

A Review of MOD's Science & Technology Capability

(Executive Summary)

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Foreword

1. The effectiveness and efficiency of our defence and armed forces depends on our ability to harness the most advanced science and technology (S&T). There are numerous examples of S&T enabling operational advantage in military capability in areas such as force design, equipment, doctrine and tactics, as well as for decision-making and policy development. Moreover, the credibility resulting from the high quality outputs from our S&T underpins UK relationships with key allies and provides in return vital access to critical capabilities. These include support to our nuclear deterrent, chemical and biological defence capabilities, and to our intelligence sharing arrangements.

2. The world and our place within it is changing. The UK drawdown from Afghanistan coincides with a period when there is a need for even greater innovation as rapidly advancing S&T changes the nature of warfare and defence. This means the MOD's S&T must continue to be rebalanced towards addressing future challenges and threats.

3. The emergence of new technology in areas such as cyber, 'big data' and analytics, autonomy and advanced manufacturing will have major impacts on defence and warfare in the future. The commercial sector will play a large role in developing these technologies. The MOD will need to adopt new and different approaches to access and exploit advanced S&T from industry. The resources needed to achieve this will need careful balancing with the essential need for continuing investment in S&T in academia and public sector defence laboratories.

4. Against the backdrop of these important changes, I was asked by the MOD's Permanent Secretary and the Vice Chief of Defence Staff to review the MOD's S&T Capability. This review provides recommendations to ensure that S&T is able to supply the MOD and our Armed Forces with the best support for our defence capabilities for the future.

5. To help in undertaking the review, I commissioned ten panels comprising over 60 experts (from academia and industry) to look across the MOD's S&T capability residing both within Dstl and where possible in its supplier base. I am extremely grateful to these experts for their commitment, hard work and input into this report. I also consulted our Armed Forces Chiefs of Service. In addition I spoke to several senior international defence S&T partners to gauge their views of UK defence S&T capability. All of these expert assessments are contained within the individual chapters of this report. Despite the challenging timescales placed on the review, I have a high degree of confidence in the review's five top-level findings:

- There was strong consistency across the review's ten capability panels that overall the S&T is of high quality. However, this needs to be considered in light of the following four points.
- There needs to be greater transparency and accountability in requirement setting for S&T. There needs to be a clear division of responsibilities between the end-users, who are the ultimate 'customer' (MOD Head Office, the Armed Forces and other holders of top level budgets) and the suppliers of S&T (Dstl and external suppliers). The customer needs to set the

strategy and priorities for S&T, and to have the capabilities to hold the suppliers to account for the delivery and quality of their work. But this 'takes two to tango'—working closely with the MOD's Chief Scientific Adviser: the MOD and Armed Forces need to develop a greater interest and expertise in S&T to allow them to act as a first-class expert customer; and Dstl and external suppliers need to be able to communicate more effectively the 'offering' of S&T for present and future defence capabilities.

- Rebalancing of the S&T portfolio is needed in two areas: towards investment in S&T that will provide longer-term capabilities as against a dominant focus on shorter-term needs; and an improved balance between technology-push, which create new opportunities from S&T, and technology-pull from the customer of the S&T. Some tough choices are needed about how and whether to maintain expertise across the whole array of defence related S&T. However, it is essential that our S&T capability must be world-leading in some major domains for our sovereign S&T capability and in order to sustain effective international partnerships and to leverage our S&T capabilities.
- The MOD and Armed Forces must ensure that they have the right level of in-house S&T skills to retain S&T capability, agility and flexibility. Indeed, the MOD and Armed Forces cannot be competent customers for S&T without this in-house S&T capability.
- Despite the apparent high quality of the majority of the S&T (as assessed by the ten capability panels), there is not enough systematic independent peer review of Dstl's internal capability or that of the external supply base to provide assurance to the MOD and Armed Forces that the quality of S&T is held to account.

6. Throughout the entirety of the review, the work was overseen and directed by a high-level Steering Group chaired by me. The Steering Group comprised Sir John Beddington, Sir Peter Knight, Prof Dave Delpy, Prof Nick Jennings, Paul Taylor and Air Marshal Sir Stephen Hillier, with David Williams and Prof Vernon Gibson as observers.

7. I look to the MOD to take forward the report's main recommendations and ensure detailed findings within the capability chapters are addressed.

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Executive Summary and Recommendations

1. Science and Technology (S&T) is an essential element of defence. There are numerous examples where the application of S&T has played a vital role in military operations, securing operational advantage, be this in military capability, equipment, doctrine and tactics, or decision-making.
2. Examples of where S&T has made critical impact range from meeting urgent operational requirements, to reducing casualties and improving protection from improvised explosive devices in operations in Afghanistan (e.g. application and advice on new armour appliqué, technical advice on development of the Foxhound Armoured Fighting Vehicle, personal protection such as provision of blast protective underwear), to the application of sensitive S&T in forensics and for detection and disruption of bomb-making factories in theatre. Application of S&T has improved fire-power, such as development of the dual-mode/dual-role seeker for Brimstone, the air-launched ground attack missile, which has been amply demonstrated in operations in Iraq and Libya. Analytical approaches such as Red Teaming have also been used to reduce risks around operational capabilities prior to their deployment and avoid unintended consequences as a result of their use.
3. Outside of operations MOD's S&T capability also demonstrates critical effects in policy and decision-making, as well as support to individual Commands for capability acquisition and development. For example, the application of S&T capability to the Type 45 SAMPSON radar in recent trials with the US has provided a detailed understanding of current and future potential capability of Ballistic Missile Defence. Another example is the application of S&T to support the Future Reserves 2020 Programme. Analysis provided a

comprehensive understanding allowing the treatment of risks around the reservist application and recruiting process (from marketing to retention).

4. There is no doubt that S&T will continue to be vital in future operations and remain a critical enabler for defence as a whole. However, with the drawdown in Afghanistan and emphasis on supporting contingent operations, the S&T Programme must be rebalanced to address MOD's future needs. Financial constraints and the continued complexity of delivering defence will mean MOD as a whole needs to adopt different and potentially radical approaches to planning, developing and generating capability. MOD's S&T must be repositioned ready to support and enable these new needs, having the flexibility and agility to create new options.
5. The emergence of new technologies for example, in cyber, internet of things, autonomous and unmanned systems, will lead to new defence capabilities, as well as new ways to handle asymmetric conflicts. MOD's S&T must be ready to exploit these new technologies, as well as respond quickly to their potential disruptive and unforeseen applications. The first steps towards innovative work in these areas is being led by MOD's Chief Scientific Adviser with investment in Disruptive Capability and the development of a S&T innovation strategy.
6. This review of MOD's S&T capability has focused on an assessment of the current strategies and priorities for its S&T, including assessment of the underpinning evidence base for these S&T requirements. It has reviewed the S&T capability to deliver these requirements, and the capacity and health of current and planned future capability across the S&T base in Dstl and to a more limited extent, in industry and academia.

7. The review focused on the work funded through Dstl. This included the central MOD S&T Programme of around £400m, as well as approximately £250m funded by other customers across Defence and other government departments (OGDs)¹. This capability was divided into ten areas for assessment, as agreed by the Steering Group:

- People
- Weapons
- Decision Support
- Chemical & Biological
- Cyber
- Autonomous & Conventional Platforms (PLATFORMS)
- Counter-Terrorism & Security (CT&SEC)
- Surveillance Reconnaissance, Sensors and Space (SR&SPACE)
- Command, Control, Communications Computers & Intelligence & Big Data Analytics (C4I)
- Enabling (covering capability for S&T requirements capture, strategy and programme formulation and management)

8. For each capability area, a panel of independent experts was established from the Defence Scientific Advisory Council (DSAC) and the DSAC register of security-cleared independent experts. Where necessary additional expertise was sought from outside DSAC. Consistency with other NSC(O)S&T² reviews was ensured.

¹ OGD investment for FY13/14 was around £30m.

² National Security Council Officials' Science and Technology sub committee.

9. Evidence presented to each capability panel ranged from documented policy, strategy and military requirements for S&T output, as well as Dstl departmental capability development plans and strategies, and internal benchmarking exercises. This was combined with engagement with military staffs, Dstl and the supplier base. MOD's Finance and Military Capability (FinMilCap) area under DCDS (MilCap) also provided advice on military context to each capability panel.

10. Dstl afforded the review highest priority, making available staff at all levels. The level of access to information and documentation provided to support the review has been first rate. In particular, the review has leant heavily on Dstl Strategy Chiefs. It is recognised that without the level of support from the Strategy Chiefs, it would have been difficult to achieve the degree of transparency around future S&T plans and capability strategies, and the review could not have been completed satisfactorily.

Drivers and Requirements for S&T Capability

11. The ultimate 'customers' for MOD's S&T output are MOD Head Office, the Armed Forces and other holders of top level budgets; in addition there are others, including other government departments and our international partners, who lean on and in some cases, fund MOD's S&T capability across the entirety of the defence and security spectrum.

12. Customer needs span a very large range of S&T requirements at different time scales and in widely different domains of activity. For the long-term S&T is needed to support the UK response to the evolution of the ways and means of defence and warfare, including developments of unmanned platforms, autonomous systems, remote monitoring, developments in cyber and an enormous array of other technological issues. Understanding human factors will continue to

be a vital S&T need. S&T is also needed to support policy development and strategic force planning. But equally there will continue to be important short-term S&T requirements to deal with rapidly evolving threats, and immediate S&T requirements for equipment procurement and operations.

13. S&T capability cannot be delivered at a moment's notice. The teams that are capable of delivering short-term S&T requirements can only exist if there is long-term sustained investment in S&T capability. Teams are needed that combine expertise with experience, in facilities that are fit for purpose and with the necessary licences to practise. Such teams take time to develop. It is that underpinning S&T capability for the longer-term that has, in recent years, allowed MOD's S&T capability to be agile and react with the pace necessary to respond appropriately to customer's short-term needs. This has only been possible through core investment by the S&T programme.

14. The consequence of these requirements is that the MOD and Armed Forces need to be sophisticated and strategic expert customers for their S&T needs. MOD's Chief Scientific Adviser needs to play a key role in the transmission of S&T between customer and provider, but whilst this role is necessary, it is not sufficient. The funders and the users of the S&T need to be capable and interested in the capacity of S&T to deliver the innovation that is needed for their work now and in the future. Based on the findings of this review, this will require new S&T capabilities and ways of working. The remainder of the Executive Summary sets out the findings that led to this conclusion and the recommendations that, if implemented, will provide some of the key solutions.

15. The review panels found that, although there are long-term strategic needs for MOD's S&T capability, current articulation of S&T

requirements tend to be over-focused on near-term problems and specific tasks. They do not reflect the need to build long-term S&T capability in specific areas. While some S&T requirements are based on published government policy, the panels found that the provenance of other key documents and supporting strategy was often unclear. A consistent finding across all the areas of S&T capability was the lack of S&T requirement for investment into longer-term S&T capability and of mechanisms to assess the balance of delivery between longer-term and shorter-term S&T requirements.

16. Although the different levels of S&T requirements are scrutinised at various points within MOD, they are not prioritised effectively in a coherent way. S&T requirements and programme investment are largely driven from bottom-up needs, without any real prioritisation. Consequently, when demand outstrips capacity, such requirements do not provide adequate direction to Dstl and others on where to focus and sustain development of S&T capability and where to disinvest.

17. There is a confusion between the customer and provider of S&T, with a blurring of the role of Dstl, which acts as both customer and provider for the MOD and Armed Forces. This is problematic for several reasons. The ultimate customer and funder, for it is the customer that pays, for the S&T must be the MOD and the Armed Forces. In the absence of a clear S&T strategy from the customer/funder it is very hard for Dstl to allocate its resources in the most effective and responsive way. Secondly, it creates invidious choices for Dstl to decide how to allocate resources between its internal programmes and external providers. Thirdly, the customer cannot hold the provider to account for the quality of its work if it is effectively one and the same organisation. None of this should be taken as a criticism of Dstl, which has been placed in this position by

decisions taken outside the organisation. But these problems need fixing.

18. Furthermore, the way S&T requirements are increasingly refined and interpreted into the programme across this blurred customer-provider split (staff in the Commands, embedded Dstl Science Gateways, Dstl Account Managers and Dstl Capability Advisers) potentially drives out opportunity to access new S&T capability and to provide technology-push for new innovative solutions. In almost all cases, Horizon Scanning for new challenges and S&T opportunities was found to be a 'nice to have' and did not appear to influence the S&T capability area being reviewed.

19. The review panels included an assessment of whether there was a clear connection between MOD's stated S&T capability requirements and the military capability decisions which were being made. However, on the evidence available this was difficult to assess and warrants further work.

20. Whilst it is recognised that defence is a complex enterprise, the complexity of the S&T requirement setting does not provide a transparent and auditable process. The capability panels found little evidence that the existing complex S&T requirement setting process allowed the best and most innovative S&T capability to be applied. With the exception of new work on Disruptive Capabilities and the Knowledge, Innovations and Futures Enterprise (KnIFE) technology elements of the programme, the core programme is evolutionary. This tends to pull the programme and S&T capability back to what it has always done.

21. Requirements for S&T need to be simplified to provide greater clarity and be more effectively prioritised to enable S&T capability to be resourced effectively. Requirements must incorporate a need for

more effective Horizon Scanning and technology-push as an integral element and not a separate activity. Furthermore, requirements for S&T need to be driven top-down in a coordinated and coherent fashion and not solely consolidated from bottom-up needs.

22. A mechanism is needed that sets direction and requirement for longer-term S&T capability which drives the commissioning of programme formulation and investment to reflect both the longer-term, strategic needs and the near-term needs of MOD.

23. In addition to clarified and simplified S&T requirement setting, there needs to be better tailored education for the customers and end-users of S&T. This could augment existing technology and acquisition courses within the Defence Academy. This should target end-user communities, as well as others involved in defining and refining S&T requirements, to ensure a better understanding of what S&T can provide and how to articulate effectively end-user needs.

Recommendation 1: MOD must implement a structure that provides transparency and accountability in S&T requirement setting and encourage innovation. This should include assessing the connection between the S&T capability requirements and military capability decisions by end-users. The 'customer' must be effectively distinguished from the provider of S&T. There must be clear two-way interaction established between customer and provider, involving MOD's Chief Scientific Adviser.

Recommendation 2: MOD must develop more effective education and training around the setting of requirements and exploitation of S&T, targeted at those involved in capability planning, policy development and research management.

Recommendation 3: *There needs to be more investment in S&T for longer-term developments in defence and warfare alongside shorter-term and tactical needs, and a better balance between technology-push from S&T providers, which creates new opportunities from S&T, and technology-pull from the end-users.*

MOD's S&T capability response to requirements

24. Looking to the future some tough choices are needed about how and whether to maintain expertise across the whole array of defence related S&T. However, it is essential that our S&T capability must be world-leading in some if not all major domains both for our sovereign S&T capability and in order for us to sustain effective international partnerships and to leverage our S&T capabilities.

25. MOD's S&T capability comprises a diverse mix of suppliers, with more than 50% of programme being delivered by suppliers external to Dstl. Choices have to be made about where to invest externally and where to develop S&T capability in-house within Dstl. In certain critical areas of sovereign S&T need, capability has to be retained within Dstl. This is particularly so for chemical and biological, and counter-terrorism & security areas, where operational advantage and sensitive collaboration provides significant access to capability and intelligence from allies.

26. Where S&T capability sits outside, Dstl's approach is to maintain sufficient technical depth in order to contract and engage with external suppliers and provide MOD with enough support to be an 'expert customer'. However, the panels found no evidence of a

unified view of what this expert customer should comprise³, although it was recognised that the role of expert customer will vary across the S&T capability areas. For example, the level and currency required to be an expert customer in communications and information technologies, will be quite different from that of materials and structures around military platforms, due to the pace of which various technologies advance. There will also be technology development occurring in academia or industry, in the UK and abroad, that MOD, Dstl and its external suppliers are not aware of. Such work must be captured, wherever possible, by Horizon Scanning.

Recommendation 4: *MOD must establish what 'expert customer' means for defence S&T, where that customer function should sit, and the consequences for the depth and breadth of MOD's S&T capability. There must be a more robust process for identifying which S&T areas to protect and from which to divest.*

It follows that:

Recommendation 5: *MOD must develop a coherent S&T strategy which, where necessary, sustains underpinning S&T capability. This must in*

³ National Security Through Technology (Cm 8278) defines an intelligent customer as 'having a clear understanding and knowledge of our requirements and of the products or services being supplied in response, including the management of their supply, as well as the ability to use those products or services safely and effectively', this is expanded at paragraph 3.3.2 on "Being an intelligent customer", which includes amongst others a *knowledge of a particular technology—how we plan to use it operationally and how it was designed to be used through-life (including subsequent upgrades and insertion of new technologies)—we must understand and assess the market place, what is potentially available, who the suppliers are, and what processes and standards are being used.*

turn drive the quantum and balance of S&T investment in Dstl and other providers. The outputs of Horizon Scanning must be driven more effectively into the S&T strategy and its execution.

27. As a Trading Fund, Dstl must respond to the resources and funding it gets from its various customers. Dstl has planned a reduction of permanent staff numbers to mitigate effects of any future reduction in income. For example, MOD's Annual Budget Cycle 2015 is likely to lead to reduction of Dstl income from the central S&T Programme as well as DE&S by some £25–30m in each of FY15/16 and FY16/17.

28. The capability panels found varying levels of evidence for S&T requirement driving adoption and prioritisation of specific breadth and depth of S&T capability. In most cases, S&T capability elements are being managed against historical levels of breadth and depth and not against the underlying priorities for these areas. Some difficult choices are already being made within Dstl. Where areas are protected, for example in cyber, and the work is being delivered predominately in-house by Dstl, this is leading to reductions in staff working in other areas that are already at the minimum to support MOD as an expert customer, for example in weapons. Panels also observed that even where areas are ring-fenced against further reduction, the resilience of S&T capability to provide enough support to MOD to be an expert customer is limited. The MOD and Armed Forces must understand and agree the S&T capability choices that are being made within Dstl.

29. Even where Dstl retains a predominately in-house S&T capability in chemical & biological defence, the panel deemed this as now being fragile. Further cuts could undermine the comprehensive

approach required in chemical & biological defence and would weaken the S&T capability as a whole.

30. A number of capability panels noted that while succession planning for S&T staff and capability within Dstl does exist, there was little evidence of effective implementation at present. In some instances this was a consequence of underfunding over a number of years. Notably, S&T capabilities in Weapons and Platform Protection are much eroded and could limit support of future military equipment and systems.

31. The capability panels found it very difficult to assess the breadth and depth needed by Dstl in the future for each S&T capability. In most cases the understanding of what is required to be kept within Dstl and what can be provided by external suppliers is unclear and not uniform across the different S&T capability areas. In addition, there is insufficient prioritisation of S&T requirements by MOD at present to allow any effective strategy on the breadth and depth required to meet MOD's future needs.

32. A common theme from all the panels was the need to balance the retention of key skills in-house at sufficient depth, against a reliance on external S&T capability within industry and academia, whose drivers to maintain specific S&T capability may be different from MOD's.

Recommendation 6: *MOD must work with Dstl to develop and implement robust capacity assessment and succession planning for its scientists and engineers within each S&T capability area. It is urgent that the MOD and Armed Forces understand and agree the S&T capability choices that are being made at present within Dstl.*

Peer review

33. The fundamental benchmark for assessing the effectiveness of any S&T enterprise is international peer review. Such peer review can provide a better understanding of the wider supply base, but also confidence that the success or otherwise of a piece of science relates to the competence of the team not the tractability of the problem in question. Clear and effective peer review, as assurance of quality, is also vital to ensure effective and efficient research, particularly where a significant breadth of S&T needs to be covered.

34. In terms of assessing the effectiveness of both internal and external S&T capability, the panels found little evidence of benchmarking against similar external S&T capability. In terms of assessing quality of scientific output, there was also limited evidence of independent peer review, and in most cases where peer review was used, it was limited to internal review or government-to-government international research collaboration. In particular, there seems little evidence that external delivery of S&T is peer reviewed for quality.

35. Accepting a lack of evidence of peer review, the quality seen by the expert panels throughout the review was deemed to be good.

36. A systematic approach to peer review of both internal and external S&T capability used by Dstl is required in order to assess the effectiveness and quality of the S&T capabilities. This will help assess effectiveness of Dstl and external S&T capability against the future priorities required by defence.

Recommendation 7: MOD must develop a systematic approach to ensuring that, wherever possible, there is independent peer review of the S&T provided by both internal and external providers.

Transmission of requirements from customer to provider of S&T

37. The method of how requirements for S&T are articulated and transmitted to those undertaking work is vital to ensure that the S&T provided really meets the future needs of the customer and military end-user. Requirement setting and delivery must be an effective two-way mechanism to allow the end-user both to input into direction for S&T and to see how S&T provides new opportunities to meet military requirements. An important element of this is Horizon Scanning, which needs to be effectively connected into the overall commissioning process.

38. Current changes in Dstl (Project ROAD⁴) aim to simplify internal delivery structures. However, the interface between end-user/customer and delivery organisation has evolved somewhat in recent years since the Critical Interfaces & Structures Review of 2009⁵ set the ground for restructuring formulation and delivery of MOD's S&T programme.

39. Panels reviewed the transmission process within their individual capability areas. However, a separate panel was established to look at 'Enabling capability' associated with the commissioning and transmission processes. The Enabling capability panel covered the functions of Dstl Science Gateways embedded within the end-user community (the Commands and DE&S), the Dstl Account Manager function and Programme Manager role, as well as Capability Adviser and Strategy Chief. The panel also touched on the

⁴ Dstl project 'Reviewing Our Approach to Delivery' (ROAD) published 1 Oct 2014.

⁵ Critical Interfaces and Structures for the delivery of MOD's Science and Technology, A report for the Defence R&D Board, 25 Sept 2009.

hundred or so Military Advisers within Dstl, but these are the subject of a separate review by DCDS (MilCap).

40. The panels found that the overall process of S&T requirements setting through to delivery of programme was opaque. For example, for Integrated Survivability (within platform S&T capabilities) the lack of strategic vision, particularly in a S&T capability area which itself is so multi-faceted, translated into no real feeling of coherence at S&T programme and capability level. Furthermore, the cross-cutting nature of S&T capability areas with respect to the end-users across the four Commands provides an additional challenge to transparency. The current process of programme formulation does not easily lend itself to measuring the efficiency and effectiveness of the overall programme in meeting the needs of individual Commands.

41. The Enabling capability panel noted that in terms of setting and refining S&T requirements, and producing programme mandates, the Account Manager, Programme Managers and Capability Advisers all had roles to play, some of which overlapped with the embedded Science Gateway community. There was limited evidence that this capability effectively engaged with or had a 'working-level' understanding of the wider supplier-base, in particular the UK science base in academia. This effectively limits the understanding of the 'art of the possible' during programme definition.

42. Engagement with academia tended to be at tactical and more project levels within Dstl, but this was patchy. For example, the panel reviewing the Weapons S&T capability noted that existing academic links had been severely damaged when work was competed recently for external supply. However, the panel assessing Chemical & Biological S&T capability noted good academic

engagement. Both the People and CT&SEC panels also observed that there should be greater engagement between MOD S&T and the national Research Councils. A number of different models in the UK and in partner nations such as the US, are used to engage with industry and academia. An analysis of their strengths and weaknesses would help to ensure that the UK maximises the effectiveness of its defence S&T engagement with academia and industry.

43. It was noted that Managing Successful Programmes was being embraced successfully as part of S&T delivery. However, the role of Account Managers in commissioning and developing Programme Mandates does not sit well if they are part of the organisation charged with delivery. In addition, Programme Managers are recruited on the basis of providing a professional manager role. This contrasts for example, with the approach taken by DARPA, where senior technical experts are appointed to lead and develop, often quite radical, technical programmes, as well as separate professional Programme Managers.

44. In terms of exploitation of S&T, embedded Science Gateways and Capability Advisers both have roles to play, but the governance and accountability framework for Dstl staff (albeit embedded with the end-users) providing technical assurance to the end-user for delivery needs to be clarified.

45. Connectivity with the end-user is enhanced by the use of Military Advisers within Dstl. These advisers augment the function of the Science Gateways and Capability Adviser in providing military context and review of work. Evidence was limited; however, it tends to suggest Military Advisers focus on the 50% of the programme delivered internally within Dstl, and do not work directly with the external supply base.

46. A simplified and clearer connection is required between end-user (either within the Commands or embedded in Dstl) and that of the S&T providers whether internal or external, noting that innovation is best achieved through an iterative process across such boundaries. Roles for commissioning and defining S&T programme mandates and requirement setting need to be clarified and defined with clear separation of commission and assurance from delivery. There needs to be clearer metrics for assessing the prioritisation and exploitation of S&T, which can be used at all levels across the Commands and MOD Head Office.

Recommendation 8: *Governance, roles and responsibilities for S&T requirement setting, exploitation and assurance of the quality of the S&T need to be reviewed and clarified.*

Recommendation 9: *There should be a review of the engagement mechanisms between government defence programmes and S&T in academia and industry that are used internationally. This should examine best practice and see what can be usefully applied to improve existing UK practice.*

47. The following table provides an overall assessment on the health of MOD's S&T capability from each of the ten capability panels. Red indicates a significant problem, amber indicates a potential or marginally significant problem and green indicates no significant problem. Panels assessed the most significant risk as one of overall resilience of the S&T capability now and into the future.

48. Where two colours with an arrow are indicated in the assessment, this indicates the perceived direction of travel by the panels.

49. The chapters provide detailed assessment of each capability area, highlighting strengths and weaknesses and further narrative against the table. Further evidence behind each chapter is available should it be needed.

Science Capability Review Panel RAG Assessment (Summary)

Part One: Requirements

Assessment Question		People		Weapons		Decision Support		CB		Cyber		Platforms		CT & Security		SRSS		C4I & Big Data	
Drivers and Requirements for S&T capability	Strategic Capability Alignment to Policy	Human Sci	Med Pol			Req	Alignment			MOD Req	Dstl Strat					Space			
	Strategic Capability Alignment to Threat					Req	Alignment			MOD Req	Dstl Strat								
	Strategic Capability Alignment to Emerging technology					Req	Alignment												
	Strategic Capability Alignment to Military Requirements					Req	Alignment			MOD Req	Dstl Strat					Space			

Part Two: Capabilities

Assessment Question		People		Weapons		Decision Support		CB		Cyber		Platforms		CT & Security		SRSS		C4I & Big Data	
Capability Response to Requirements	Capability Reflects Policy?															MOD Req (Space Red)	Dstl Strat (Space Amber)	MOD Req	Dstl Strat (BD Amber)
	Capability Reflects Threat?															MOD Req (Space Red)	Dstl Strat (Space Amber)	MOD Req	Dstl Strat (BD Amber)
	Capability Planning Reflects Emerging technology?															MOD Req (Space Red)	Dstl Strat (Space Amber)	MOD Req	Dstl Strat (BD Amber)
	Capability Reflects Strategic Military Requirements?													Non-Ops	Ops	MOD Req (Space Red)	Dstl Strat (Space Amber)	MOD Req	Dstl Strat (BD Amber)
	Overall Assessment															MOD Req (Space Red)	Dstl Strat (Space Amber)	MOD Req	Dstl Strat (BD Amber)
Flexibility and Agility for Capability to Respond to Future Needs	Capability Responsive to Future Uncertainties?															Space			
	Robustness of S&T recruitment and succession plans?			Dstl	WOC	Industry										Space			→
Benchmarks for current and future capability	Evidence of quality benchmark for internal work?																		
	Internal Depth / resilience now?																		
	Internal Depth / resilience over next ten years?						Size	Demand						Not Assessed					
	Evidence of internal exploitation?																		
	Evidence of quality benchmark for external work?						Not Assessed			Industry	Academia					Not Assessed			
	External Depth / resilience now?															Not Assessed			
	External Depth / resilience over next ten years?															Not Assessed			
	Evidence of external exploitation?															Not Assessed			
	Overall Assessment									Size	Quality	Exploitation				Not Assessed			
	Current internal/external balance based on policy?	Human Sci	Med Pol																
Future internal/external balance based on policy?								Not Assessed											
Wider Engagement	Engagement with Industry?																		→
	Engagement with Academia?																		
	Engagement with Allies?																		→
	Confidence in UK 'peer status'?	Stance A work	Stance C work								Offensive	Defensive/SA				Int	Sensors/Space		
The role of an Intelligent Customer	Intelligent Customer Capability & Resource (Systems Integration)						Not Assessed			Offensive	Defensive/SA							Int Production	
	Intelligent Customer Capability & Resource (Supply Chain / Defence Market awareness)									Offensive N/A						Space			
	Intelligent Customer Capability & Resource (External Engagement)									Offensive N/A						Space			

