

Avionics and Mission Systems

A Key Element in Delivering Through-Life Capability

Keith Hayward and Michael Codner

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The report expresses the views of the authors. It does not represent the opinion of the Royal United Services Institute nor of any of the organizations which have offered advice and support.

Comments pertaining to this report are invited and should be forwarded to: Dr Lee Willett, Royal United Services Institute, Whitehall, London, SW1A 2ET, United Kingdom, or via email to dr.leewillett@rusi.org

Authors

Professor Keith Hayward is Head of Research at the Royal Aeronautical Society and an Associate Fellow of the Royal United Services Institute.

Michael Codner is Director of Military Sciences at the Royal United Services Institute.

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Foreword

In its Defence Industrial Strategy (DIS), the UK Ministry of Defence (MoD) has encouraged the development of new business models for the defence industry. With the Equipment Plan featuring fewer programmes, companies are being asked to develop new ideas and structures for providing support services and systematic programme and capability upgrades. This has thrown out a challenge to all levels of industry and to the MoD as a customer. It has also presented a number of serious issues for the UK avionics and mission systems sector, particularly the problem of maintaining a sustainable avionics support capability in the UK as the traditional prime contractor becomes the primary source of life-cycle management.

The Royal United Services Institute for Defence and Security Studies (RUSI) is undertaking several projects on the implications of DIS. This *Whitehall Report* in particular:

- assesses the challenges facing the avionics and mission systems sectors following the DIS;

- examines the potential effects upon the supply chain of single availability based contracts with the prime contractors; and
- considers an innovative solution from industry (the Total Support Services alliance) to meet these challenges.

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Executive Summary

The Defence Industrial Strategy: A New Business Model for Defence?

The Defence Industrial Strategy (DIS) affirms that there will be fewer major systems programmes in the future, but offers companies increased longer-term returns from support and systematic upgrading. The DIS makes frequent reference to the width and breadth of the UK defence industry supply chain and its importance to the nation's overall innovative and managerial capability in defence. It also recognizes the risk of too much vertical integration in the supply chain.

Nevertheless, the Ministry of Defence (MoD) has made a strategic decision to outsource the provision of support and logistics for aircraft under a single availability based contract to the prime contractors – principally BAE SYSTEMS and AgustaWestland. The prime contractors will be responsible for managing the supply chain. This is intended to achieve more effective asset management and reduced costs. But it may have the effect of undermining important aspects of appropriate sovereignty by eroding key capabilities.

The Defence Industrial Strategy and the Avionics and Mission Systems Sectors

Avionics and other electronic mission systems are critical to overall capability, creating advantage in platform performance, situational awareness and precision of attack. They form a growing element of platform development and support and maintenance costs due to their complexity and diversity, and to systems integration demands. Possession onshore of an avionics and mis-

sion systems capability is essential not only to meeting routine operational and support needs, but also in retaining an onshore location for innovation to support upgrades and future new platform requirements such as unmanned aerial vehicles (UAVs).

The UK has a world-class avionics and mission systems sector, but this is threatened not only by an intermittent flow of new programmes, but also potentially by the terms of the single availability based contract. There is a risk that much of the added value of the service contracts will be concentrated at the prime level, as the prime contractor might seek to 'squeeze' cost out of the supply chain. This could mean that the appropriate incentives to reduce cost and to improve service through innovation will not flow down to key supplier companies.

With the defence customer funding fewer programmes, the Tier 2 supplier would have to fund independently more of the technology development required for new projects and to support existing through-life contracts. This might lead to a 'commoditization' of the UK supply chain and a hollowing-out of the UK defence industrial base.

This would seriously threaten to diminish the UK's onshore mission systems and avionics capability. Over time, it would also reduce the sector's ability to take on the risk implied by long-term contracting, as well as reducing its ability to develop new technology in the UK. Supporting this technology base will be vital to ensure that UK industry can bid effectively for overseas business and participate influentially in international programmes.

A New Defence Business Model Needs Best Practice Supply Chain Management

Effective through-life capability management (TLCM) for defence programmes demands the adoption of a new business model that maximizes opportunities for effective technology insertion as well as cost-effective support and sustainability. At one level, this will be facilitated by designing platforms with open architectures and by implementing from the outset a holistic approach to avionics support and upgrades.

More generally, TLCM should reflect best practice from the civil sector, where genuine risk-sharing partnerships between prime contractors and major suppliers are designed to encourage greater responsibility for designing, integrating and managing complete sub-systems in return for greater rewards. In defence terms, this should allow a more effective and efficient approach to satisfying platform availability contracts and, if organized correctly, fewer points of contact for the prime contractor and an increased capability for innovation and technology insertion.

However, in order to meet these requirements, the supply chain needs both the flexibility and the capacity to deliver cost-effective solutions to the prime contractor and to the MoD customer.

Alliance Solutions in Avionics and Mission Systems

One approach to this challenge is the formation of flexible coalitions or alliances that have the critical mass to assume high-level responsibilities, but the scope to allow other members to join as appropriate and the ability to retain a degree of competition. Partnering at the sub-systems level should not reduce competition. Such alliances should not exclude overseas competition, but the principle of appropriate sovereignty may block some competitors.

The Total Support Services (TSS) Example

Thales UK, Smiths Aerospace and Selex Sensors and Airborne Systems have formed Total Support Services (TSS), an alliance designed to provide the UK with a platform equipment support capability in avionics. This alliance will combine resources and competencies to enable the delivery of a comprehensive systems approach to TLCM and to provide a springboard for future innovation and upgrade capability. Key features of the alliance include:

- Pooling of avionics support infrastructure.
- Extensive experience of best practice supply-chain management.
- Pooling of technical competencies to enable the design of complete sub-systems, the management of technological obsolescence and full avionics support.

In developing an appropriate mix of capabilities to provide higher-level and higher-value solutions, this approach:

- supports the prime contractor in fulfilling its responsibilities for managing the overall programme by providing greater assurance of sufficient competence in an increasingly sophisticated and potentially costly part of an aircraft life-cycle; and
- gives the MoD customer a more cost-effective approach to its support and upgrade requirements, while meeting key aspects of the appropriate sovereignty principle.

Responsibility for Supply Chain Management

In delegating managerial responsibilities for TLCM-based procurement, the MoD must monitor continually the operation of large contracts to ensure they are delivering cost-effective solutions in the longer term. Such responsibilities also include the need to

develop supply chain structures to meet the challenge of obsolescence and to provide timely and innovative technological solutions as the strategic context evolves. The Ministry of Defence will need to develop adequate in-house expertise at the strategic level for this purpose. The recent appointment of a Head

Office Defence Commercial Director and the decision to merge the Defence Procurement Agency and Defence Logistics Organisation into a single 'integrated procurement and support organization' show promise in this respect in terms of potential for strong direction and coherent action.

Report

A New Business Model for Defence?

In December 2005, the United Kingdom (UK) Government published a White Paper on its Defence Industrial Strategy (DIS).¹ On 3 July 2006 a report, *Enabling Acquisition Change* (EAC),² commissioned by the DIS on the subject of the Ministry of Defence's (MoD) ability to undertake some of the key recommendations of the White Paper was released. The DIS affirms that there will be fewer major platform programmes in the future, but offers companies in the defence industrial complex increased longer-term returns from support and systematic upgrading to major programmes. The DIS makes frequent reference to the width and breadth of the UK defence industry supply chain, and to the importance of the supply chain to the nation's overall innovative and managerial capability in defence. Nevertheless, the Ministry of Defence (MoD) has made a strategic decision to outsource the provision of support and logistics for aircraft under a single availability based contract to the prime contractors – principally BAE SYSTEMS and AgustaWestland. The prime contractors will be responsible for managing the supply chain. This arrangement is intended to achieve more effective asset management and reduced costs. However, it may have the

effect of undermining important aspects of appropriate sovereignty by eroding key capabilities.³

Appropriate Sovereignty

Two of the three DIS appropriate sovereignty criteria – defence capability and strategic influence – are applicable generically to avionics and mission systems. Potentially, these criteria give very significant military advantage to the air platforms in which they are embedded. They also meet the criterion of defence capability in that there would need to be assurance of supply. This point is amply demonstrated by the current differences between the UK and US Governments over assured access to Joint Strike Fighter (JSF) technology, access that would permit national upgrades and technology insertion. In the medium to long term, avionics and mission system technologies would enable UK Armed Forces to fulfil the expectations of MoD's future operational concepts in the development of agile mission groups.⁴ Strategic influence is a consequence of coherent defence capability which allows UK forces to attain the specific strategic roles in coalition operations that enhance national influence. To be one of a relatively small number of nations that can operate truly agile air forces safely and effectively would be profoundly important to influencing coalition policy. This also would offer considerable leverage in collaborative multinational programmes.

¹ Ministry of Defence, UK. (2005). *Defence Industrial Strategy: Defence White Paper*. Presented to Parliament by The Secretary of State for Defence, By Command of Her Majesty. Command 6697, December 2005.

² *Enabling Acquisition Change: An examination of the Ministry of Defence's capability to undertake Through Life Capability Management*, June 2006 (EAC).

³ Appropriate sovereignty is a concept introduced by DIS and defined in pp.21–22, para. A2.13.

⁴ Joint Doctrine and Concepts Centre (JDCC), Ministry of Defence, UK. *The UK Joint High Level Operational Concept: An Analysis of the Components of the Defence Capability Framework*. The High Level Operational Concept (HLOC) 'provides a conceptual headmark for joint operations in 2020 in order to inform Force Development, joint experimentation, future capabilities requirements, the Equipment Capability Customer and single-service conceptual development' (p.1-1, para.103). The new title of JDCC is the Development, Concepts and Doctrine Centre (DCDC).

The Growing Significance of Support

This role-shift of support to industry has been a part of a wider reform of the Defence Logistics Organisation (DLO)⁵ in its present form, the Defence Logistics Transformation Programme (DLTP).⁶ This initiative is an important element of the shift in focus of acquisition processes from initial acquisition costs⁷ to through-life costs⁸. The MoD Investment Approvals Board (IAB) is required to ensure that through-life costs rather than initial acquisition costs are taken into account for project approval. And critically through-life costs must include planning and budgeting for future upgrades. These changes have major implications for OEMs⁹ who will need to identify the demands of through-life capability management (TLCM) including upgrading and incremental insertion of technology in the initial design of new platform acquisitions. The demands of support and specific implications for innovation capacity will shape the overall pattern of equipment provision.

The objectives of DLTP include simplified end-to-end processes from 'foxhole to factory', improved supply chain performance, maintenance, repair and upgrade turnaround times and reduced spares holdings. A principal enabler is a robust and cost-effective supply base for the future.

Efficiency demands significant reductions in support cost targets. A consequence is major reductions in staff and closures of facilities.

The Defence Industrial Strategy and the Avionics and Mission Systems Sectors

Since the Second World War, avionics and other electronic mission systems have formed an increasing element of platform development costs. The DIS illustrates the balance of design and development effort for a representative combat aircraft as 40 per cent avionics and general systems, compared with 38 per cent platform and overall system engineering, the balance of 22 per cent being propulsion.¹⁰ It is equally the case that avionics and mission systems are fundamental to delivering key capabilities required by the customer, such as higher levels of platform performance, improved situational awareness and precision of attack. As the DIS notes, the innovation and ability required to exploit technology developments and improve other aspects of military capability may increasingly 'reside at [the] lower, partial system and sub-system, levels'.¹¹

Having an onshore avionics capability is of great importance to the UK for several reasons:

⁵ On 3 July 2006 the Secretary of State for Defence announced that the DLO is to be merged with the Defence Procurement Agency (DPA), a recommendation of EAC.

⁶ Since its formation as an outcome of the 1998 Strategic Defence Review, the DLO has been evolving from a conglomeration of individual Armed Service logistics operations into a truly joint and integrated organization with a structure to match. The DLTP is the latest and arguably most extensive phase in this reform process. The intended DLTP effectiveness outcomes are: end user, front-line confidence; simplified end-to-end processes; logistics support optimized to enable 'effects based operations'; improved force-level readiness and sustainability; consistent and improved supply chain performance; improved platform reliability, availability and sustainability; and lean repair loops, improved turnaround times and reduced spares holdings. See <http://www.mod.uk/DefenceInternet/MicroSite/DLO/OurTeams/TheDefenceLogisticsTransformationProgrammedltp.htm>

⁷ The costs of the Concept, Assessment and, most significantly, the Development and Manufacture phases of the CADMID acquisition model. The remaining phases are In-Service (during which support and upgrade costs are the major contributors to through-life costs) and Disposal.

⁸ This shift was actually an element of the Smart Procurement/Acquisition initiative that formed part of the 1998 Strategic Defence Review.

⁹ Original equipment manufacturer.

¹⁰ DIS, p.43, fig. A5(iii).

¹¹ DIS, p.62, para. B1.25.

Avionics and Support and Maintenance Costs

Avionics and other electronic systems form a growing element of platform development and support and maintenance costs, due to their complexity and diversity and to systems integration demands. Avionics and mission systems account on average for around 25 per cent of DLO aircraft maintenance expenditure. This figure will increase substantially as the complexity of platforms increases. Knowledge of sub-systems design and integration will make a substantial contribution to answering problems posed by supporting and maintaining the more complex platforms in a cost-effective fashion through a direct understanding of the technology at a systems level.

Managing Obsolescence

As platforms are increasingly likely to have longer or extended life-cycles, managing obsolescence is an essential MoD requirement. Individual platforms and major systems are vulnerable to two forms of obsolescence. First, there is component or technology obsolescence that can render hardware or software unsupported. An aircraft such as Tornado or even Typhoon depends upon circuitry and other components dating from the 1970s and 1980s, several epochs in electronics. The second, and more invidious form is performance decay where, either because of the age of the system or because new operational threats have emerged, relative performance declines or the role for which it was designed has changed or even disappeared.

Component obsolescence is the most obvious problem and is especially acute in the avionics and electronics sector due to the rate of change in terms of both components and performance. The product cycle in commercial electronics and associated software has now reduced to approaching eighteen months. The cycle is driven by a highly dynamic stream of technological innovation. The result is a mismatch between the life

cycle of the platform and significant numbers of its components creating problems throughout an aircraft's operational service. As avionics and mission systems become even more sophisticated and operational life cycles grow longer, component obsolescence will become even more acute.

To date, the response to this problem has been piecemeal, often as a last resort. For industry, the resulting work has been spasmodic (albeit welcome) and difficult to anticipate. While the MoD might have preferred a more strategic answer, funding problems have invariably undermined good practice. In the shift to platform availability contracting, and as industry assumes more of the responsibility for TLMCM, there is an opportunity to develop a more strategic approach to component obsolescence. This would entail monitoring and managing component obsolescence across several aircraft platforms with the aim of reducing the overall cost of updating avionics components. An alliance of supplier companies is an attractive option for providing this flexibility and efficiency and for the development of effective component procurement strategies.

The problem of performance decay is now to some extent anticipated by building opportunities for continual improvement into a platform's life cycle – so-called incremental or spiral development. These acquisition models entail anticipating performance obsolescence and planning for several future incremental capability upgrades during the lifetime of a deployed system. In the case of avionics, this process is likely to entail high level re-design, development and integration of complete mission-critical sub-systems. In most cases, the most appropriate source of expertise and capability will lie with the avionics equipment suppliers. They have the competence and ideally the specialized technology base to design, develop and supply the required systems upgrades. It is important also in establishing through-life support arrangements that the staffs of appropriate suppliers work physically close to operators

to understand operator needs and problems to enable the development of the best upgrade solutions.

The Importance of Innovation at the Sub-Systems Level

Meeting the challenges of long-term support and maintenance, managing obsolescence and retaining the capability to respond to new requirements as they appear depend upon the capacity to innovate. Maintaining this capacity in turn requires investment in technology acquisition, people and processes by both the MoD and industry. The DIS recognizes that a substantial part of the innovative capacity of the UK's defence industrial base (DIB) lies below the prime level: 'the UK will need to have a leading edge understanding in the areas of design and performance of sub-systems (and the) properties and limitations of key components'.¹² Supporting the technology base at this level also will be essential to ensure that UK industry can bid effectively for overseas business and participate as high-value partners in international collaborative programmes.

Maintaining the depth of innovation in the UK supply chain will require an adequate flow down of national resources and a fair share of the rewards of MoD contracting, whether from research programmes or TLMCM business. This requirement is relevant even at the level of those smaller companies who generate novel ideas and applications especially from the civil sector.

The MoD cannot assume with any confidence that the technological base for incremental acquisition and other planned

upgrades will be supported by avionics companies located in the UK. There appears to be a sanguine expectation underpinning the MoD's new business model that key technologies will emerge from investment in civil programmes – 'spin in' rather than 'spin out'. There is some validity because the rate of change is generally faster in the civil world, but there are still peculiarly military requirements that will depend upon a dedicated stream of research and development. In general, however, the availability of state-of-the-art defence avionics will depend upon the willingness on the part of companies to make the necessary investment both to adapt civil technology and to develop the specialized equipment for the defence market. Without the appropriate incentive to make these investments, capacity will either decline or move offshore.

The UK Avionics Industrial Base: Threatened by the New Business Model?

As the DIS recognizes, the UK possesses a strong and broad capability in avionics and mission systems which 'has enabled the UK to deploy world-class capability without undue dependence on other nations and to participate in international future programmes, such as JSF, with market-leading technology'.¹³ This achievement has been against a background of increased competition amongst Tier 2¹⁴ suppliers in the UK market. Since the 1980s, Tier 2 companies have borne the brunt both of competitive procurement and of the MoD's increased willingness to buy offshore. This has had some positive effects on the overall competi-

¹² DIS, p.122, para. B11.6.

¹³ DIS, p.86, para. B4.25

¹⁴ The widely used stratification of the supply chain by tiers is as follows:

Tier 0: Customer

Tier 1: Integration Contractor (Prime)

Tier 2: Equipment Supplier (Sub-contractor)

Tier 3: Component Supplier (including SMEs)

Tier 4: Technology Supplier (Research and Technology Organisation)

Tier 5: Research Supplier (University etc.)

tiveness and exportability of UK defence companies. By the same token, inward investment has helped ensure the vitality of the UK DIB, especially at the Tier 2 level and below. Nonetheless, the UK defence business has been tough, offering decreasing margins on product development and through-life support. However, this was compensated by regular government investment in product and capability development.

This balance is now threatened, though, not only by intermittence in the flow of new programmes, but also potentially by the terms of the new single availability based contract. There is a risk that much of the added value of the new service contracts will be concentrated at the prime level, as the prime contractor could seek to ‘squeeze’ cost out of the supply chain. This could mean that the appropriate incentives to reduce cost and to improve service through innovation will not flow down to key supplier companies. With the defence customer funding fewer programmes, the Tier 2 suppliers would have to fund independently more of the technology development required for new projects and support existing through-life contracts. If these companies were forced to compromise on development effort for reasons of affordability, this could lead to a ‘commoditization’ of the UK supply chain and a hollowing-out of the UK DIB. This neglect of development would threaten to diminish significantly the UK’s onshore mission systems and avionics capability. Over time, it would also reduce the sector’s ability to take on the risk implied by long-term contracting as well as the sector’s capacity to develop new technology in the UK. Supporting this technology base will be vital to ensure that UK industry can bid effectively for overseas business and participate influentially in international programmes.

A New Defence Business Model Needs Best Practice Supply Chain Management Effective TLMCM for defence programmes

demands the adoption of a new business model that maximizes opportunities for effective technology insertion as well as cost-effective support and sustainability. At one level this requirement will be eased by designing platforms with open architectures and by implementing from the outset a holistic approach to avionics support and upgrades. More fundamentally, at an operational level such effective management will depend upon the creation and sustainment of an effective approach to supply chain management, and the development of a robust supply chain management structure that runs from the prime contractor to Tier 2 and on to the small and medium enterprises (SMEs) further down the industrial hierarchy.

In other sectors, for example in the automotive industry, globalization and rationalization forces have changed the relationship between prime contractors and their key suppliers. When there are fewer, larger systems suppliers, a relationship based on competition is not sustainable. In the automotive sector, market dynamics have led to strong and lasting partnerships between the primes and their suppliers. There is flow down of risk and design, and shared investment. Production and maintenance synergies are designed into the programme and there is intense focus on the costs of ownership – particularly in the high-volume fleet car markets. Such relationships are still atypical in the UK defence market. Adopting the ‘partnering’ approach to defence contracting throughout the supply chain will generate benefits for prime contractor, supplier and customer alike. This effect will be even more valid in the case of TLMCM; where there is even more time to generate savings through co-operation and a cross-fertilization of best practice and systematic improvements in work practices.

Ideally, defence programme TLMCM should reflect best practice drawn from the civil sector, where genuine risk-sharing partnering arrangements between prime contractors and key suppliers are designed to

encourage greater responsibility for designing, integrating and managing complete sub-systems in return for greater rewards. In the defence sector similar arrangements should allow a more effective and efficient approach to satisfying platform availability contracts and, if organized correctly, fewer points of contact for the prime contractor and an increased capability for innovation and technology insertion. However, in order to meet these requirements, the supply chain needs both the flexibility and the capacity to deliver cost-effective solutions to the prime contractor and to the MoD customer.

Alliance Solutions in Avionics and Mission Systems

In general, developing and supporting complex electronics systems increasingly requires a wide range of competences and a 'critical mass' to support investment. In particular, OEMS need the competences to be intelligent customers of their supply chains.

It is unlikely that all the capabilities needed to support a complex platform are available under one corporate roof. Typically, collaboration may provide an alternative to offshore sourcing. Collaboration at this level could entail a design house construct, or an alliance (consortium, joint venture or looser arrangement) where tasks, roles, risks and rewards are shared between members. A well-structured, flexible coalition or alliance should have the critical mass and range of capabilities to assume high-level responsibilities for complete sub-systems support and upgrade. It should also have scope to allow other members to join as appropriate. Such alliances should not exclude overseas involvement, but the principle of appropriate sovereignty may block some competitors. This

model implies that there is a necessary balance between competition and long-term benefit.

An alliance able to increase its share of the value of through-life contracts might also be better placed to counter adverse rationalization pressures that might otherwise be inevitable amongst avionics companies, which would lead to an undesirable reduction in competition. Of course, collaboration and alliance activity might eventually lead to some consolidation in the avionics and electronics sector, allowing European companies – or transatlantic enterprises for that matter – to be more competitive in a global defence market. In the short term an alliance approach would provide a compromise between the need to increase the capability and 'critical mass' of avionics companies to support the commitment entailed by through-life management contracting, and the need to retain some degree of competition for future products and services.

The Total Support Services (TSS) Example

Thales UK, Smiths Aerospace and Selex Sensors and Airborne Systems have formed Total Support Services (TSS), an alliance designed to provide the UK with a platform equipment support capability in avionics.¹⁵ The TSS alliance offers a combination of complementary resources and competencies which should enable the delivery of a comprehensive systems approach to life-cycle management, as well as providing a springboard for future innovation and upgrade capability. While the members of the alliance are part of a global defence-aerospace industry, each has a well-established UK-based industrial footprint and a track record of

¹⁵ Smiths Aerospace is part of Smiths Group, a transatlantic aerospace and systems company with extensive experience of delivering integrated sub-systems solutions to customers such as Boeing Commercial. Thales UK has an interest in a broad range of avionics and defence electronics manufacturing and services, and has considerable experience of systems integration. Selex is a leading European sensor-solutions company delivering key sub-systems to the UK's Tornado and Typhoon aircraft programmes.

research and development (R&D) in support of MoD and other customer programmes. Equally significant in the new defence business environment is the fact that the alliance points to its early willingness to accept system-level availability contracts which guarantee levels of product and service availability at agreed prices.

Key Features of the Total Support Services (TSS) Alliance

- Pooling of avionics support infrastructure and onshore capabilities for through-life support and upgrade of critical electronic systems.
- TSS staff will be deployed forward allowing closer relationships between company and service personnel which will encourage mutual learning and training and instil a greater understanding of, and a more responsive approach to, the customer's upgrade and continuous improvement requirements. The outcome should be improved operating procedures to increase availability and reduce the need for equipment removals.
- Extensive experience of best practice supply chain management often derived from working in demanding civil markets such as civil aerospace. Such experience includes understanding of long-term partnering networks with incentives to drive down costs and to improve overall performance.
- Thorough understanding of 'lean' processes, with commitment to continuous improvement.
- Delivery of supply chain efficiencies through increased buying power and positive approaches to vendor relationships. Such supply chains could serve several platforms, delivering further savings to customers and manage the complete avionics supply chain including third parties.
- Improved access to off-shore suppliers in Europe and the US. This would reduce undue reliance on single sources and would provide an ability to tap a broader technology stream, as well as delivering the benefits of international competition.
- Pooling of technical competencies to enable the design of complete sub-systems, the management of technological obsolescence and full avionics support.

In developing an appropriate mix of capabilities to provide higher-level and higher-value solutions, this approach is designed to:

- Support the prime contractor in fulfilling its responsibilities for managing the overall programme by providing greater assurance of sufficient competence in an increasingly sophisticated and potentially costly part of an aircraft life-cycle. The TSS alliance argue that their approach will not add another layer in the relationship with prime contractors and customers, but would offer capabilities across several platforms as well as simplifying the supply chain by integrating the delivery of complete sub-systems.
- Give the MoD customer a more cost-effective approach to its support and upgrade requirements. By offering higher value solutions to potentially complex problems – especially where upgrades are involved – the Alliance argues that its experience and knowledge of complete sub-systems design and development can enable it to reduce the overall risk of cost escalation and delay.
- Allow significant through-life savings and increased system availability, whilst sustaining and enhancing operational availability and capability.

Evidence that this alliance could offer significant savings to its prime and MoD customers comes from experience with the Tornado programme and from company analyses of their activities in managing avionics systems support and upgrade programmes.

The Tornado Case

Adopting a 'systems approach' to Tornado avionics support and upgrading generated significant and attestable benefits and savings for Strike Command. The contractual arrangements transferred risk and responsibility for availability and cost to the supplier structure. They included a ten year availability service including line replaceable unit (LRU) availability guarantees, test equipment, technical support and obsolescence resolution.

The benefits included a 15 per cent reduction in repair volumes, a 36 per cent reduction in test equipment, spares and repairs costs, and a 90 per cent reduction in Strike Command manpower requirements in the relevant areas. There were also qualitative improvements in responding to main equipment obsolescence.

Strategically, the TSS alliance contends that it will offer a cost-effective approach to managing obsolescence, an approach which retains the capacity to anticipate critical points in a platform life-cycle. The alliance intends to respond to the problem as a 'domain-wide' issue instead of a single company taking responsibility only for its own equipment. As a centralized function the alliance would monitor both component obsolescence and performance decay. As decisions would be taken across the full avionics domain, the alliance argues that significant cost reductions will be generated to be shared between it, the platform prime contractors and their MoD customers. In particular, the alliance will take responsibility for system elements and components in the complete avionics supply chain in addition to those produced by the alliance members.

Maintaining Competition and Access

As discussed earlier partnering at the sub-systems level does not imply a diminution of competition. The avionics and missions systems sector is characterized by intense international competition. Indeed more innova-

tive and cheaper solutions could lie outside established partnerships and alliances. The principle of Appropriate Sovereignty will continue to demand some onshore location and commitment to technology transfer which might block some competitors. Nevertheless, in the interests of achieving the most cost-effective solutions, MoD will need to monitor and be engaged in the development of a competitive environment throughout the supply chain.

Over the long term, these factors further reinforce two further key principles. First, there is a need to develop open systems architectures which will ease the process of incorporating into systems the innovative technologies provided by partners at the various levels of the supply chain. Secondly, MoD needs to take active measures to prevent undue exploitation of vertical integration by either prime contractors or major sub-systems suppliers, especially if the latter are in an alliance, delivering integrated electronics solutions.¹⁶ This requirement will be particularly important in facilitating access by new suppliers with novel technologies, especially highly innovative small- and medium-sized companies.

¹⁶ *Defence Industrial Strategy (DIS)*, p.62, para. B1.27.

Commercial Benchmarking

A more sophisticated approach to supply chain management reflects wider commercial world best practice and the range of expertise required to deliver cost-effective goods and services are now so extensive that 'the viability of the vertically integrated corporation is called into question...and manifestly ill-equipped to respond flexibly and efficiently to an emerging corpus of highly demanding consumers'.¹⁷ In industries as diverse as Offshore Oil, Automotive and Construction alternative models tend to focus on some form of alliance or partnering which seek to provide 'a win-win situation for all parties that are less about a macho quick hit, ... and more about ensuring that the other transactional partners also have a chance to survive so that, through their survival, the first party is allowed the opportunity also to prosper'. Squeezing supplier profit margins simply to achieve a short-term reduction in input prices undermines innovation and precludes more substantial longer-term performance improvements.

Following the automotive experience, the civil aerospace industry has rapidly moved to adopt 'lean practices' and value-chain management concepts, many of which centre on partnering with suppliers collectively to achieve overall efficiency and cost improvements. This has included a vigorous and ruthless drive to reduce the number of direct suppliers to the 'prime', and has converted a number of traditional suppliers to commoditization, where their product or service is bought from an open, global market where quality is maintained by regulation and price is usually the sole differentiator. Conversely, in return for accepting higher levels of technical and financial risk, a number of companies or groups of companies become 'preferred suppliers' or even risk sharing partners, capable of delivering complete systems or sub-systems. At this level, companies have the incentive to invest in new technology and new processes designed to increase the overall effectiveness of the product design, development, production and support system. This does not close competition at the outset of a new programme or later derivative, nor does it entirely eradicate a ruthless downward pressure on price from the prime, but it presents a much more rational and strategic approach to supply chain management that gives key players opportunities to satisfy their own corporate needs. This in turn enables a healthier, more competitive supplier base

over the long term. Referring again to wider examples of best practice, 'With strategic suppliers, [the aim is to] build long-term relationships that aim to increase the competitiveness of both parties. Collaborative supplier relationships are mid- to long term, and focus on continuous improvement of joint processes'.¹⁸

Working with the Primes

There are signs that the message of partnering to deliver long-term savings is working its way down the supply chain. At the top level, AgustaWestland has a partnering and transformation agreement with MoD which has borne fruit in the Sea King Integrated Operational Support (SKIOS) contract in which comprehensive long-term support is delivered by an alliance led by AgustaWestland as the prime contractor. BAE SYSTEMS has re-configured its approach to support and maintenance to mirror new DLO processes. This represents a clear and admirable determination to develop a customer-focused business. But equally, as any prime contractor might, BAE SYSTEMS will be determined to maximize its share of the support budget though leveraging its platform design intellectual property rights (IPR) and rationalizing its supply chains.

On the other hand, BAE SYSTEMS acknowledges that some form of partnering with its supply chains could produce mutual benefit. More importantly, it has begun to consider whether alliances such as TSS might add value. In this respect, BAE SYSTEMS, TSS and the DLO are exploring a number of co-operative options. However, it is clear that the onus will be on TSS to demonstrate the superiority of the alliance approach and clearly to demonstrate benefits against other options.

Unsurprisingly, however, the perspective of suppliers deprived of a direct relation-

¹⁷ DTI 'How Supply Chain Management Works', www.dti.gov.uk/energy/eid/study.pdf. This report was commissioned by the DTI in the late 1990s.

¹⁸ *Ibid.*

ship with the MoD customer is that the potential for abuse by dominant prime contractors seems more evident than does the promise of value-added partnership.¹⁹ Such concern goes beyond the companies involved in the TSS alliance, to include especially those companies that have been involved in maintenance and support contracts with the MoD. The DIS frequently refers to the problem, for example stating that 'to ensure all avenues of innovation are available, vertical integration could sometimes be counter-productive';²⁰ and the incentive to reduce costs and to innovate 'will not be achieved if the platform system provider or prime contractor exercises inappropriate dominant power'.²¹ However, this concern underlines the requirement for the MoD customer to take a more active and continuous role in monitoring supply chain relationships and to take action to head off closure and abuse of any dominant position.

Responsibility for Supply Chain Management: An Active Role for the MoD

Delegating managerial responsibilities for TPCM-based procurement has obvious advantages for the MoD, among which are savings in in-house human resources. However, this transfer of functions does not imply a totally hands-off approach. Through the new organization provisionally named the 'integrated procurement and support

organisation (IPSO)²² that is to be formed as a merger of the DPA and DLO, the MoD must (as in the US) be prepared continually to monitor the strategic operation of large, long-term contracts to ensure they are delivering cost-effective solutions in the widest sense. This purview includes ensuring that the relationship between the designated prime contractor and its supply chain is capable of meeting the challenge of obsolescence and that all suppliers are positioned and incentivized to provide innovative solutions to complex technological challenges. MoD interventions should include monitoring and adjusting the programme to maintain openness and appropriate points for competition. In particular, there may be a need for oversight of some decisions between making or buying-in system elements and components.

The senior leadership of the MoD is aware of this need. In an address to the Royal United Services Institute²³ after the publication of the EAC Report, Lord Drayson, Minister for Defence Procurement, mentioned that MoD was aware that there would be a natural tendency for prime contractors to integrate their supply chains vertically. He remarked that MoD would expect primes to be transparent about their supply chain arrangements and that it would ensure in drawing up contracts, particularly for long-term partnering arrangements for the provision of support that the supply chain issues that are central to this study would be addressed.

¹⁹ This view was expressed widely at the Royal United Services Institute's 'Defence Acquisition Symposium: the Defence Industrial Strategy and Government-Industry Relationships'. London: RUSI. 29–30 March 2006.

²⁰ *DIS*, p.62, para. B1.27.

²¹ *DIS*, p.62, para. B1.26.

²² Adoption of this recommendation contained in EAC was announced by Ministers on 3 July 2006. The new organization is sometimes referred to as the Defence Material Organization.

²³ The address was given on 5 July 2006. These remarks were in response to a question by Air Chief Marshal Sir Brian Burridge.

Official US Studies

Nearly a decade ago, following the rapid consolidation of the US defence industrial base, the influential Department of Defense (DoD) Defense Science Board reported on the dangers of vertical integration.²⁴ In order to mitigate these risks, the report called for vigorous application of anti-trust legislation and a good visibility of the supply chain. This was especially important as the DoD moved to procure systems of systems and adopt life-cycle contracting with the prospect of losing direct interaction between customer and lower tier suppliers. So far, these dangers do not yet appear to have materialized. More recent surveys from the DoD's Industry Policy unit show the development of a healthy range of alternative suppliers across the spectrum of key technologies.²⁵ But it is evident that continued vigilance remains central to procurement liberty in the US. Such vigilance includes programme managers being encouraged to retain both some sight of the sub-contractor selection process and an ability to influence the selection itself. In fact, a programme manager may require that certain sub-contracts be awarded only after explicit DoD approval if there is felt to be a potential for bias in sub-contractor selection and if the 'potential bias cannot be adequately mitigated'.²⁶

A recent (October 2005) US Government Accountability Office forum on the defence supply chain identified managing multiple tiers of the supplier base as a major challenge. Participants noted that 'the current lack of visibility into the supply chain complicates efforts to maintain a strong supplier base'. Most of the innovation, it was asserted, took place amongst the lower tier suppliers, but the 'focus of defence acquisition policy is on a handful of prime contractors. Competition should still be encouraged and primes especially should seek to diversify their suppliers. But defence business, especially in logistics, should be actively managed by the DoD to ensure future competition and competence in the supply chain. It was also noted that, above all, the DoD's acquisition staff had to be equipped to 'manage in a new acquisition environment'. This would require a substantial change in atti-

tude away from a culture based on a succession of major platforms to one with a wider understanding of 'business' with a well-grounded approach to risk management able to cope with the 'increasing sophistication of the services that the government procures'.²⁷

Reflecting on both US experience and the warnings thrown out by the DIS, it follows that the MoD needs specialist in-house expertise at the strategic level to monitor the development of supply chains and to provide guidance and advice to specific programmes and projects. A supplier's record of performance and use of best practice in delivering capability and services to cost and time are important factors in the selection process following an invitation to tender. It is the contention of this paper, however, that the appropriateness of the supply chain to be able to provide upgrades and through-life support should also be a principal factor in the choice. With the relevance of supply chain considerations for particular projects found mostly in the medium term – in terms of promoting innovation at sub-system levels in the incremental development and upgrade processes – the problem is that supply chain considerations will not necessarily be of short-term significance and therefore not the first concern of IPSO Integrated Project Team Leaders (IPTLs).

For MoD as a whole, the strategic issue of the relationship between particular supply chains and the evolution of the UK DIB is a challenge for the medium to long term. And while government and departmental aspirations may extend into the more distant future, political and budgetary considerations in practice enforce a short-term focus.²⁸

²⁴ Defense Science Board, Department of Defense (DoD), United States (US). *Defense Science Board Task Force on Vertical Integration and Supplier Decisions*. Report dated May 1997.

²⁵ Office of the Secretary of Defense (Industrial Policy), DoD, US. *Annual Industrial Capability Report to Congress*, February 2005.

²⁶ *Annual Industrial Capability Report to Congress, ibid.*

²⁷ General Accountability Office, *Supplier Base Forum*, GAO-06-533SP, March 2006, pp.17–18.

²⁸ Indeed, longer-term partnering arrangements can be seen in part as a device to compensate for the short-term pressures to which MoD is subject.

Yet if sub- and partial system suppliers are not afforded the appropriate incentives in the short term through the supply chain structure, their capacity to provide critical innovation will dwindle in the longer term and may cease to be available onshore. Responsibility for concerns such as these does not sit at the level of IPTLs, nor even arguably at the highest levels of the IPSO. It sits with the Defence Management Board (DMB) and the Defence Council. At the highest level, this matter is also an inter-Departmental concern involving the Department of Trade and Industry (DTI) and Treasury as well.

These strategic functions could be embedded in IPSO. However, the 'sponsors',²⁹ the Equipment Capability Department, and the 'users',³⁰ the Front Line Commands – all share an interest in the issue, as does the Defence Scientific and Technical Staff. There is a case for an organ to be located in the Central Staff with responsibility directly to the Investment Approvals Board (IAB).

There is a concern expressed informally by MoD officials, as well as suppliers, that MoD does not have this strategic capability because of a lack of both expertise and human resources. It bears mention that the DLO is understood to be making reductions in staff of some 10,000. While the savings are to be achieved through outsourcing and efficiencies, the capacity to monitor and manage the supply chains which are the receivers of this outsourcing and the requirement to ensure efficiencies and sustainment of the necessary industrial capacity in the long term actually place a greatly increased set of very specific demands on MoD. It will need to develop adequate in-house expertise at the

strategic level for these purposes. A suitable organ will need to have sufficient authority to direct and advise in favour of long-term considerations at the expense sometimes of procurement choices based on short-term factors.

The Defence Commercial Director

Encouragingly, on 26 June 2006 MoD announced the appointment of a Central Staff Defence Commercial Director (DCD) to 'lead the Department's relationship with industry' and 'have a key role in the agreement of strategic commercial arrangements'. EAC recommends that the DCD should be 'owner of the Procurement Process' and should be a full member of the IAB.³¹ This post could provide the leadership and focus for just such a strategic capability for supply chain oversight provided the occupant is provided with the resources and has sufficiently effective terms of reference. EAC indeed recommends that a strong commercial team should be built around the DCD. It is understood that the support for the DCD is a matter of active study at the time of this report.³² EAC does not, however, specifically mention the matter of oversight of supply chains in its discussion of the role of the DCD.

Engaging with Supply Chains

However, restructuring and the development of specific expertise will not in themselves be sufficient to address the problems of engagement in the supply chain. In the appropriate areas, MoD is aware that there is a need for a sophisticated corporate understanding of these supply chain concerns. There is inten-

²⁹ Since the introduction of Smart Acquisition known as Customer 1 but a recommendation of the report EAC is that the term 'sponsor' should be used and the word 'customer' should apply to MoD as a whole.

³⁰ Since the introduction of Smart Acquisition known as Customer 2 but a recommendation of EAC is that the term 'user' should be used (see previous note).

³¹ Whereas it recommends that the head of the IPSO should merely be 'in attendance'.

³² EAC paragraph 10.19.

sive work following DIS to develop this understanding. Some specific issues are:

- The required breadth and depth of this understanding, bearing in mind that part of the function of primes in a partnering arrangement is to provide supply chain expertise, and MoD will not wish to undermine intended role transfer;
- Complexity of and variations among the supply chains between and indeed within the DIS industrial sectors.³³
- The right balance between critiquing and encouraging primes in developing their supply chains and in intervention in the supply chains below Tier 1.
- Stimulating information transparency in partnering and alliancing arrangements across and within Tiers.
- The nature of any interventions in supply chains below Tier 1.
- The nature, availability and extent of any discretionary financial investment by MoD in Tier 2 and below to develop underpinning technologies and encourage innovation.
- Suitable contracting structures that will encourage partnering behaviours.
- The relevance of non-defence sector models and benchmarking, for example in commercial aerospace, fuel and automotive industries.
- Actual extent of MoD ownership of the overall system of systems which will vary between sectors and military capabilities.
- The balance between the efficiencies of supplier consolidation and diversity which will preserve competition where appropriate and realistic and stimulate innovation.
- The need for measurement and output targets for IPTs that properly reflect the demands of TLMCM.

- The immaturity of MoD's through-life costing and management processes.

Conclusion

In conclusion, on the industry side it is encouraging that key primes, in particular BAE SYSTEMS and AgustaWestland, are addressing the issue of partnering seriously. Equally encouraging is the response of Tier 2 avionics and mission systems suppliers to the challenge of the new emphasis on support. The TSS model is now being recognized as a potentially effective and coherent response to the challenge set by DIS for more innovative solutions. This model offers to address the immediate need to support the primes in providing availability based support whilst preserving and developing critical capabilities for the future.

On the customer side, the UK Government needs to establish more precisely than is currently specified by the DIS which industrial capabilities need to be retained and developed 'onshore' – that is, by the UK defence industry. Otherwise, industry will make independent decisions and indigenous capability fundamental to the maintenance of national security is at risk of disappearing. The DIS acknowledges the strong case for ensuring that this onshore capacity includes a large element of the current avionics and mission systems capability. However, securing appropriate sovereignty through supply chain management will require active intervention on the part of the MoD. The MoD is aware that it cannot depend entirely upon the operation of the market nor on the good will of prime contractors.

There is clearly the will at present in the MoD to understand and address the complex issues of supply chain management and a broad view that there will be a need to influence the shaping of structures below Tier 1

³³ DIS divides these capabilities among the following industrial sectors and cross-cutting capabilities: System Engineering; Maritime; Armoured Fighting Vehicles; Fixed Wing; Helicopters; General Munitions; Complex Weapons; C4ISTAR; Chemical, Biological, Radiological, and Nuclear Force Protection; and Counter-terrorism.

in the aviation sectors among others. It is also accepted that avionics and mission systems are high value and defining elements of aerospace capability. The DIS has provided a strong catalyst for a new defence business environment with powerful aspirations to develop and sustain the UK DIB. However, the proof of its effectiveness will be in the outcome of the intensive package of further work which can only be measured in the medium and long term. There are three broad measures of success against DIS intentions in the aviation sectors:

- Substantial economies in TLCM costs achieved through appropriate consolidation of capability and elegant support solutions.
- Cost-effective incremental acquisition processes and upgrades to achieve and maintain required levels of air power superiority and manage obsolescence.
- Sustained national capacity and autonomy to develop, operate and upgrade systems and sub-systems in definitive areas in which the UK wishes to preserve and develop aerospace capability.

The decisions of Ministers to appoint a Head Office DCD and to accept the recommendation of EAC to create a single integrated procurement and support organization out of DPA and DLO bode well for strong direction and coherent action. However, the unfortunate pattern of previous defence acquisition reforms has been the calcification of a set of well-intentioned and appropriate initiatives, and therefore an inability to adapt to evidence of shortcomings and a changing strategic and business environment. The result has been periodic major upheavals of the acquisition process, the timing of which has often been driven by political and budgetary factors. The danger for the future is that babies may be lost with the bathwater in the intervening years between reforms, and among these could be a robust and innovative onshore avionics and mission systems capability for through-life support as well as development and manufacture. The Ministry of Defence knows that it will need to be fully engaged in the processes that it has initiated. But it will also need to be adaptive, and this must become part of the culture across the organizational divisions.