the least-cost combination of factors of production to produce *any level of output*. Allocative efficiency requires technical efficiency plus *outputs which are socially desirable* (i.e. society's preferred or best output where price equals marginal costs so that additional benefits equal additional costs). The economists model of perfect competition leads to both technical and allocative efficiency (with price equal to marginal cost). This model provides a 'benchmark' for assessing the performance of markets (see Table 1). It is also a model which solves the defence equipment procurement problem by using competition to determine prices, profitability and the efficiency of contractors. In the absence of competition, all these variables have to be negotiated between the buyer and seller with myriad challenges to both parties. **Using this approach, competition is a high-powered efficiency mechanism and is a feature of a successful industry. It is central to the Competitiveness criterion for the EDTIB.**

4. The SCP model predicts a simple causal relationship running from structure through conduct to performance with performance dependent on industry structure. Two extreme market types are identified, namely, perfect competition and monopoly. Typically, it is predicted that compared with perfect competition, monopoly results in higher prices, a lower output, monopoly profits and a misallocation of resources (reflected in monopoly prices exceeding marginal costs leading to a 'deadweight loss' of consumer welfare). Such predicted benefits of competition are the basis for the EDEM and are reflected in competitive procurement policies as used by some EU defence ministries (e.g. for equipment procurement and for military outsourcing). Competition has also been applied at various stages in a programme's life-cycle. For example, there is often competition at the initial design stage (i.e. between competing design proposals taking the form of a paper competition and usually based on technical features of the planned equipment). Next, there might be competition at the prototype stage usually with two firms invited to build competing prototypes (e.g. US combat aircraft prototype competitions leading to

the Lockheed Martin F-16 and F-35 choices with associated competing engines: a 'fly-before-you buy' policy). Later in a project's life-cycle, there might be competition for production contracts. For example, the firm winning the development contract might be guaranteed an initial production order, but be required to compete for all subsequent production contracts. In all these cases, the aim of policy is to avoid the inefficiencies of monopoly and to retain some competitive pressures on the contractor. But there are no costless policies and options. Continuing competition to, say, the prototype stage involves the costs of two competing designs; but there are benefits in reducing programme risks and uncertainties and in retaining competitive pressures on contractor prices, efficiency and profitability.

5. The features of monopoly and competition industries are compared in Table 1 which also provides an analytical basis for identifying successful firms and industries. Each industry is defined with respect to the number and size of firms, entry and exit conditions, profitability and the form of competition (see SCP paradigm). Monopoly is a single seller of a product with no close substitutes so that the monopolist is the industry. Profits are defined in relation to the economic concept of 'normal profits' which are the minimum return required to keep a firm in the industry. Competition means that in the long-run, firms earn only normal profits. In contrast, monopoly leads to 'abnormal' or monopoly profits in the long-run (i.e. above normal or high). Immediately, questions arise about 'operationalising' the economic concepts of normal and abnormal profits and the associated long-run. Further problems arise since the standard measures of profitability based on company accounts data do not correspond to the theoretical concepts used by economists. Accounting rates of profit usually show the ratio of profits to capital, equity or sales. Here, problems arise from the accounting interpretation of discretionary expenditure, depreciation, debt, risk, tax, inflation and mergers. Inevitably, data problems mean that accounting data are used to measure profitability but such data need to be adjusted for risk and need to be related to the cost of capital. A further qualification is required. The perfect competition model provides a benchmark for industrial analysis and is the basis for monopoly and competition regulatory policies used by nations.

Table 1. Market Types: A Taxonomy

Market type	Number of firms	Size of firms	Entry/exit	Profits	Form of competition
Perfect competition	Large numbers	Relatively small	Free entry and exit	Normal in long-run	Price
Monopoly	One	Firm is industry	Entry barriers	Monopoly profits in long-run	Price and non-price
Oligopoly	Few	Relatively large	Entry barriers	Monopoly profits in long-run	Non-price eg. advertising; R&D/technical progress
Monopolistic competition	Large numbers	Relatively small	Free entry	Normal in long run	Non-price: product differentiation

6. Between the extremes of competition and monopoly, there are 'intermediate' types of industry structure, comprising oligopoly and monopolistic competition. Oligopoly is often present in national defence industries (e.g. US defence market) and is a market form which has some distinctive characteristics. Oligopoly comprises a small number of relatively large firms where there are close relationships between competitors (e.g. if one firm reduces price, its rivals will follow with price cuts so that rival behaviour cannot be ignored). Such interdependence between oligopoly firms has been analysed using game theory; but one critic has stated that when game theory is used to analyse competition 'almost anything can happen' (Schmalensee, 1990 in Lipczynski, *et al*, 2005, p16).

7. A further feature of oligopoly is relevant to defence industries. This concerns the likely impact of oligopoly on technical progress, where technical progress is a further indicator of industry performance (and hence its success or weakness). The presence of large firms with monopoly power but subject to rivalry provides the ability and incentive to undertake costly R&D together with opportunities for obtaining a return from investing in such costly R&D. However, defence R&D is usually financed by government rather than private industry (Tisdell and Hartley, 2008). Nonetheless, the technical complexity of modern defence equipment requires large firms with the R&D resources needed to undertake such complex programmes.

8. Monopoly is the typical market structure for prime contractors in most EU *national* defence markets. There is also an EU-wide monopoly for missiles (MBDA) and military airlifters (Airbus A400M) and a duopoly for helicopters (Eurocopter; AgustaWestland). However, the presence of monopoly depends on the definition and extent of the market. If the defence market is defined as an EU-wide market, then the industry structure

changes from monopoly to oligopoly (e.g. BAE; EADS; Thales) and at the level of NATO and the world defence market, it becomes reasonably competitive. Also, monopoly power depends on the availability or absence of close substitutes. New technology often creates rival products, such as UAVs replacing manned combat aircraft for some missions. Industry structure also varies with the level of the supply chain. Suppliers to major prime contractors will involve more smaller firms operating in competitive markets (varying between perfect and monopolistic competition).

9. Two further aspects of the SCP model need to be addressed, namely, buyers and firm ownership. First, markets embrace both buyers and sellers. The SCP model focuses on the supply side in the form of industry structure. Buyers cannot be ignored and as with the supply-side, they can vary between large and small numbers. Typically, in most private markets, there are large numbers of buyers so that no one buyer has any power to determine prices (e.g. food; motor cars). But defence is different. Government is the dominant buyer of military equipment. For defence-specific equipment (i.e. lethal equipment), national government will be the major or for some equipment, it will be the only buyer: hence it is a monopsony buyer (e.g. nuclear-powered submarines in France and the UK; B-2 bombers in the USA). Other buyers for equipment will be foreign governments, reflected in defence exports. As a major or monopsony buyer, government can use its buying power to determine the size, structure, conduct, performance and ownership of its national defence industries. Where governments have buying power, they are a major determinant of the performance of firms and industries and hence whether they are 'strong or weak', successful or failures. Governments also purchase civil equipment (dual-use) such as food, fuel, motor cars, office equipment, clothing and a range of services (e.g. financial; consultancy) where they are one buyer amongst large numbers of buyers and where firm and industry performance depends on market structure.

10. Ownership also matters in determining firm and industry performance reflected in strengths and weaknesses, success and failures. State-ownership is believed to be associated with inefficiency, especially where state-owned firms are monopolies receiving state subsidies and are loss-making enterprises. Inefficiency arises from the absence of capital market pressures in the form of the threat of take-overs and bankruptcy and from the lack of competition in product markets (Tisdell and Hartley, 2008). Such an approach suggests that a 'weak' EDTIB will be characterised by loss-making monopoly state enterprises. Interestingly, a number of EU nations have 'privatised' their defence industries. For example, 25 years ago, the UK defence industrial base was mostly state-owned (BAe; Rolls-Royce; British Shipbuilders; Royal Ordnance; Shorts; research establishments), 'protected' by a 'buy British' procurement policy and receiving mostly cost-plus contracts. The UK defence industry is now privatised (except for DSTL) and until recently, foreign firms were
invited to bid for UK defence contracts, most of which were competitive (cost-plus contracts were no longer used (DASA, 2007).

11. The SCP paradigm provides the EDA with a 'tool kit' for analysing any defence industry (e.g. air, land and sea systems; electronics; military outsourcing). However, further developments have led to modifications of the basic SCP model. These newer

developments include contestable markets; transactions costs; game theory; and the Austrian critique. *Contestable markets* are those where there is the possibility and threat of entry by domestic and foreign firms: hence, there is a *threat of rivalry.* With this approach, contestability rather than industry structure (number of firms) determines performance. *Transaction costs* recognise that all economic activity and exchange occurs in a world of imperfect information and knowledge and so involve costs of transactions. These embrace all the costs involved in planning, bargaining, modifying, monitoring and enforcing an implicit or explicit contract. Transaction cost economics offers some distinctive explanations and interpretations of economic organisations (e.g. the make or buy decisions of firms; vertical integration; internal organisations of firms; conglomerates) and has major relevance to defence equipment procurement policy and contracting. Many real world markets, especially in defence, do not resemble the economists perfectly competitive model. They are dominated by small numbers of large firms (e.g. civil jet aircraft; computers; motor cars). *Game theory* explains the behaviour of oligopoly firms where there are interdependencies between the behaviour of rival firms. Finally, the *Austrian economists* are critical of the standard SCP model with its focus on perfect competition and equilibrium. They assert that actual economies are never in equilibrium (i.e. never at a state of rest). Instead, economies are characterised by ignorance and uncertainty which leads to continuous change and continuous market disequilibrium (the future is unknown and unknowable). Entrepreneurs play a central part in Austrian economics. Ignorance and uncertainty create opportunities for profits and it is the entrepreneur's task to discover these profitable opportunities before their rivals with competition as continuous rivalry between entrepreneurs. The Austrian approach has two major implications for public policy. First, the role of profits: policies which reduce profits as the rewards of entrepreneurship will reduce future entrepreneurial effort so adversely affecting the competitive process. Second, Austrians believe that policy-makers should avoid making statements either about the most efficient form of industrial organisation or about the wastes of advertising and duplication. Austrians claim that no-one, especially politicians and bureaucrats, has sufficient knowledge and competence to judge which form of market structure is the most efficient for meeting future consumer demands (e.g. today's sunrise industries will be tomorrow's smokestack industries). Instead, it is entrepreneurs who have profit incentives to meet new and unexpected future consumer demands (Tisdell and Hartley, 2008).

ii) Porter's Analysis: The Five Forces Model

12. The SCP model had a major influence on Porter's five forces model determining a firm and industry's competitive position (Porter, 1990, p35). The five competitive forces are:

i) the threat of new entrants;

ii) the threat of substitute products and services;

iii) the bargaining power of buyers;

iv) the bargaining power of suppliers;

v) the rivalry amongst existing competitors.

13. In the Porter model, the strength of the five competitive forces varies between industries and determines long-term industry profitability. For example, the threat of new entry and rivalry amongst existing competitors, the availability of substitutes as well as powerful buyers and powerful sellers will limit an industry's profitability. In turn, the strength of each of the five competitive forces depends on industry structure which is central to the SCP model. Porter's model which is part of the strategic management literature shows that a firm's strategies and conduct are determined by the presence and strength of the five forces. Indeed, management strategists focus on the distinctive internal characteristics of firms suggesting that each individual firm is different and its distinctive characteristics and capabilities determine its competitive advantage (e.g. innovation; reputation). It is the distinctive strategic choices taken by firms which are the main determinants of performance with firms maintaining their competitive advantage by protecting their strategies from imitation (Lipczynski, *et al*, 2005).

14. Defence markets have all the features of Porter's five competitive forces model. They are characterised by powerful buyers and powerful sellers, but industry competition and the availability of substitutes depends on a government's willingness to allow foreign firms to enter national defence markets (i.e. entry barriers).

iii) Developing the Methodology using an Economics Perspective

15. Defence markets are different from standard civilian markets. For defence-specific equipment (i.e. lethal equipment), governments are major buyers and in some cases, single or monopsony buyers. Government can use its buying power to determine the size of its national DIB, its structure, conduct and performance as well as ownership. For example, it can buy equipment from national suppliers or from overseas firms; it can support or oppose mergers; it can allow or prevent both entry and exit; it determines the form of competition for equipment contracts; it affects performance through profit, price and export controls; and it can change ownership by nationalising or privatising firms. These distinctive features of defence markets need to be recognised in analysing defence industries and in developing a methodology for measuring the strengths and weaknesses of the EDTIB.

16. The SCP model suggests a simple *starting point* for developing the methodology. Using this model, **a strong defence industry** will be characterised by private firms operating in competitive markets achieving average or normal profits in the long-run. Such firms might undertake some privately-financed defence R&D (but see below). However, whilst competition is necessary for an efficient industry it is not sufficient. Competitive firms also need to be subject to fixed price contracts ('hard' budget constraints). In contrast, **a weak defence industry** will be characterised by a loss-making state-owned enterprises receiving state subsidies and operating as a monopoly. Such firms are 'protected' from rivalry and from the efficiency incentives provided by

private capital markets with their threats of take-over and bankruptcy. Inefficiency is more likely where such firms also receive cost-plus contracts (which are 'blank cheque' contracts providing 'soft' budget constraints).

17. Left to themselves, private markets are likely to 'fail.' Such market failure reflects monopolies and other market imperfections as well as externalities and public goods (where beneficial externalities include R&D spill-overs; harmful externalities include pollution and traffic congestions; with defence as a classic public good: Sandler and Hartley, 1995). Where markets fail, then state intervention might be required to 'correct' for market failures and 'improve' the operation of markets. Various parts of defence markets are likely to 'fail' including defence finance and provision as the classic public good problem; where private markets under-invest in defence R&D; and where there will be 'too little' technical spill-overs from such R&D. There are also barriers to new entry and defence industries which are highly imperfect through monopoly, duopoly, oligopoly and the potential for collusive tendering. For EDA, a distinctive contribution might be to identify genuine economic benefits from collective action. Again, public goods in both defence and peace-keeping are classic examples as well as transnational externalities where action in one nation creates a benefit or cost in another country (and where there is no market compensation). EDA might act as an international agency which aims to identify and 'correct' gaps in international networks where there is a failure to achieve the economic benefits from international collective action (Sandler and Hartley, 2001). However, there is a further factor affecting the performance of defence markets in the form of the 'military-industrial-political complex (MIC).

18. Government policy and choices are affected by powerful interest groups (public choice models). In the MIC, these comprise the Armed Forces and bureaucracies (e.g. Defence Ministries; procurement agencies; NATO) each aiming to maximise their budgets. Budget maximisation will involve exaggeration of the enemy threat (e.g. terrorism) and under-estimation of the costs of responding to the threat (e.g. under-estimation of weapons costs). The industrial component of the MIC consists of powerful producer groups seeking to maximise income and profits (known as rents) who will support the Armed Forces and bureaucracies in their bid for larger budgets. Industry will point to the wider economic benefits of supporting a national DIB (e.g. jobs; technology; spin-offs; exports and import-saving). Finally, the political component of the MIC consists of government and opposition politicians who seek to maximise votes and achieve re-election. This might be reflected in politicians supporting weapons programmes which benefit their constituents. Overall, recognition of public choice models means that governments can also fail. **Furthermore, it means that agents in political market places will seek to influence the development and application of any methodology for assessing the strengths and weaknesses of the EDTIB, including the selection of appropriate performance indicators and their interpretation (e.g. critics will claim that data collection is 'too costly' and they will argue for the use of qualitative and subjective assessments rather than using quantitative data).**

19. Further distinctive features of defence markets concerned with the economics of procurement choices need to be recognised in developing and applying the methodology. These features comprise:

i) *Principal-agent problems*. The principal, such as a government, has objectives which it needs to achieve (e.g. acquisition of a new weapons system). It uses an agent (e.g. the Defence Ministry and its procurement agency) to achieve its objectives. But problems often arise since the agent's objectives often differ from those of the principal. The challenge, then is to write a contract which offers incentives to the agent to ensure that the principal's objectives are achieved. Further complications arise since there are often a number of different principals and agents at different levels in an organisation and the incentives of the various groups are likely to conflict (e.g. government ministers; senior Defence Ministry officials; Armed Forces; procurement agency; industry). Moreover, principals and agents operate under major information problems.

ii) *Information asymmetries* between the government buyer and a monopoly contractor. Typically, government is poorly informed about the contractor's production possibilities and its motivation (e.g. commitment to efficiency of operations on the contract: Sandler and Hartley, 1995, chp 5).

iii) *Moral hazard and adverse selection* further reflect information constraints. Moral hazard arises where the procurement agency is unable to observe the contractor's efforts to minimise costs and to maximise effort on the contract. Adverse selection arises where the contractor has more information than the procurement agency on external factors affecting the contract (e.g. about the technology affecting the likely costs of developing a new weapon system). Often adverse selection allows the firm to extract rents (profits) from the government.

iv) *Transaction costs* arise in defence procurement and contracting. These are costs in the form of specifying, negotiating, agreeing, writing, monitoring and policing a contract, especially one which allows for unforeseen contingencies and the possibility of renegotiation. Typically, defence contracts involve substantial transaction costs since their contingencies are much harder to anticipate and formulate in a clear manner capable of being incorporated in a legally-enforceable contract. And these costs affect both buyer and sellers. Firms bidding for complex defence contracts will incur substantial transaction costs in formulating their tender. A costly competitive tendering process will deter many firms from bidding: hence, for such contracts, only a limited number of firms might be invited to bid, so offering the bidders a reasonable chance of success.

v) *The hold-up problem*. This problem arises in defence where costly investments are required (e.g. in R&D and production) which have no alternative uses in the civilian sector. For costly investments where government is the only customer (e.g. nuclear-powered submarines), firms will be reluctant to invest their own funds in such a defence-specific activity for fear that they will never recover

their costs. The result is that governments usually finance such activities via cost-plus contracts or generous cancellation clauses which reimburse all the firm's costs together with an adequate profit allowance.

vi) *Non-competitive contracts.* These require procurement agencies to determine prices and profits and require estimates of contractor efficiency (see information asymmetries). In contrast, with competitive contracts, competition determines prices, efficiency and regulates profits. Non-competitive contracts can distort defence markets and the resulting price reflects the bargaining behaviour and bargaining power of both the buyer and seller. For example, government as buyer can threaten to cancel or import foreign equipment and refuse to pay more than a fixed sum. In contrast, a monopoly seller might refuse to undertake a project if the price is below some minimum level and threaten to close plants in marginal constituencies and high unemployment areas.

vii) *The regulated firm*. Where there are monopoly defence contractors, government might decide to treat these as regulated firms aiming at state regulation of their prices and/or profits. Again, regulation might produce some unexpected and undesirable outcomes. For example, profit regulation might lead firms to substitute other expenditures to remain within the profit limits (e.g. spending on staff or luxury offices, etc: Tisdell and Hartley, 2008).

Assessing strengths and weaknesses of the EDTIB

20. Having developed an economic methodology for analysing any defence industry, the next task is to apply it to formulate criteria and indicators for assessing the strengths and weaknesses of European defence industries. The methodology needs to deal with the three Cs of the EDTIB, namely, capability, competence and competitiveness. The first two appear not to have an economics dimension, but such a conclusion is incorrect.

21. *Capability* aims at meeting the real operational requirements of the Armed Forces, with emphasis on European and national operational sovereignty (EDA, 2007). Operational requirements involve consideration of 'trade-offs' between specific industrial capabilities, risks and costs. The Armed Forces will seek to retain as much defence industrial capability without regard for the risks and the costs involved in maintaining capabilities. For example, the military will fail to assess the risks that a specific capability will be required in a specified time-period (i.e. they will fail to rank risks and regard all eventualities, some of which are highly unlikely, as equally risky). Nor will they recognise costs and budget constraints in retaining industrial capabilities. Economists will stress that retention of a capability will involve the sacrifice of alternatives within the defence budget. On this basis, the demand for some capabilities might be so remote and unlikely and yet very costly that they are not worth retaining.

22. *Capability* also embraces the commitment to create an EDTIB which is "more integrated, less duplicative and more interdependent" with increased specialisation at all levels of the supply chain (EDA, 2007). Centres of excellence will emerge from a

'market-driven' process "moderated by policy considerations including the requirement to achieve an appropriate regional distribution" and a closer integration with the wider, non-defence European technological and industrial base (EDA, 2007). The assessment of strengths and weaknesses needs to recognise these features of capability which require indicators of integration, duplication, interdependence,
regional distribution and the use of civil technologies (dual-use).

22. *Competence* embraces the rapid exploitation of the best technologies (EDA, 2007). These involve application of civil technology and the application of best technology to development and production processes as well as to final products. Examples include the Boeing bid for the JSF contract where Boeing promised to apply low cost manufacturing technology from its civil jet airliner production to the manufacture of the JSF. Other examples include the application of motor industry manufacturing technologies to defence production (e.g. inventory management (JIT)) and the application of new technology in the form of UAVs. On technology, economic models suggest that large firms in oligopoly markets are best suited to developing and applying new technology (see also section below on Innovation). Assessing such competence might use patent indicators as well as relying on qualitative assessments (e.g. case studies of firms and their reputation on technology).

23. *Competitive* within and outside Europe. This is a central part of the economic methodology in the form of the SCP model. It requires measures of international competitiveness for assessing import penetration into the EU defence market as well as EU shares of world export markets, together with a range of indicators for assessing performance (see Table 2). **Overall, Table 2 is particularly appropriate for assessing the competitiveness of the EDTIB**.

24. Table 2 presents a summary of the methodology used to determine strengths and weaknesses of the EDTIB. **A 'strong' EDTIB will be characterised by:**

i) *Privately-owned firms in competitive markets*. Competition is defined to include large numbers of firms which are small in relation to the size of the market. A minimum of 4-5 similar-sized firms is required for competition with either free entry and exit or contestable markets (i.e. the threat of entry). If the market is restricted to the nation state, then such competition is most likely in the supply chain with prime contractors being monopoly suppliers. However, if the market is opened-up to all EU firms or to the world, the number of primes increases substantially. Market power can be measured by concentration ratios which show the proportion of total industry sales provided by the top one or the top three or five firms.

ii) *Number and size of firms*. Competition is characterised by large numbers of small firms. However, in assessing strengths it is necessary to consider whether firms are achieving all available scale and learning economies (in fact, competitive firms will achieve all such economies); whether there is excess

capacity and 'too much' duplication: hence the relevance of the number and size of firms.

iii) *Market conduct*. Strong industries will have higher than average R&D, capital investment and numbers of qualified scientists and engineers (QSEs) and lower than average advertising and marketing efforts. Two comparators can be used, namely, comparisons with other firms in the industry or comparisons with the average for the economy.

iv) *Industry performance*. Again, a strong industry will have above average labour productivity and above average export market shares combined with below average import penetration. It will have a favourable/high innovation performance and be subject to fixed price contracts with activities located in 'appropriate' regions (i.e. the regional dimension needs to be included in the analysis). Finally, financial indicators will include rising share prices and normal or average profits in the long-run.

v) *Wider economic benefits*. Public support for defence might be maintained by focusing on the contribution of the EDTIB to creating and maintaining jobs, including high-wage jobs, and its contribution to technology and spill-overs as well as exports and import-savings benefits. However, many other economic activities contribute to jobs, etc: hence, it is necessary to show that the EDTIB makes a **net economic contribution** by comparing the performance of the EDTIB with the average performance for the economy (i.e. focusing on the alternative use value of resources). **Net economic benefits arise where defence industries make a greater contribution to output than the alternative use of resources.**

25. Care must be taken when using these indicators of strengths and weaknesses of the EDTIB. Table 2 takes an EU perspective but national perspectives also need to be included in any analysis and evaluation. Nor should reliance be placed on any single indicator. **Instead, analysis and conclusions need to be based on a range of indicators with weights attached to each indicator (e.g. equal unit weights provide a simple scale) and recognising that some indicators might be in conflict**. For example, a high rate of innovation might be associated with job losses. Similarly, at any moment of time, above average profitability arises under both competition and monopoly (competition leads to average or normal profits in the long-run; but this requires a judgement on the time period for the long-run). Nor is profitability such a simple measure: it needs to be adjusted to reflect differences in the degree of risk on defence work. For example, a contract for standard ammunition which has been produced for 25 years involves much less risk than the first production contract for, say, Typhoon or F-35.

26. Fixed price contracts also need to be assessed against other indicators. Whilst such contracts offer high-powered efficiency incentives, they create problems. For example, the competition for contracts might lead bidders to offer 'optimistic' cost, time and performance estimates which are then used as the basis for awarding a fixed price contract. Once started, projects are difficult to stop. Substantial cost overruns on a fixed

price contract might place the contractor at the risk of bankruptcy. If governments are unwilling to allow a 'national champion' to exit the defence industry because of bankruptcy, they will have to bail-out the firm, so effectively renegotiating the contract (hence, destroying the efficiency incentive properties of the original fixed price contract). In these circumstances, a second best solution might require a target cost incentive fee contract where cost savings and cost overruns are shared between the state and the contractor.

27. **The approach of Table 2 is subject to a major practical issue, namely, the lack of appropriate data**. Defence companies are usually involved in both military and civil business and their published accounts generally report on the total activities of the business. There are exceptions (e.g. some companies are defence-only firms such as BAE, Lockheed Martin and Northrop Grumman). In other instances, relevant data are available but only at the industry level (e.g. arms exports). It is also recognised that Defence Ministries might have access to some of these data but will be unable to release the data for reasons of commercial confidentiality. **Nor must it be forgotten that EDA request for data are not costless and involve industry in substantial collection (transaction) costs.** Elsewhere, some indicators require qualitative judgements (e.g. rate and type of innovation by a company). For such cases, assessments of performance might have to be based on judgements about whether an indicator suggests above average/good/very satisfactory or average/satisfactory or below average/poor.

Table 2. An Economic Methodology for Measuring Strengths and Weaknesses of the EDTIB.

Indicator	**Strengths**	**Weaknesses**	**Performance Measures**
OWNERSHIP	Privately-owned competitive	State-owned monopoly	Ownership data
STRUCTURE			
a) Number of firms	Large numbers	Monopoly (one)	Number of firms in market (define market)
b) Size of firms	Relatively small (related to market)	Large	Concentration ratios
c) Entry	Free entry/exit	Entry/exit barriers	Legislation (Article 296; Buy US Act) Government bail-out (yes/no)
d) Scale/learning	Achieving	Failing to achieve	Evidence on scale and

economies	substantial scale/learning economies	scale/learning economies	learning curves
e) Role of capital market	Allows take-overs/mergers and bankruptcy	Prevents mergers and bankruptcy	Ownership data. State ownership. Government golden share.
CONDUCT			
a) R&D	Above average	Below average	R&D levels; per capita; share of sales
b) Capital investment	Above average	Below average	Capital investment levels; per employee; share of sales
c) QSEs	Above average	Below average	Total numbers; share of total employment
d)Advertising/marketing	Below average	Above average	Advertising/marketing share of sales (also acts as entry barrier). Political lobbying
PERFORMANCE			
a) Labour productivity	Above average	Below average	Output per employee; Value added per employee
b) Competitiveness:			
Exports	Above average	Below average	Export market shares.
Imports	Below average	Above average	Import penetration of home market
c) Innovation	Favourable/high	Poor/low	Ability to introduce new technology/new ideas. Patents
d) Type of contract	Fixed price	Cost-plus	Fixed prices provide high-powered efficiency incentives
e) Location of R&D	Appropriate regional distribution	Inappropriate regional distribution	Regional distribution of R&D

f) Share prices	Rising or stable	Falling	Threat of take-over
g) Profitability	Average/normal in long-run	Abnormal in long-run	Profits as a return on capital; profit as a share of sales
ECONOMIC BENEFITS			
a) Employment	Net benefits	No net benefits	Numbers of jobs; type of jobs (skills; average wages/salaries)
b) Exports/import-savings	Net benefits	No net benefits	Values of exports and import-saving
c) Technology, including spin-offs	Net benefits	No net benefits	Examples of civil applications of defence technology

II. INNOVATION PERSPECTIVE

Defence R&D and technological development: debates and controversies

28.. Defence R&D could be defined as "*all defence R&D financed by government including military nuclear and space but excluding civilian R&D financed by ministries of defence (e. g. Meteorology")"*.

29. It should be noted that this definition- given here by the GBAOR (Government budget Appropriations or Outlays for R&D)- is correct but has some limits for taking into consideration the potentiality of dual use of technology. As it has been underlined by Mowery '*defence related R&D and procurement programs provided a powerful impetus to the development and commercialization of new civilian technologies in commercial aerospace semi conductors, computers a computer software'* (Mowery, 1998).

30. The impact of US R&D and its gap has been lengthy discussed (James 2006). For our purpose, it is important to underline that the impact of defence R& D varies largely because it still remains embedded in national R&D systems. Innovation and its realization depend largely of the links existing inside and outside the national systems of innovation. For this reason, the perception of defence R&D, the concept of duality, the willingness of technological independence may show a discrepancy from countries to countries. The French position claiming '*competitive autonomy'* and *technological independence* is summarized in Table 3. This Table illustrates that if figures about R&D are quite diverse, their understanding and their geopolitical interpretation may appear to be distinct (notably for the DGA). The following Table explains this assessment.

Table 3. Different approaches to defence R&D according to DGA, France

Notions	**Main approach in US**	**Main vision in France (and in Europe)**
Capacity approach	Exhaustive approach: quest for technological superiority in all areas. This translates into a quest for mastery of all innovative technologies without reference to capacity requirements and the ongoing improvement of mature technologies	Selective approach: strategy of global technological surveillance, but selection of sectors as a function of priority capacity requirements.
Concept of duality	Objective of extending the use of technologies developed within the framework of military contracts into the civilian market in order to foster R&D costs as much as possible through sheer volume of sales	Objective of using technologies developed for the civilian market for the benefit of the military sector.
Technological dependency	Refuse of all types of dependence	Quest for '*competitive autonomy'* in France. Dependence accepted in the rest of the European Union
Financial support	Large initiatives and significant financial support for upstream civilian research from the defence department with a view to US duality.	The French Ministry of Defence only supports upstream research that meets considered specific to defence.
Policy coordination	Close connection between research, industry and international relations policies. Strong institutional coordination.	Large degree of autonomy in research, industry and international relations policies. Absence of institutional coordination in Europe.

Source: DGA (in Conseil Economique de la défense, 2006 : 131)

Patent, inventions and revealed technological advantage

31. Patents are generally used for evaluating the quality of research. It should be noted that this indicator is incomplete and imperfect, gives only a proxy of what technological activities are:

"*The dream of getting hold of an output of indicator activity is one of the strong motivating forces for economic research in this area. After all a patent does represent a minimal quantum of invention that has passed both the scrutiny of the patent office as to its novelty and the test of the investment of effort and resources by the inventor and his organization into the development of this product or idea, indicating thereby the presence of an non- negligible expectation as its ultimate utility and marketability. One recognizes, of course the presence of a whole host problems: Not all inventions are patentable, not all inventions are patented, and the inventions that are patented differ greatly in 'quality'* (Griliches 1990, 1669).

32. This paradox seem really important in the defence industry where patents are present and necessary for firms' survival but not enough for capturing all the technological activities (for example in aeronautics know-how remains largely tacit and traditional whereas in electronics the patenting race is considerable).

33. Let us examine the majors indictors used for depicting inventive activity:

(i) Patent intensity

The patent intensity is the percentage of company turnover that is protected by patents.

(ii) Patent data sources in defence and the knowledge base of firms:

Using the company name, patents of all the firms using the patent data base provided by the European Patent Office (EPO) can be collected. The EPO includes all the patent applications in Europe since 1978. Each patent includes much information: the date of application, applicant, countries where the patent is valuable, date of publication, title and abstract in some cases. One important feature of this database is the technological class.

Each patent is being reviewed by an independent examiner from the EPO and associates the patent with the most relevant technological class. For example, an invention concerning a carrying system for luggage on airplanes will be classified in the corresponding category: the classification is then very specific in the sense that careful attention is paid in the use of the final product or the proceeding. Nevertheless, classification is only based on the final use of the innovation: in other words, what is the purpose of the innovation? Every innovation that concerns for example the landing gear of an airplane will be classified in the airplane category exclusively. Thus, one can manage to know what knowledge is necessary in order to produce a landing gear; one only knows that the firm has the capacity to product a landing gear. If one wants to know all the processes that are required for the production of a landing gear, one should describe the production with careful to identify if knowledge in physics is necessary, for example, or in chemistry.

Technological classes are a good measure of technological knowledge but one has to consider that the knowledge associated with technological classes doesn't reflect all the knowledge available inside. **Patents are the output of the knowledge production function and are a good proxy of the knowledge base of firms** but not an exhaustive one.

(iii) Revealed technological advantage

This indicator shows that if a firm is specialized in technology (*i)* when its patenting activity is higher in the field (*i)* comparing with the average of firms in technology (*i)* which are in the same industry.

Innovation

Innovation intensity:

34. Innovation intensity is defined as the percentage of the turnover that has been realised due to the sale of new products or of products that have clearly been modified.

Notion of sectoral systems of innovation:

35. The notion of sectoral systems of innovation highlights an important point: innovation isn't an isolated activity in economic life. In fact, innovation cannot be studied without analysing the context where it takes place. Like Malerba (2002) suggested

"[...[a sectoral system of innovation and production is a set of new and established products for specific use and the set of agents carrying out market and non-market interactions for the creation , production and sale of those products. Sectoral systems have a knowledge base, technologies, inputs and demand."

36. Thus, there is a strong link between three dimensions: the specificity of the space where the firm acts (institutional framework), the relationship between actors (connectedness) and the knowledge base of firms (cognitive). Researchers pointed out the importance of network as a key tool to drive innovation. Defence is a particular case of sectoral system. As pointed before, sectoral systems have a product-based view. The defence industry, however, cannot be fully bounded by a set of products that is common for all defence firms. In order to analyse the specificity of defence firms, it is useful to highlight the links between the three dimensions described above. Coordination of actors inside the institutional framework (or the lack of coordination) may have a significant impact on the collective innovation and more globally on technological output.

Duality of knowledge and knowledge base

37. Historically, the notion entered the discourse on weapons and technology exports that started soon after World War II. The authors emphasize the fact that:

"*dual use was viewed as a negative feature that complicated export controls: countries might try to obtain military sensitive technologies under the guise of buying civilian technology. The presumed dual nature of some products and technologies also created tensions between the economic and the defence perspective on technology exports, not only within the US, but also between the US and west-European countries." (Te Kulveand Smit, p.954).*

38. The notion of dualism then switched to another meaning after the end of Cold war. Dual use technology was seen as a positive feature that should be promoted. The idea was that dual use technology could solve two problems: the first is related to the difficulty of maintaining a high technology defence technology base restrained by a limited defence budget; the second concerns improving a country's economic competitiveness by a more efficient allocation of R&D funds. The relationship between military and civilian spheres has been discussed very often.

39. The **spin-off paradigm** suggests that military R&D is useful to the civilian markets in the sense that funds allocated to military R&D allows research programs that couldn't be driven by civilian firms. This paradigm qualifies the Cold War era (e.g. conquest of space). The benefits resulting form those program were important for the civil sector.

40. The **spin-on paradigm** concerns the knowledge spill over that may occur from the civil R&D activities to the defence sphere. This paradigm characterized the post-Cold War era: defence budget fell leading to a decrease in military R&D expenditures. In order to maintain the global technological level of defence industry, defence related firms had to absorb external knowledge coming from civilian R&D.

41. In the context of duality of knowledge, knowledge may generate a transformation of know-how for various uses (civilian and military ones), and may create opportunities for recombining it. In this context **technological diversification** is perceived as an opportunity that has to be cautiously managed in order to preserve the coherence of the firm in related technological areas and technological complementarities among projects:

"*If diversification in related business is profitable, one could reasonably expect diversification in related technologies to be equally important at least in knowledge insensitive industries (….) Altogether, we observe the following. First both the scope and the coherence of a firm's knowledge base contribute significantly to the firm's innovative performance. The joint effect of both scope and coherence of the firm's knowledge base is also quite strong. Greater coherence means higher technological complementarity amongst research project, which implies higher technological spillovers across them. In*

turn, the larger number of projects within firms, the greater the basis for internal complementarity given coherence (Nesta and Saviotti, 2006, 125-133).

42. In the context of the DTIB, firms and government agencies need to develop new organizational and technological capabilities because "*firms know more than they make*" (Brusoni, Prencipe, Pavitt, 2001). In order to achieve a really dynamic coordination, knowledge management (define later) must be consistent with the objective of innovation and of development of a **broad knowledge base** capable of providing the knowledge necessary for the design and development of technologies within the firm or in collaboration with external partners. New types of relationships between various organizations are therefore required for the purpose of knowledge development and its preservation.

Knowledge management and knowledge integration

43. Firms belonging to defence industry have a clear R&D policy and put a lot of emphasis on technological **knowledge accumulation** in order to orient their projects and products. This leads them to combine existing knowledge within present technological trajectories and in future markets. Most of the firms are high technology companies with a large and coherent knowledge base that serves as a foundation for future innovative**. Knowledge coordination** is a very sensitive issue and systems integration has become a core capability – both technological and organizational – in that the firms have to cope with the fact that knowledge is distributed within the organisation and therefore is difficult to manage. Knowledge integration underlines the fact that knowledge accumulation is a path-dependant process more likely to be implemented in related technological areas than in unrelated fields.

44. In this context, **technological outsourcing** is a delicate exercise that has to take into account the possibility to really integrate external technological resources. In the case of Rolls Royce for example Prencipe (1997) shows that this problem is not a trivial one:

"Outsourcing decisions have strategic implications. Firms developing product systems should maintain in house a through understanding of the contracted out technologies to

be able to integrate them into the system and 'control' their evolution over time. In fact, innovations can arise from existing and novel technological trajectories and, therefore, undermine static component hierarchies, and shift critical system level problems. This requires to carry out technological monitoring activities in order to recognize and then assimilate would be threatening technologies. " (Prencipe, 1997, 1274).

45. As firms alone cannot manage all the knowledge that is necessary for the design and realisation of systems and sub-systems, knowledge integration and knowledge coordination have become vital for firms in the defence industry. In this perspective, KM programs have gradually evolved to become a strategic component of innovative policies and play a critical role in managing knowledge.

« *Knowledge management (KM) covers any intentional and systematic process or practice of acquiring, capturing, sharing and using productive knowledge, wherever it resides, to enhance learning and performance in organisations. These investments in the creation of "organisational capability" aim at supporting - through various methods - the identification, documentation, memorization and circulation of the cognitive resources, learning capacities and competencies that individuals and communities generate and use in their professional contexts. Practices, like formal mentoring, monetary or non-monetary reward for knowledge sharing and the allocation of resources to detect and capture external knowledge are examples of knowledge management* "(Foray and Gault, 2003: 12).

KM policy is a way of preserving knowledge and of focusing attention on crucial know-how.

KM intensity

46. The CIS3 survey (Community Innovation Survey, 3, EC, Brussels) gives information about the KM practices of innovative firms. Four KM policies are investigated:

- KM1: a written KM policy;

- KM2: a knowledge sharing culture

- KM3: an incentive policy to retain employees

- KM4: alliances for knowledge acquisition

As proposed by Kremp and Mairesse (2002), an indicator of the level of KM is easily given by summing the number of knowledge management practices implemented by the firm. We call KMI this indicator that can have the value 0 to 4 according to whether the firm uses none, one, two, three or four of these KM practices. This indicator gives a simple overall measure of the intensity of KM in a firm.

Assessing the Strengths and Weaknesses of the EDTIB from an Innovation perspective

47. Innovation is central to all three Cs for the EDTIB. On *Capabilities*, innovation affects the technology for operational sovereignty and for upgrading platforms. *Competence* depends on the country's knowledge base, including its skills base. And *Competitiveness* is affected by innovation in the form of non-price competition, reflected in the performance characteristics of defence equipment (e.g. speed, range, stealthiness of combat aircraft: see also SCP model, especially market conduct and performance sections). Some innovation performance indicators are quantitative. Examples include Government spending on defence R&D; the numbers of scientists and engineers; and the number of patents/licences. But, many of the innovation performance indicators are qualitative and subjective. Inevitably, policy-makers are required to reach an overall assessment of innovation performance based on their subjective evaluation of a 'mix' of quantitative and qualitative performance indicators (e.g. by attaching weights to various performance indicators). Often, assessment will be based on broad comparisons such as average/satisfactory or above/below average, where the average might be the industry or the economy.

48. In some cases, policy-makers will identify major gaps in knowledge which might require new research studies. For example, there are numerous instances of technology spin-off; but there are few good quality published studies of the market value of such spin-offs nor are there studies of the transmission mechanism whereby technology is spun-off from the defence to the civil sector (e.g. via universities; labour turnover and mobility; through the supply chain). Further challenges arise in identifying genuine market failures which justify worthwhile state intervention to 'correct' such failures and

improve the operation of markets (e.g. technology spin-offs are beneficial externalities where private markets are likely to under-invest in such activities).

Table 4. Assessing the Strengths and Weaknesses of the EDTIB: The Innovation Perspective

The Three Cs	Performance Indicators
CAPABILITIES	(To be applied to all aspects of Capabilities)
Technologies for operational sovereignty	R&D spending: Government/Private Investment in facilities/equipment Investment in human capital (skills)
Emerging technologies	Ability of firms to maintain facilities/equipment/skills to cope with peaks and troughs in requirements.
Technology for upgrading platforms	Minimum design requirements for operational sovereignty/through life management.
	Patents: Numbers/Market value Number of competitive suppliers
COMPETENT	
Knowledge Base	Links with Universities and civil/non-defence industries Opportunities for new entrants, including civil (non-defence) firms : dual-use technologies. Willingness of buyer (Armed Forces; procurement agency) to consider/accept/introduce new ideas. Ability of firms to introduce new technologies quickly. Qualitative indicators of KM.
Skills Base	Numbers of QSEs. Numbers of skilled production workers
COMPETITIVENESS	
Equipment quality (non-price competition)	Relative technical advantage Performance characteristics

WIDER ECONOMIC BENEFITS	
Technology spin-offs Technology spin-ons	Examples: radar; composites; internet. Assess market value (there is a lack of published studies)

Overall Conclusion

49. We have shown the relevance of the economics and innovation literature to developing a methodology for measuring the strengths and weaknesses of the EDTIB. There results a massive research agenda which faces major difficulties in 'operationalisation.' The approaches suggest a wide range of 'performance indicators' which, even if the data were available, are sufficient to confuse and bewilder any policy-maker. **However, in many cases defence-relevant quantitative data are not publicly available and their collection would be a major and costly exercise for both Industry and the EDA.** In other instances, only qualitative judgements are feasible. Then, there arises the task of aggregating different performance indicators comprising quantitative and qualitative data.

50. To avoid such complexities, we suggest that EDA **starts** by developing and acquiring experience with the methodology by **focusing on a few key performance indicators for each of the Capability, Competence and Competitiveness aspects of the EDTIB.** EDA policy-makers will have to award weights to different aspects of the 3Cs reflecting their policy objectives (e.g. what are EDA trying to achieve and which elements are important?). It will be necessary to assemble all relevant published data and then to combine the different quantitative and qualitative indicators into such groups as 'below average/average/above average.' This allows the different units of measurement to be aggregated (e.g. profitability as a return on sales and total employment). Next, scores have to be attached to the assessment: for example, below average might be given a score of zero or one; above average, given a score of two or three. The various indicators need to be given weights: for example, one simple weighting system might assign a weight of one to all performance indicators (i.e. equal weighting).

51. An alternative approach to assessing strengths and weaknesses of the EDTIB might be to **start** with the features of a successful EDTIB. These include private ownership; competition; free entry (or contestable markets); freely working capital markets; and fixed price contracts. The opposite features form the basis for identifying a weak EDTIB, namely, state-owned enterprises operating as monopolies with entry barriers, subsidies to cover losses, no take-over mechanism and cost-plus contracts.

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