In-Service Support: Best Practices of Selected Countries

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Abstract

In-Service Support (ISS) provides operational value to defence management in terms of the availability and reliability of equipment during missions and training and it extends the overall life of the equipment. This paper takes a two-pronged approach to analyzing ISS activities: firstly, key theoretical aspects are considered, with in-depth analysis on long-term and relational contracts in ISS provision, considerations pertaining to in-house contracting versus private sector subcontracting, and issues in long-term contracts. Secondly, the approaches to ISS management employed by three countries - Australia, France and The United Kingdom - are examined, along with a detailed analysis of the European multinational armament organization OCCAR. This analysis finds, among other things, a preference towards the inclusion of off-ramps in support contracts, as well as an emphasis of including the private sector in support activities whenever feasible.

Résumé

Le soutien en service contribue de façon importante à la gestion de la défense sur le plan opérationnel en assurant la disponibilité et la fiabilité de l'équipement pendant les missions et les entraînements, en plus de prolonger sa durée de vie. Dans le présent article, nous analysons les activités de soutien en service en nous appuyant sur une approche à deux volets : d'abord, nous examinons les principaux aspects théoriques de la question en effectuant une analyse approfondie des contrats à long terme de soutien en service, en

comparant la passation de marchés à l'interne à la sous-traitance avec le secteur privé, et en nous penchant sur les problèmes inhérents aux contrats à long terme. En second lieu, nous examinons les méthodes de gestion du soutien en service employées dans trois pays, soit l'Australie, la France et le RoyaumeUni, et nous analysons en détail la façon de faire de l'Organisme conjoint de coopération en matière d'armement (OCCAR). Au terme de cette analyse, nous avons conclu, entre autres, qu'il était préférable d'inclure des voies de sortie dans les contrats de soutien en service ainsi que d'encourager la mobilisation du secteur privé pour les activités de soutien, si possible.

Executive summary

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In-Service Support (ISS) is crucial to the availability and reliability of defence equipment as well as the minimization of overall ownership cost. ISS contracts are normally signed for long periods corresponding to the service-life expectancy of equipment. ISS contracts between a defence organization and an ISS contractor are generally governed by performance-based criteria with provisions for on-ramps and off-ramps. Since long-term contracts are typically incomplete, i.e. there are always issues that cannot be resolved by courts, they are complemented by relational contracts where partnership continuation depends upon informal incentives rather than court enforcement of contract provisions. Especially for developmental and less than strictly off-the-shelf defence projects, inevitable complexity leads to contract incompleteness.

Outsourcing ISS contracts has, in the post-Cold War period, become the norm rather than exception. Where in-house ISS remains relevant is in deployed operations. If outsourced, ISS can be performed by the original equipment manufacturers (OEMs) or domestic contractors that can well be subsidiaries of OEMs in which case technical data (TD) and intellectual property (IP) contractual issues may not arise, a first advantage of bundling with OEMs. The second advantage is typically the lower cost from bundling, scale economies

and the global supply chain affiliation of subsidiaries. If OEMs have no subsidiaries, domestic firms can still be sub-contracted by OEMs due to their efficiency or under offset obligations.[1] Whereas the potential of integrating into the global supply chain is an advantage, there may be a high cost premium to defence if the domestic firm is only sub-contracted under offset obligations. Loss of in-house capabilities and the resulting lock-in constitute another drawback to outsourcing if the field is not sufficiently competitive.

On-ramps enable potential competitors to prepare bids with sufficient lead time, impose market discipline on the incumbent and regulate the field of competitors by defining or refining the service. They also provide a vehicle by which alternative contractors, who would not otherwise have been interested, might enter the bidding at on-ramps. Since investment in specific assets is inevitable, lengthier contracts will thicken the field of potential bidders.

Off-ramps must accompany on-ramps. Whereas on-ramps aim at thickening the field, credible off-ramps provide effort incentives to incumbents. They will also reduce the risk associated with random shocks to contractor performance so that an off-ramp doesn't unduly disqualify the incumbent. Moreover, since the value of the relationship is private information to parties, each would have an incentive to overstate their outside options in order to capture more of the value generated. If and when one of the parties grows frustrated with the division of this value, the off-ramping can be initiated by either party.

Whereas on-ramps and off-ramps provide cut-off benchmarks for performance, the length of the contract and its renewability are substantial rewards for good performance. First, a longer contract alleviates the asset specificity and moral hazard problems. Second, less

[1]The term "offset obligations" or "offset policies" refer to forced counter-trade in defence equipment procurement projects between sovereign nations.

direct monitoring of contractor effort would be required as the purchaser could draw inferences from repeated observations of outcomes. Third, it means less overall contract costs due to the infrequency of contractor switches. Finally, if good performance can be rewarded with contract extensions, the effort incentive problem can be alleviated.

Finally, there exists an inherent tension between incentive provision and contractual enforcement. As a contractor's quality is revealed over its tenure, lower quality contractors can be off-ramped and, as an effort incentive, compensation may be back-loaded. However, it will be constrained by potential on-ramping of lower cost contractors.

Australia's Force 2030 policy outlines its approach to ISS. Their perceived vulnerability in terms of geographic location is a driving force behind its ISS policy. They thus deem it necessary to perform nearly all ISS functions on their own soil. Years of underinvestment and good outside labour options have left Australia in a position where they must pay a high premium to achieve this domestic requirement.

Australia has begun using more performance based contracts, focusing on key performance indicators to measure the success of their contractors. To maintain a measure of control over the contracts, the Australian government insists on maintaining the unilateral ability to off-ramp any firm for any reason. The government argues this ensures that the firms are kept honest, while firms argue that this threat prevents them from properly investing in the necessary equipment.

France's approach to ISS is laid out in their 2008 White Paper. Since they wish to maintain a domestic presence in all sectors, they adopt a free market approach only when they feel that the domestic market is strong enough to not rely on government contracts, as seen with

a number of support contracts to DCNS, a French naval defence company. France is also engaged in further European integration. As such, they give preferential treatment to firms in other EU nations, and are actively involved with OCCAR, the European Organization for Joint Armament Cooperation.

The UK's ISS strategy is developed in their 2005 Defence Industrial Strategy White Paper. Recent evidence shows that the UK is interested in privatizing as much of the ISS process as possible, although they have identified certain key industries which they will actively support with ISS contracts. The key for the UK is the acquisition of IP for its domestic industries. It has always relied on military spending to stimulate domestic research, and is focused on acquiring IP from foreign ISS suppliers. The UK has been very clever with its use of performance based contracts, as seen with its revolutionary approach to acquiring tanker aircraft by leasing them from a private civilian airline.

OCCAR manages a handful of armament programs for its member nations, a list that includes Belgium, France, Germany, Italy, Spain and the United Kingdom as formal members. The organization's primary role consists mainly of offering management services to the participating states for each defence system under its umbrella. OCCAR recognizes ISS to be the longest and most costly phase in a defence system's life cycle when compared to development, procurement, service and obsolescence. Its ISS management philosophy is therefore based on ensuring management processes, oversight, and adopting performance measures so that trouble areas can be evaluated and corrected.

ISS management activities are largely performed by OCCAR staff in conjunction with the participating nations, while direct work on the systems, such as maintenance, spares, ware-

housing, refits and so on, are contracted out to industry entities. Support contracts tend to be awarded to the original equipment manufacturers, though a policy of a commercial-based approach is adopted as a means to provide a greater level of efficiency and competitiveness in support and maintenance operations.

The OCCAR analysis also includes an in-depth case study regarding the A400M Airbus Tactical and Strategic Airlift. This section focuses on how the organization seeks to implement the policy approaches it has identified to lower overall life-cycle costs, in particular those associated with the in-service phase for a given system. Key measures in this regard include optimizing maintenance practices across all participating nations, awarding support contracts to efficient industry entities through a process of open competition, and capitalizing on economies of scale gained through international cooperation.

Sommaire

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Le soutien en service est essentiel pour assurer la disponibilité et la fiabilité de l'équipement de défense, et pour minimiser les coûts généraux de propriété. Les contrats de soutien en service sont habituellement des marchés à long terme dont la durée correspond à la durée de vie attendue de l'équipement. Les marchés conclus entre une organisation de défense et un fournisseur de soutien en service sont généralement régis par des critères de rendement et comportent des voies d'entrée et de sortie. Comme les contrats à longue échéance ont tendance à ne pas être exécutés dans leur intégralité (par exemple, il existe toujours des différends impossibles à résoudre devant les tribunaux), on préfère accorder des contrats dits « relationnels », c'est-à-dire qui favorisent la continuité du partenariat en offrant des incitatifs informels plutôt que de recourir aux tribunaux pour en faire respecter les clauses. Les contrats complexes, en particulier ceux des projets de développement et d'acquisition d'équipement non nécessairement standard, sont souvent inachevés.

Au cours des années suivant la guerre froide, la sous-traitance de contrats de soutien en service est devenue la norme plutôt que l'exception. Dans les opérations de déploiement, par contre, on préfère encore confier le soutien en service à l'interne. Si l'on opte pour la sous-traitance, on peut conclure un marché avec le fabricant d'équipement d'origine

(FEO) ou avec un entrepreneur national qui peut aussi être une filiale du FEO. Dans un tel cas, il est peu probable que des problèmes de données techniques (DT) ou de propriété intellectuelle (PI) surviennent, ce qui constitue le premier avantage d'un regroupement de services sous un FEO. Le deuxième avantage est que les coûts sont habituellement moins élevés en raison du regroupement lui-même et du fait que l'on bénéficie d'une économie d'échelle et que la chaîne d'approvisionnement est composée d'organisations affiliées. Si le FEO ne possède aucune filiale, il peut conclure un accord de sous-traitance avec une autre société nationale réputée pour son efficience ou en lui imposant des obligations de compensation.[2] Bien que la possibilité d'intégrer une société nationale à la chaîne d'approvisionnement constitue un avantage, cela peut engendrer une prime à coût élevé pour la Défense si le marché de sous-traitance ne comporte que des obligations de compensation. Par ailleurs, si le marché n'est pas suffisamment compétitif, l'un des inconvénients de la sous-traitance est la perte de capacités internes et la diminution des possibilités qui en découle.

Les voies d'entrée donnent un délai suffisant aux candidats pour préparer leurs soumissions, imposent la discipline financière à l'entrepreneur titulaire et balisent la compétition en définissant ou affinant la demande de services. Elles offrent aussi à d'autres entrepreneurs, qui n'auraient autrement pas montré d'intérêt, la possibilité de faire leur entrée à différentes étapes d'un projet. Comme les contrats de longue durée mènent inévitablement à l'achat de biens spécifiques, cela fait augmenter le nombre de soumissionnaires potentiels.

[2]Le terme « obligations de compensation » ou encore « politiques de compensation » désigne les échanges de contrepartie que s'imposent entre elles des nations souveraines dans le cadre de projets d'achat d'équipement de défense.

Toute voie d'entrée doit être accompagnée d'une voie de sortie. Tandis que la première vise à élargir l'éventail de candidats, la dernière comporte normalement des incitatifs au rendement. Elles réduisent également le risque associé aux chocs aléatoires sur le rendement de l'entrepreneur de manière à ne pas le disqualifier injustement. D'autre part, comme la valeur de l'entente est une information confidentielle pour les parties concernées, chacune d'elles peut exagérer ses autres options afin d'obtenir une plus grande part de la valeur. Si l'une ou l'autre des parties est insatisfaite du partage de la valeur, elle peut enclencher le mécanisme de sortie.

Si les voies d'entrée et de sortie constituent des étapes charnières en ce qui concerne le rendement, un contrat de longue durée et renouvelable est en soit un bon incitatif au rendement. Premièrement, un contrat à long terme atténue les problèmes liés à la spécificité des biens et minimise les risques moraux. Deuxièmement, cela réduit la nécessité de surveillance directe des travaux de l'entrepreneur, car l'acheteur peut faire des déductions à partir des résultats observés par le passé. Troisièmement, la rareté des changements d'entrepreneur réduit le coût global du contrat. Enfin, en récompensant l'entrepreneur en lui accordant une prolongation de contrat, on l'incite à continuer d'offrir un bon rendement.

Il existe une tension inhérente entre l'offre d'incitatifs et l'application des clauses contractuelles. Comme on ne peut pas savoir immédiatement quelle sera la qualité des travaux, le mécanisme de sortie permet d'écarter un entrepreneur offrant un faible rendement. On peut aussi payer l'entrepreneur une fois les travaux terminés de manière à l'inciter à offrir un bon rendement. Cependant, cette solution est limitée par les voies d'entrée qui permettent de remplacer un entrepreneur par un autre demandant moins cher.

La politique de l'Australie en matière de soutien en service est décrite dans le document Force 2030. La vulnérabilité apparente de ce pays liée à son emplacement géographique est l'un des principaux éléments qui motivent cette politique. Ainsi, l'Australie considère qu'il lui est nécessaire de faire exécuter la presque totalité du soutien en service sur son territoire. Par conséquent, après des années à négliger de bonnes options offertes à l'extérieur de son territoire, l'Australie se trouve maintenant dans une situation où elle doit débourser des sommes élevées dans le soutien en service.

L'Australie a commencé à accorder des contrats axés sur le rendement. Afin de garder un certain contrôle sur les contrats, le gouvernement australien se réserve le pouvoir d'écarter tout entrepreneur pour quelque raison que ce soit. Elle explique que cela lui assure une plus grande honnêteté de la part des entreprises, tandis que ces dernières avancent que cette mesure les rend hésitantes à investir dans l'équipement nécessaire.

La France explique son approche en matière de soutien en service dans son livre blanc de 2008. Comme elle souhaite maintenir une présence dans tous les secteurs, la France opte pour une approche axée sur le libre marché seulement lorsqu'elle croit que le marché intérieur est assez fort pour ne pas avoir recours aux marchés publics, comme ce fut le cas pour les différents contrats conclus avec DCNS, une entreprise française de défense navale. La France promeut aussi l'intégration européenne. À ce titre, elle accorde la préférence aux entreprises des autres pays de l'Union européenne et joue un rôle actif au sein de l'Organisme conjoint de coopération en matière d'armement (OCCAR).

Le Royaume-Uni établit son approche en matière de soutien en service dans le livre blanc sur la stratégie industrielle de la Défense, publié en 2005. Selon des preuves récentes,

le Royaume-Uni viserait à privatiser le plus possible le soutien en service, bien qu'il ait identifié certaines industries auxquelles il s'engage à soutenir activement en octroyant des contrats de soutien en service. L'important pour ce pays est d'acquérir les droits de PI pour ses industries. Le Royaume-Uni a toujours compté sur ses dépenses militaires pour stimuler la recherche au sein du pays et entend donc acquérir des droits de PI de fournisseurs de soutien en service étrangers. Le Royaume-Uni fait une utilisation très intelligente des contrats axés sur le rendement, comme en témoigne son approche révolutionnaire consistant à louer des avions ravitailleurs d'une entreprise civile privée de transport aérien.

L'OCCAR administre divers programmes d'armement pour le compte des pays qui en sont membres, dont la Belgique, la France, l'Allemagne, l'Italie, l'Espagne et le Royaume-Uni. Son rôle principal consiste d'abord et avant tout à offrir des services de gestion aux états participants pour chaque système de défense qu'il couvre. L'OCCAR sait que le soutien en service est la phase la plus longue et la plus coûteuse du cycle de vie d'un système de défense. Par conséquent, il veille au bon fonctionnement et à la surveillance des processus de gestion, et adopte des mesures de rendement permettant d'évaluer et de redresser les aspects problématiques.

Les activités de gestion du soutien en service sont en grande partie menées conjointement par le personnel de l'OCCAR et les pays participants, tandis que les travaux ayant un lien direct avec les systèmes (maintenance, pièces de rechange, entreposage, carénage, etc.) sont confiés à des entreprises. Les contrats de soutien sont généralement octroyés aux fabricants d'équipement d'origine et une approche commerciale est employée pour assurer un haut niveau d'efficience et de compétitivité dans les activités de soutien et de

maintenance.

Dans notre analyse de l'OCCAR, nous faisons une étude de cas approfondie concernant l'avion de transport tactique et stratégique A400M Airbus. Nous nous penchons sur la façon dont cette organisation met en œuvre ses stratégies pour réduire le coût global du cycle de vie, en particulier sur celles qui concernent la phase de soutien en service d'un système donné. Les principaux facteurs à cet égard sont l'optimisation des méthodes de maintenance chez les différents pays participants, l'octroi des contrats de soutien à des entreprises compétentes dans le cadre d'un processus concurrentiel ouvert, et les avantages que l'on peut tirer des économies d'échelle découlant d'une coopération internationale.

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1 Introduction

In this paper we analyze ISS practices from a theoretical perspective. We examine the practices of 3 countries, as well as the multinational European armament organization OCCAR,[3] as a means to further understand the real-world approaches to ISS support that have been employed. By doing this we hope it is possible to provide guidance on how Canada can evaluate and possibly modify its own ISS practices.

1.1 Document Structure

This paper begins with a detailed and in-depth look into the theoretical aspects of ISS management, with a keen emphasis on those aspects of contracting that are essential to the present research. Following this introduction of contract theory, the three country analyses are presented, in turn, on Australia, France, and The United Kingdom. A subsequent section then describes the ISS management practices of OCCAR and presents a case study of the A400M Strategic Airlift. Finally, a conclusion to the analysis is offered.

[3] OCCAR is an acronym standing for 'European Organization for Joint Armament Cooperation'.

2 Long-term and Relational Contracts in ISS Provision

In-Service Support (ISS)[4] provides operational value to defence in terms of availability and reliability of the equipment upon missions and training, and of an extension of its useful life. Moreover, beyond sustaining a given defence platform, a larger meaning of ISS includes various refits corresponding to technological advances over the long service life of equipment. From the perspective of firms, the best definition can be found on the Boeing website:

> Boeing Global Services & Support Integrated Logistics division comprises a full array of coordinated logistics services that address the lifecycle of aircraft and weapon systems. This approach offers a single point of accountability at all points during the service life of a product. As a result, mission effectiveness and readiness are improved while the total cost of ownership is reduced.[5]

It is usually hoped by both firms and government that ISS contracts will be signed for periods synchronizing with the service-life expectancy of military equipment. These periods vary in terms of decades but adapt to demands for their mid-life refits. The relationship between defence a procurement agency and an ISS contractor is often governed by a long-term performance-based contract with provisions for on- and off-ramps. However, since long-term contracts are typically incomplete and complemented by relational contracts, an

[4] Alternatively used terms are sustainment and life-cycle support, among others.
[5] Boeing Official Website (2012).

analytical examination of ISS invokes various insights from transaction cost economics as well as the very recent studies of relational contracts. The critical role that relational contracts play consists of sustaining a hybrid mode of organization over the long term with the hierarchical military and the market-based contractor sustaining the military's equipment. Thus the relationship is more of a partnership than what can be considered a classical relationship.[6] In fact, this partnership evolves and may be learned.

This analytical part of the report is organized around practical questions related to ISS and insights from economic analysis will be used to clarify issues. In nearly all NATO countries, the post-Cold War period witnessed a significant switch from in-house to outsourced ISS although the trend had started in the 1980s. This transition has at times been criticized for economic, military and political reasons.[7] There are two groups of relevant questions in outsourcing ISS. The first relates to issues raised by transaction cost analysis and the second relates to the nature of long-term contracts governing ISS.

2.1 Issues Arising from Static Considerations

2.1.1 ISS In-House, or Contracted Out?

The relevance of transaction cost analysis is in assessing candidate defence services for outsourcing. Defence services could be "contracted-out to the private sector so long as

[6]Of course, beyond the necessity of a hybrid organization, developing trust is crucial in sustaining cooperation in terms of productive effort expended by the contractor and the credibility of back-loaded compensations promised by the principal; see Chassang (2010), and Gibbons and Henderson (2012). Smythe (2004) clarifies the distinction between relational and non-relational contracts, a question with operational urgency in law posed by Hviid (2000).

[7]See Geary et al. (2010) for economic and military reasons, and Minow (2005) for political reasons, especially for concerns over accountability and democratic control.

they offered cost savings without damaging operational capability."[8] The question does cut deeper because, if cost is a concern and the whole defence organization can be optimized by adjusting the mix of in-house and outsourced activities,[9] even the combat functions can become candidates, as they did in Iraq and Afghanistan, for outsourcing. Remaining within the scope of the current work, this report will focus solely on ISS without discussing to what extent the core competency, i.e. the combat function, can be considered for outsourcing. The interface of combat functions with supporting services and the required delineation for outsourcing, though simple in principle, present serious challenges when operational capability is imposed as a constraint although it is plain that some tradeoff is inevitable and widely accepted by defence policy-makers. Thus, as major inputs into the production of defence output, platforms or equipment have to be available, and reliably so, for combat operations, including surges or pulses.

Meanwhile, in-house work is typically based on an incomplete contract[10] with residual rights to government so production can be easily ramped up. Alternatively, ISS contracts can be written to integrate potential surges or pulses by inducing the contractor to invest in contractor excess capacity rather than preserving in-house capacity as insurance.[11] Therefore, this excess capacity would vary inversely with tolerance of interruption relative to operational effectiveness, although different services may differ in this regard.

[8] Hartley (2004) also discusses the outsourcing of combat functions.

[9] A recent review of transaction cost economics has been carried out by Gibbons (2010). What is interesting about this review by Gibbons is that he is a major contributor to the long-term and relational contracts studies.

[10] Aghion et al. (2013) view trust in this context as complementing incomplete contracts. In fact, one of the arguments against outsourcing is probity, which invokes trust within the defence organization supporting operational capability.

[11] In-house capacity could also serve as a check against hold-up.

An innovative outsourcing relationship in the UK clarifies this distinction between availability for combat and non-combat situations. The future strategic tanker aircraft outsourcing,

> "will involve the provision of such services over a 27-year period at an estimated cost of some £13 billion. This will replace the traditional solution whereby the Royal Air Force (RAF) owns, operates and services its fleet of tanker aircraft. The contractor will be required to provide capability during peacetime, transition to war and conflict. The partnering element in the contract allows the contractor to hire any spare capacity to third parties (e.g. for commercial air freight)."[12]

In this context, the major transaction cost issue is a combination of asset specificity and probity hazard. The extent to which the contractor can internalize and implement the sovereign transactions and provide the service is a probity issue. Seemingly iron-clad contractual obligations, though they might induce the contractor to supply the service impeccably in combat situations, might be perceived as flexible in non-combat situations when lesser levels of availability might benefit the contractor more than it inflicts operational costs on defence. After all, the alternative for-profit use of the service might well be the reason why the contractor invests in such specific assets in the first place. This is the intersection of transaction cost economics and of relational contracts in that the continuation of this long-term relationship may well depend on the continuation benefits for parties to the contract.[13] Thus, if one draws a strict distinction between combat and non-

[12] Hartley (2004).

[13] See Section A for a simple but rigorous treatment of this key criterion for a continuing relationship in the absence of contract verifiability.

combat situations, probity becomes less of a concern in the latter and, consequently, less of a cost to be reckoned with as the service availability in non-combat situations is less time-critical.

This discussion suggests that ISS is a strong candidate for outsourcing if, indeed, contractor reputation supports the expectation that reliability and availability are not undermined whenever defence activity peaks towards strategic manoeuvres and combat. In fact, as the case studies in this research show, ISS outsourcing has become a mainstream arrangement in the post-Cold War period. This transition can be viewed simply as a shifting of the integrator role from the defence sector to the private sector with a continued movement away from in-house sustainment.

This shift results from a new environment favouring outsourced ISS. First, in the post-Cold War period, more internationalization and collaboration in defence allowed countries to trust international contractors with their operational capabilities. This represents a fall in the demand for in-house ISS. Second, with the consolidation in defence industries, original equipment manufacturers (OEMs) have been able to offer better terms due to scale economies in ISS. Third, bundling of equipment and ISS has further contributed to those better terms from scale economies. These last two factors, one a supply side factor and the other from the demand side, led to an expansion of outsourced ISS.

2.1.2 Contracting out ISS

Countervailing the ISS provision by OEMs has been ISS provided by domestic companies.[14] These domestic companies do include transnational companies with subsidiaries in various countries.[15] Domestic ISS companies must be classified into two groups for analytical purposes. Regardless of origin, the first group of companies refers to those that are integrated into the global supply chain. Hence no efficiency issues arise if they provide similar ISS services internationally upon winning contracts.[16] The second group of companies, competing against OEMs and the first type, enjoy preferential treatment under domestic protectionist policies at times due to security exceptions under WTO rules. These are not dissimilar to OEMs subject to offset policies[17][18] in the sense that OEMs under offset obligations have to subcontract to domestic contractors not all of which would be so efficient as to naturally be part of the global supply chain. However, in the light of industrial policies, government may be willing to pay a premium for domestic contractor inclusion.[19] This can be realized by an OEM as prime contractor pairing up with domestic subcontractors or by a domestic contractor as prime. In the former case, unless domestic contractors form part of the global supply chain, OEM would only choose to subcontract to these firms under offset obligations. Thus, if the premium the government is willing to pay for imposing offsets is not high, awarding contracts to the OEM may well be optimal

[14] CAE, IMP and Bombardier provide examples of this within Canada.

[15] Such as L3 in Canada.

[16] For example, IMP Aerospace of Halifax seems to be well-placed to capture exports in the future and plug into the global supply chain (COGINT (2012)).

[17] The term "offset policies" refers to reciprocal trade agreements that are imposed in defence procurement ventures between sovereign nations.

[18] ISS contracts can impose offsets.

[19] By a proper design of the service to be procured, government can induce competition and domestic contractor involvement. See Ganuza and Pechlivanos (2000).

as the winning OEM may wish to subcontract to efficient domestic contractors anyway.

ISS contracts with OEMs can, in principle, be part of the equipment procurement contract or be negotiated separately. Complexity of the product would favour separate contracting despite additional transaction costs arising. However, these latter costs would trade-off against another type of transaction cost that can arise, namely that of potential misinterpretations and consequences.[20] Thus, separate contracts will clarify the distinctions between contractual obligations under equipment and ISS contracts. A strategic advantage can be lost if the procurement contract precedes the ISS contract as the situation could lead to a hold-up especially if the OEM's ISS provision is known to dominate alternatives in efficiency. The bargaining power gained by OEM upon procurement contract may lead to rent extraction from the purchaser through this bargaining advantage.

2.2 Issues in Long-Term Contracts

Notwithstanding the issues raised above, ISS contracts induce further questions if they are long-term in nature.[21] New implementation issues and continuation questions arise.

2.2.1 Formal versus Relational Contracts

Writing formal contracts that codify precise details of performance measures in less than strictly off-the-shelf projects is nearly impossible. Informal incentives thus become un-

[20] Gibbons and Henderson (2012) discuss the importance of clarity in inducing continuation in relational contracts.

[21] Though there appears to be a trend of signing shorter-term ISS agreements, as discussed later in this research.

avoidable. For example, within firms, such performance indicators as teamwork, leadership, and initiative become partial benchmarks for compensation and promotion. Employees typically realize this necessity and firms carry out reward promises for fear of tarnishing their labour market reputation.[22] This contractual inevitability of informal incentives carry over to relationships between principals and agents at all levels, including military equipment procurement and ISS. One of the environments where informal contractual obligations inherently reside is long-term relationships where parties can sign contracts for as long as a period of twenty years. And, of course, potential continuation in the future with the next generation equipment renders the potential contracting horizon longer.

Formal or explicit incentive contracts are those that can be enforced by a third party. This threat of enforcement via courts is always a costly proposition. This distinction between formal and informal contracts can be expressed by distinguishing between observable, but not verifiable, actions or information, i.e. observable by the parties but not verifiable by the third party. But, as an outsider, the court cannot possess more information than the parties to the contract and will have difficulty assessing performance details and evaluations, and would have to call upon costly experts. Thus parties resolving any disagreement amongst themselves might just be the least-cost solution.

2.2.2 Relational Incentive Contracts

Relational contracts, strictly speaking, cannot be fully enforced and so they instead rely on *self-enforcement*; i.e., parties to the contract trade off short-term benefits from "cheating" for long-run benefits that accrue from cooperation. The contract design may provide

[22] Levin (2003).

incentives to reinforce this trade-off. In reality, many formal contracts are enforceable but a combination of formal and relational components may dominate formal contracts by reducing the overall cost of implementing some contractual obligations, i.e. the expected costs of relational contracting regarding such obligations may be lower than the corresponding legal enforcement costs.

Measurement of a contractor's precise contribution to production is difficult, if not prohibitively costly, to measure. The contractor is better informed on productive actions whereas the principal learns the set of productive actions over time.[23] In particular, it is nearly impossible to design an enforceable contract where the compensation is based on a contractor's contribution to production expressed in monetary terms. In other words, this contribution is not objectively measurable. For instance, in a particularly prevalent phenomenon in defence procurement, contractors normally undertake more than one project at a time and the allocation of their best personnel to a given project[24] may well be observable but certainly not verifiable.[25] Yet, it is always subjectively assessed by parties to the contract. Similarly, in the case of a simple agency such as the manager and the worker, this subjective assessment is easier if the manager is experienced and trained to observe the agent's behaviour (hidden effort) and opportunities (hidden information) whereas significantly more difficult in more complex environments such as a defence contractor's provision of services. These subjective assessments may not be perfect measures of agent performance but may complement the available objective measures.

[23] Chassang (2010) focuses on how parties figure out and settle on the details of cooperation.

[24] Rogerson (1994).

[25] This is to say that it would be very difficult for a client of said contractor to determine that they are being shortchanged in terms of allocation of personnel.

2.2.3 ISS Contracts and On-Ramps

Certain long-term contracts can be so imposed to preserve adequate competition by re-competing contracts or periodic re-solicitations, thus attracting other contractors or, in other words, integrating on-ramps.[26] The building of on-ramps into ISS contracts exhibits some incentive properties. First, the lead time toward an on-ramp enables potential competitors to prepare their bids. Second, the existence of potential competitors would impose market discipline on the incumbent. Third, the purchaser could adjust the width of the competitor field by defining or refining the service,[27] narrowly defined services attracting a smaller number of bidders to on-ramps.

Loss of in-house capabilities and the resulting lock-in is one of the potential drawbacks of outsourcing. As insurance against consequences such as hold-up, contractor disinterest, or exit (especially with aging systems), on-ramps provide a vehicle by which alternative contractors, who would not otherwise have been interested, might enter the bidding. The global ISS market being fairly large, interest in a particular country would depend on what is on offer, and is therefore endogenous. In aviation, ISS contracts are generally nearly twice the value of the original equipment market.[28] As fleets age, the ISS market is expected to grow, and the value of ISS contracts increase as fleets age. Thus, an on-ramp is a realistic instrument to generate and impose market discipline.

[26] Ganuza and Pechlivanos (2000).
[27] Ganuza and Pechlivanos (2000).
[28] Chrisman (2011).

2.2.4 ISS Contracts and Off-Ramps

The length of the contract before any statutory re-competition arises fulfils two basic functions. First, if the contractor is to invest in specific assets, the lengthier contract will thicken the field of potential bidders. Second, the lengthier contract also reduces the risk associated with random shocks to contractor performance so that an off-ramp doesn't unduly disqualify the incumbent.

In general, on-ramp and off-ramp instruments are meant to regulate the field of potential contractors, as explained in Section 2.2.3 above, and hence generate potential competition.[29] This "double-scissor" mechanism is supposed to generate a positive probability of entry for contractors in the field so as to ensure potential competition. While the incumbent may be off-ramped upon failure to satisfy contract performance measures, an internal phenomenon, the presence of potential contractors, an external phenomenon, complements the former and completes the entry-exit incentive system.

A final factor in off-ramp considerations is that the value of the relationship to each party to the contract is private information. This value includes the value generated from the contract work as well as the outside options. Each party would thus have an incentive to overstate their outside options in order to capture more of the surplus generated.[30] If and when one of the parties grows frustrated with the division of the surplus, the off-ramping can be initiated by either party.[31]

[29] Or, in other words, a version of contestability.
[30] Halac (2012).
[31] See Section 3 for specific instances of off-ramping in Australia.

2.2.5 Contract Performance Measures and Compensation

There are two groups of performance measures and targets as part of the incentives governing long-term contracts. The first group not only includes the on-ramp and off-ramp benchmarks and conditions but, surprisingly, the length of the contract itself. First, a longer contract alleviates the asset specificity and moral hazard[32] problems. Second, less direct monitoring of contractor effort would be required as the purchaser could draw inferences from repeated observations of outcomes. Third, it means less overall contract costs due to infrequency of contractor switches. Finally, if good performance can be rewarded with contract extensions, the effort incentive problem can be alleviated.[33] The contract extension incentive is indeed powerful not only for performance but also for making effort decisions over a longer horizon.

The performance measures in ISS conrtacts can be classified into two broad categories. The first group includes indicators of equipment availability and reliability, refined into proper metrics. The second group measures reduced ownership costs if, indeed, outsourcing contracts reduces overall expenditures without negatively affecting operational availability.[34] Of course, in the presence of multiple measures, an overall performance evaluation requires assignment of weights to these various measures.

Unlike in procurement of equipment, however long it may take, where upon delivery the OEM and the purchaser may no longer need to interface, in ISS the user has to maintain an

[32] This phenomenon arises because, under a lengthier contract, the contractor can reap the benefits of a higher present effort in later periods.

[33] In the case of the US Air Force E-8C Joint Surveillance Target Attack Radar System (Joint STARS) contract, the ISS contractor's term was repeatedly extended upon good performances to a total of 22 years from a base contract of 6 years. See Geary et al. (2010).

[34] See Geary et al. (2010).

active and visible role in directing, managing, and executing the product support strategy.

A final comment about relational contracts relates to tenure. A given relational contract specifies continuation conditions, i.e. criteria on off-ramps and on-ramps, and the compensation in terms of tenure.[35] If a party is found to have deviated, the contractual relationship can be "endogenously" terminated.

A contractual enforcement constraint entails that compensation cannot increase too fast with tenure, since, otherwise, the contractor can become too expensive and the principal may renege, terminating the current relationship by off-ramping the contractor. This is the inherent tension between incentive provision and contractual enforcement. Moreover, when the principal is learning the contractor's quality, which is an adverse selection problem, compensation must increase with tenure; yet, this increase is constrained by on-ramps that may franchise new firms with ability to perform at lower cost.

The learning effect from firm heterogeneity can alleviate the tension between incentive provision and contractual enforcement. This suggests the following compensation dynamics: it is low towards the beginning of the contract tenure and starts increasing with time, consistent with the learning effect. Since less productive firms are expected to have a shorter tenure,[36] in order to prevent their rents, compensation must be back-loaded but constrained later in tenure via the learning effect.

[35] Yang (2013).

[36] Off-ramps would theoretically 'weed-out' such low-productivity firms.

3 Australia

As their 2009 White Paper states, Australia sees itself as being in a relatively volatile region of the world. Adding to their risk is that there is a vast physical distance between themselves and their allies, most notably the United States. Another concern is that as the nations in the Asia Pacific region become richer, they devote more resources to their militaries than in the past. All of these factors have led Australia to develop a policy called Force 2030, which seeks to provide a stronger military and a more robust defence industrial base by that year.[37]

This plan, as it relates to ISS, has a few key components. Their goal is to invest immediately in certain key areas to allow for a future cost savings of 20 billion Australian dollars by 2020.[38] They then will be in a position to adequately support the needed equipment that will be phased in for 2030. The parts of their defence plan that relates to ISS are called the Strategic Reform Program and Smart Sustainment.

3.1 ISS and Australia's Domestic Defence Industry

To understand their approach to ISS, it is also necessary to know about the structure and status of the Australian defence sector of the economy. There are not many domestic producers of military equipment in Australia.[39] A majority of equipment is purchased off the shelf from foreign countries. However, in order to achieve the self-reliance that they

[37] Australia White Paper (2009).
[38] A.G. Houston and I.J. Watt (2012).
[39] Clegg (2012).

deem necessary due to their geographic situation, Australia desires to perform all of their ISS within Australia. In this sense, Australia cannot reap the savings that other countries can by bundling ISS and procurement contracts, as discussed in Section 2.1.2. However, the firms in Australia that are capable of performing ISS are mostly foreign owned, so in some cases subsidiaries of OEMs can be used as ISS contractors. In order to ensure that Australia can indeed perform its own domestic ISS on their purchases, they are careful to obtain intellectual property rights when they acquire new equipment.[40]

Australia has seen a downturn in the ability of their domestic firms to perform ISS reliably.[41] Years of underinvestment in the military has translated into fewer contracts for the private sector. With a resource boom underway in the region, many defence firms have lost skilled labour to the resource sector. In order to ensure a security of supply on their support contracts, it is recommended by some that the Australian government should manage the timing of their service contracts better to provide more contracts to these firms and to ensure steady employment.[42] [43]

Australia spends roughly 5.5 billion Australian dollars yearly on ISS.[44] Such a large value indicates that most ISS is performed in the private sector rather than within the Australian Defence Force (ADF) itself. In fact, there has been some concern regarding the degradation of skills within the ADF, and that soon it may no longer be able to perform routine

[40] Joint Standing Committee on Foreign Affairs, Defence and Trade (2012).
[41] Bergmann (2012).
[42] Clegg (2012).
[43] This potential Australian policy of securing survival of a key industrial capability is similar to Canadian suggestions regarding shipbuilding by optimally spacing navy ships construction; see Williams (2006).
[44] Clegg (2012).

maintenance, even when deployed.[45] This is an obvious concern regarding the level of oursourcing, as discussed in Section 2.1. Not much ISS is contracted directly with the OEM. Since most equipment is procured overseas, and in light of the government policy of self-reliance, it is insisted that ISS be performed domestically.[46] Exceptions to this policy include the C-17[47] and Super Hornets[48] that take advantage of the scale economies provided by US ISS contracts.[49] Although implicitly there is a monetary cost to have all support done domestically, the government does not state at what threshold they find the cost too prohibitive. It may be the case that this is done to permit the government to be more flexible in its decision making process. The evidence suggests that it is rather high, as very few ISS contracts are performed overseas. Although, as discussed in Section 2.1.2 above, contracting with OEMs could still lead to domestic firms providing ISS, so long as they are competitive enough to already be a part of global supply chains.

3.2 A Measure to Help Obtain Intellectual Property Rights

Some OEMs have subsidiaries in Australia that can perform the ISS; this naturally simplifies any IP problems, but in other cases the ADF contracts out to other domestic firms. One option being considered is to group procurement from a foreign firm and ISS contracts with a domestic firm together from the early stages of procurement. This ensures

[45] Joint Standing Committee on Foreign Affairs, Defence and Trade (2012).
[46] A.G. Houston (2012).
[47] Clegg (2012).
[48] Auditor-General Ian McPhee (2012).
[49] It is possible that mobility of aircraft enables such sustainment overseas.

that IP is transferred from the OEM to the domestic firms at a lower cost, as government has more bargaining power at this point, as mentioned in Section 2.1.2.[50]

3.3 Australian ISS Contracts and Off-Ramps

The Australian government has shown a strong desire to include off-ramps in their contracts.[51] They see it as being optimal to maintain the ability to unilaterally end or renegotiate the contracts for a number of reasons. Underperformance, such as the failure to meet key performance indicators, is one of the primary reasons that the government demands to be able to unilaterally end the contract. They also believe that the presence of these off-ramps will encourage the firm to work harder to maintain the contract.[52] Finally, as shown with the case of their aging F-18s, costs can become very unpredictable when the platform is asked to perform for a longer time than expected, as discussed in 2.2.3.[53]

The government also wishes to maintain off-ramps for use when the rewards or punishments in place no longer have the proper incentivizing effects on the firms.[54] At this point, the government wishes to be able to end the contract and renegotiate another with more effective rewards for overperformance and disincentives for underperformance. In general, the government wishes a series of short term contracts, which they believe will ensure that competitive forces will produce the lowest possible cost.[55] This is the policy they use with

[50] Joint Standing Committee on Foreign Affairs, Defence and Trade (2012).
[51] Defence Material Organisation (2012).
[52] Clegg (2012).
[53] Auditor-General Ian McPhee (2012).
[54] PBC Discussion Paper (2010).
[55] Clegg (2012).

the ISS contract for the Collins submarine.[56]

This approach is not without its critics. The government's ability to unilaterally decide that a contract should be renegotiated puts firms in a risky position. They may make large investments to maximize their profits, which in turn could be rendered poor choices *ex post* if a new contract is suddenly imposed on them.[57] Also, the government's lack of willingness to sign long-term contracts could also make long-term investments by firms a poor choice. If a firm is worried about losing a contract, they may not invest in equipment that could save money in the long run. Moreover, the candidate field may narrow, blunting the on-ramp incentive. The end result would be higher costs for the government.[58] The government's response to these criticisms is that any firm performing well enough according to the key performance indicators agreed upon will not need to worry about losing the contract, and thus should make the investments.[59]

An additional criticism regarding the use of off-ramps is that it corrodes any trust developed between the government and the firms.[60] With many of the new contracting models, a level of trust is relied upon by both sides. In the case of Australia and other small countries, the additional problem is that there may be no alternative to the current contractor.[61] In order to convince firms that the government can be trusted, off ramps must be used as sparingly as possible. If the government can develop a reputation as a fair partner who does not use off ramps for inappropriate reasons, then firms may believe that the government will

[56]Joint Standing Committee on Foreign Affairs, Defence and Trade (2012).
[57]PBC Discussion Paper (2010).
[58]Clegg (2012).
[59]Joint Standing Committee on Foreign Affairs, Defence and Trade (2012).
[60]PBC Discussion Paper (2010).
[61]Clegg (2012).

continue this behaviour in order to protect this hard earned characteristic. Unfortunately, changes in government add uncertainty to the situation as challengers may not value the reputation as much as the incumbents. Thus, it may not be possible to overcome the issue of trust.

The tradeoffs discussed in Sections 2.2.3 and 2.2.4 are clearly evident here. The short contracts act as on-ramps for potential competitors to keep the current contractor engaged and efficient. However, constant renegotiation discourages firms from acting efficiently, which of course is the primary reason to outsource ISS in the first place.

Although actually executing a contractual off-ramp has not had to be used often by the Australian government, it has done so on occasion, one example being the removal of Boeing from the sustainment contract for the F/A-18 and awarding it instead to BAE.[62]

3.4 Performance-Based Contracts in ISS

The past decade has seen Australia transition towards the use of performance based contracts (PBCs). The past problem was that different sectors of the military were using different types of PBCs, some of which were not designed appropriately. A part of the Smart Sustainment program is to ensure that PBCs are used effectively by all branches of the military. The traditional approach in Australia, prior to PBCs was based on the assumption that the government could determine the best way to do ISS. Thus, performance of firms would be judged on the inputs (labour and capital) into the contract. This approach punished the firms for deviating from the agreed upon inputs, even if a more efficient way

[62] Clegg (2012).

presented itself. This model ensured the government knew what actions would be done, but the outcomes were not guaranteed. It has been described as a hostile and bureaucratically intense approach, as the government needed significant human capital to properly write and monitor the contracts.[63]

The new method involves signing a contract where a firm is rewarded or punished based on the results it produces. These Key Performance Indicators (KPIs) are the outcomes that the ISS firm produces. The theory is that firms are efficient organizations that can best decide how to achieve the objectives. KPIs are often things such as what fraction of the time is equipment is unavailable due to servicing, or how many hours of flight time does a plane get?[64]

The government recommends the choice of 3 to 5 KPIs, and that appropriate weights must be chosen so that firms cannot focus on a single KPI while failing to satisfy the others, something alluded to in Section 2.2.5.[65] It is stressed by many that these KPIs should be explicitly determined beforehand, and clear to all parties involved. They must also be relevant and achievable. The Aerospace division had developed a "payment-at-risk" model, where money is withheld for poor performance. The idea was that for every KPI that a firm failed to achieve, some money would be withheld. They found the firms very receptive to this type of contract. It is necessary with this approach to review the firm periodically to ensure that it is en route to meeting the targets.[66]

One interesting case was with the Armidale Class Patrol Boat. Since the OEM was a

[63] Clegg (2012).
[64] Auditor-General Ian McPhee (2012).
[65] Defence Material Organisation (2012).
[66] PBC Discussion Paper (2010).

domestic firm, it was possible for this firm to be the ISS contractor as well. They developed an abatement point system where points where deducted in one period whenever the boats could not perform a task as set out in the KPIs. The more serious the failure, the more points were deducted. In the next period, the number of points available at the start of the period would be proportional to the number of points available at the end of the previous period. Thus, if the firm failed to live up to expectations in one period, it would have to work hard to regain the trust in the next period.[67]

3.5 Risk Tolerance and Operational Availability

It is difficult to say with certainty how tolerant of risk Australia is in having their operations interrupted by ISS failure. On one hand, their desire to maintain domestic control of ISS is evidence that they are greatly concerned. Also, their contracts have fines that are imposed non-linearly on the severity of failures to reach KPIs, even to the point of contract termination.[68]

On the other hand, they outsource ISS to such a high level that their military personnel no longer have all the necessary skills to maintain the equipment when deployed.[69] Also, the government's Strategic Reform Program has significantly reduced the amount of inventory maintained by the Australian Defence Forces.[70] This approach is in line with the just-in-time manufacturing ethos, but it puts the operational capabilities of the military at risk. This obviously makes the surge capacity discussed in Section 2.1.1 more difficult to

[67] PBC Discussion Paper (2010).
[68] PBC Discussion Paper (2010).
[69] Joint Standing Committee on Foreign Affairs, Defence and Trade (2012).
[70] A.G. Houston (2012).

achieve.

3.6 Conclusion

Due to its unique geopolitical circumstances, Australia puts in considerable effort to maintain maximum domestic ISS capabilities in all areas of military technology. Further, the above analysis makes it clear that Australia wishes to maintain a high level of control over their ISS contracts. They recognize the potential of performance based contracts over previous models, but still wish to maintain the power to unilaterally end contracts. In a sense, they understand that there are benefits to tapping into the efficient nature of firms, but are unwilling to give up too much control. The result may ultimately be that the efficiency gains are not fully realized.

Their overall approach seems comparatively well-suited to the new realities of defence spending in the post-Cold War era. They have developed close partnerships with firms, and have developed systems for acquiring IP for use by domestic firms. The fact that military personnel are no longer able to maintain the equipment themselves while deployed is a potential problem. The use of ISS contractors to make repairs in war zones opens a number of potentially difficult legal issues.

Although Canada is located in a relatively safer area of the world, there are still lessons that can be learned from the Australian experience. Canada may also wish to maintain control over all aspects of ISS, as relying on firms in allied countries could result in a lower priority of service during peak operational activity. Australia's use of KPIs in their contracts also provides a useful template for the Canadian government.

4 France

To gain insight into France's policy towards in-service support, it is necessary to understand the country's overall military industrial policy. France's 2008 *White Paper on Defence and National Security* outlines the country's official policy. This section underlines key aspects pertinent to ISS from an analysis of this report, and provides empirical evidence by taking a look at an ongoing ISS agreement with DCNS for the support of a variety of naval platforms.

4.1 ISS Aspects of France's Military Industrial Policy

Reviewing France's White Paper,[71] there is a clear emphasis towards maintaining "proficiency in the technologies and capabilities needed to design, manufacture, and maintain the military equipment essential to areas of sovereign prerogative." France differs from most countries, in that it is large enough to be able to maintain domestically certain industries which it considers essential. From observation, it is clear that this list includes such areas as aerospace and nuclear weaponry.

France is willing to acquire defence systems and seek support assistance internationally, but only if security of supply is not compromised. If a market is sufficiently thin (few sellers) or those firms which provide the good or service are seen as unreliable, then France considers it necessary to develop the domestic capability in order to perform the task. No precise measure is provided as to when these conditions are met. This is not to be construed

[71] A full reference for the France White Paper (2008) is presented in the bibliography.

as saying that France will always look first to domestic firms for support services; rather, if French firms are able to survive without domestic government contracts, then the French government is willing to consider bids from foreign companies as well.

On the other hand, France also wishes to support the further integration of the defence industry within the European Union, as evidenced by their participation in multinational armament programs such as OCCAR. In these instances, limited priority tends to be given to firms within the European Union ahead of those of other foreign countries. Their stated goal is to provide these firms with longer production runs, by having them perform support services for multiple European countries. This will help ensure that Europe maintains key military industrial capabilities.

When viewed in light of the discussion in Section 2.1.1, it is obvious that there is increased risk, and France will no longer have legislative control over firms which perform ISS. This could lead to a situation where the government of France believes it can no longer fully rely on the firms tasked with performing the ISS. However, offsetting this effect is the fact that these firms should be more likely to have the proper skills and experiences to perform the needed ISS.

To further help in this regard, France desires to engage in more public private partnerships (PPPs). Part of this is to make known their needs ahead of time so that domestic and European Union based firms can position themselves to bid on these contracts when the time comes.[72] Removing the cloud of uncertainty can have a stabilizing effect for these firms, allowing better planning for future contracts. Furthermore, these PPPs help firms

[72] Australia was a leader in this regard, and Canada's Project Accord serves the same purpose.

and the government by allocating risk more equitably amongst the relevant parties.

In order to facilitate better cooperation with private enterprise, and to ensure that ISS contracts are fair to all parties, the French government realizes they need to develop and maintain technical expertise in-house. This will ensure that the government knows what services can reasonably be expected to be provided by private enterprises. Also, the government plans to consolidate their central administration in one location to facilitate sharing of information between the different defence teams.

One important aspect regarding future contracts that is discussed in the White Paper is France's need to be able to react more quickly to changes in warfare and the geo-political situation. It is often the case that weapon systems developed in the past are not necessarily the most appropriate in terms of future – or even *present* – needs. As such, future procurements may often be subjected to shortened lead times. The impact of this on potential ISS contracts can be significant. If an ISS contract for a defence platform is signed at the time of procurement, the result may be that the haste leads to a contract with the original equipment manufacturer, as alternative firms may not have had the opportunity to develop the capabilities necessary to support the system. Further, the OEM may be a foreign firm, and it may also be the case that it is impossible to have a full competition for the ISS contract. These factors may lead to a lack of competition and, ultimately, significantly higher costs for ISS. However, as discussed in Section 2.1.2, signing ISS contracts with OEMs at the time of procurement may lead to savings, if the OEM credibly believes that the country may walk away from the deal entirely.

4.2 Increased Reliance on Industry in ISS

The French government is eager to rid itself of as much in-house support as possible.[73] As they state, that they wish to "speed up the process of transferring industrial project management from the State to companies. Maintenance of operational serviceability using internal resources must be strictly limited to work that could not be carried out safely or promptly enough by an industrial firm." This is a pattern that we observe in many developed countries. As fewer resources are being devoted to the military, they find it necessary to outsource to private firms in the hopes of finding cost savings. In addition, this provides domestic firms with a stream of income that can be used to maintain employment levels. This allows France to achieve their goal of maintaining key domestic industries.

France does not differ from many countries in realizing that the old methods are no longer effective. "The traditional sequential approach (manufacture by industry previously owned by the State, maintenance by the State, midlife renovation and decommissioning) is often obsolete." It is now widely accepted that there is a larger role for private firms to play in the defence sector, as discussed in Section 2.1.1. The government and industry must prepare to move forward on a new, more open footing.

4.3 The Use of Performance Indicators

Part of this new approach is contracts based on performance indicators. Success or failure of an ISS contract will be measured by the number of hours the equipment is operational,

[73] This mirrors a desire to generate a greater dependence on industry in the case of OCCAR; see section 6.4 for a more complete discussion.

or whether or not certain pieces of equipment are available at all.[74] In order to get these results, the appropriate incentives will be offered by the French government. These incentives are however not clearly defined in the White Paper or other available sources, though it seems likely that these are handled on a case-by-case basis.

4.4 A Look at the ISS Agreement Signed with DCNS

The French navy provides a good example of modern ISS contracts. Starting in 2005, DCNS, a largely state-owned ship manufacturer, won a contract to service a number of French naval ships, including: the *Tourville* Frigates, *Primauguet* Frigates, *Type A69* Frigates, and the submarine *Le Temeraire*.[75] DCNS was the OEM for most of this equipment. These contracts differed from previous as payment was based on the availability of the ships rather than on the work that was done. Incentives were put in place to ensure that the time they were removed from service would be limited

The satisfaction of both parties with this arrangement was revealed in 2009 and again in 2011 when the navy signed two more contracts with DCNS to provide work on other ships including the *Horizon Class*, *Foudre Class*, *Mistral Class*, and *LaFayette Class*[76] combat vessels. Again, DCNS was the OEM for most of these ships, removing the potential problem of accessing the IP.

[74] These KPIs are also used by Australia with their F-18s.
[75] Defense Industry Daily (2009a).
[76] Defense Industry Daily (2011).

4.5 Conclusion

France's approach to ISS is clearly very Euro-centric. They have a *revealed preference* for performing ISS domestically, but have also shown that they are willing to engage with their EU allies for some ISS. Whether the motives are purely motivated by cost savings or an attempt to foster further European integration is not entirely clear. Although they are willing to source ISS to foreign firms in some areas, they still wish to maintain domestic ISS capabilities in any market that they perceive as being too "thin". Also, national champions such as aerospace, nuclear, and shipbuilding are kept domestically for the most part. Perhaps this is not surprising considering France's comparative advantage in those areas.

France's use of performance based contracts does not seem to be as far along as that of other countries; although, clearly, the shift towards using KPIs has begun. France's larger size gives it more flexibility compared with Canada. It may not be possible for Canada to have the option to maintain domestic ISS in all fields. However, Canada could follow France's example to allow foreign firms to perform ISS if the domestic market can be maintained without the government contract. This could free up resources to allow the development of domestic ISS in "thinner" markets.

5 The United Kingdom

The UK's approach to in-service support is closely tied to their procurement policy. The 2005 Defence Industrial Strategy White Paper spells out the country's approach to dealing with ISS through a process they refer to as "Through-Life Management". Their overall approach is designed to achieve a number of goals, the most important being their desire to maintain a domestic presence in a number of key industries.[77]

In order to develop an understanding of the UK's approach to ISS, an analysis into the nature of its defence industrial base – particularly since the end of the Cold War – is necessitated.

5.1 ISS and the UK's Defence Industrial Base

Similar to the situation in other countries, the demand for weapons from UK firms has dropped since the collapse of the Soviet Union. However, despite this, the UK wishes to maintain the domestic capacity to produce and maintain certain weapon systems that they have determined are essential or otherwise advantageous.

In order to achieve this goal, the UK's Ministry of Defence (MoD) has changed how it relates to the defence industrial sector in a number of key ways. Firstly, firms now recognize that there are going to be fewer procurement contracts than in the past. Thus, these firms now wish to obtain ISS contracts to ensure a steady stream of revenue as already discussed in Section 2.1.1 above. The MoD shares this goal, and now often ties

[77] U.K. White Paper (2005).

ISS contracts to the original weapon supplier, as exemplified by their *Future Strategic Tanker Aircraft* program.[78] This leads to substantial cost savings as mentioned in Section 2.1.2.

Secondly, the types of weapons that the UK obtains have changed. They now have a preference for systems with "open architectures," that is, systems that are easy to upgrade or swap components. This allows for continuous support, sustainment, and enhancement of equipment, whereas in the past there would be more discrete jumps in quality.[79] If properly achieved, this increased openness should have the added benefit of allowing more firms to be able to service the equipment. When viewed in light of the discussion of on-ramps in Section 2.2.3, it becomes obvious that this approach allows the UK to free itself from being tied to a single firm. It is possible for many firms to compete over the ISS contracts.

5.2 The Importance of Intellectual Property

The emphasis on "openness" in defence system architecture is quite indicative of how the UK approaches procurement and ISS. It is obvious that the military and government of the UK place a high premium on domestic intellectual property. One issue that the UK has when procuring equipment from abroad, specifically the USA, is that government's unwillingness to provide all the necessary IP, so that the UK has the domestic capability to service and support the equipment.[80]

[78]U.K. White Paper (2005).
[79]U.K. White Paper (2005).
[80]U.K. White Paper (2005).

A good example of how this was raised recently is the case of the JSF (F-35). The ISS for the JSF was to be provided to all members by the Lockheed Martin Global Support System. This is a cooperative amongst the member nations. The lack of sovereign control to improve and maintain the aircraft was difficult for the UK to accept, so it entered into a deal with BAE and Lockheed, where BAE would acquire all the technical specifications necessary for the UK to service these aircraft themselves.[81] That is one of the reasons that the UK entered into the JSF project at such a high level.

5.3 The Role of the Private Sector in ISS

The White Paper makes it clear how much more of a role the government wishes the private sector to take in the workings of the military. To ensure that these firms are able to continue to exist, the military allows them greater access to different support services to maintain their revenue flows. Whereas in the past their role was limited to equipment procurement and upgrades, they now perform more services such as recruitment, training, support services, and the provision of information. Theoretically there is still more room for increased private sector cooperation including in the planning stages and deployment support. As mentioned already in Section 2.1.1, a discussion of this nature is beyond the scope of this paper.

Many of these policy changes come through the notion of Through Life Capability Management (TLCM). It is defined as "an approach to acquisition and in-service management of military capability in which every aspect of new and existing military capability is

[81] U.K. White Paper (2005).

planned and managed coherently across all Defence Lines of Development (DLoD) from cradle to grave."[82] These DLoDs include: training, equipment, personnel, information, concepts and doctrine, organization, infrastructure, and logistics and interoperability. The approach is to no longer view equipment in isolation, but rather as part of a larger system.

To facilitate this approach, the government of the UK relies on increased cooperation with the industrial base. As the UK wishes to maintain certain key domestic capabilities[83] the government must increase communication with firms so that they are prepared, when the time comes, to do the business that is required of them. On the other hand, the firms must not take advantage of this desire of the government by extracting too much rent from the government. If the government is planning to ensure a steady stream of funds through ISS contracts, these firms must not collude with one another to drive up prices. Of course, firms are profit maximizing entities, so it is not enough to simply take them at their word.

Another measure taken by the UK government is the adoption of a MoD "Unified Customer" approach. The idea is that all parts of the MoD get together to act as a single point of contact with industry, to facilitate communication between the two.[84]

5.4 The Adoption of Performance-Based Contracts

The UK broadly uses two types of performance-based contracts. The first type is based on *availability*. These contracts state that the firm's performance is judged based on the number of units of a specific type of equipment that are available for use at any given

[82] Vega Official Site (2012).
[83] Ship maintenance, for example.
[84] Brittain, Jon (2008).

moment. An example of this is the Royal Navy's *Asute-class* submarine.[85] It is expected that by 2024, seven of these submarines will be in service. The purpose of these ships is to provide continuous at-sea deterrence. The contractor's performance will be measured by the number of submarines that are not sidelined, undergoing refits or maintenance for critical systems at any given time, and are thus capable of performing their given task.[86]

The second type of contract focuses on *capability*. In this case, the supporting firm is judged based on their ability to provide the resources necessary to perform a certain task. This may even include allowing for private ownership of the asset. For example, prior to 2012 the four *River Class* offshore patrol vessels used by the Royal Navy were in fact owned by Vosper Thornycroft, the OEM. They were responsible for all maintenance and repairs to the ships while the Royal Navy was responsible for their operation. The price that Vosper charges would be expected to include an amount to cover the additional wear and tear that one observes when an object is rented rather than owned. There is a moral hazard problem that could potentially lead to the UK government the RN sailors using the equipment in a more strenuous manner than they would if the equipment was government owned. Another problem that could arise is a potential hold up problem, where Vosper may try to extract more funds from the government if there is an immediate demand for their use. The same approach is to be used by the *Future Strategic Tanker Aircraft* (FSTA). Since these aircraft are Airbus A330s, a very popular commercial airliner, it was deemed a better approach to have these aircraft owned by a third party, and then lease their use when required for military purposes.

[85]PBC Discussion Paper (2010).
[86]PBC Discussion Paper (2010).

5.5 Conclusion

Overall, the case of the UK is very similar to that of France. They wish to maintain domestic capabilities in certain key areas, and are willing to allow foreign firms to bid on the ISS contracts for the other areas.

The UK has a strong focus on IP acquisition. They have traditionally seen military spending as a way to produce technological spillovers for the non-military economy. If it is no longer possible to have as much research and development done domestically, then they wish to offset the loss of domestic technological advances with advances imported from foreign countries. As such, they place a high premium on acquiring IP in their ISS contracts.

The UK also seems quite keen on outsourcing more and more of traditional defence department roles to the private sector. As mentioned in the conclusion of the Australian section, there is a risk of going too far in this regard. Legal questions arise from having private sector contractors deployed in a war zone. Similar to the countries already discussed, the UK is also moving towards the use of performance based contracts. This approach requires a smaller government role, and allows for potential cost savings in this regard.

Much like the case for France, Canada does not have the same resources that the UK has to devote to the military. As such, it may be difficult to model Canada's approach on that of the UK. However, their use of ISS contracts to leverage technological spillovers for their domestic economy is something that Canada can consider emulating.

6 OCCAR

OCCAR, the European *Organization for Joint Armament Cooperation*, manages a handful of armament programs for its member nations, a list that includes Belgium, France, Germany, Italy, Spain and the United Kingdom as formal members. OCCAR has adopted a policy of openness in armament cooperation with other European nations, and so development efforts often include non-member states as participants.

While, at present, a handful of programs are managed by OCCAR, those currently in place account for key systems in each of the operational battlespaces, including: strategic / tactical airlift (Airbus 400M), attack helicopters (Eurocopter Tiger), multi-role armoured vehicles (Boxer MRAV), and multi-mission frigates (FREMM).

Given the diversity and scope of these armament programs, an overview of the management processes, particularly those relating to the management of the life cycle of defence systems, is pertinent to the present analysis.

In terms of the in-service support phase of a given defence system's life cycle, OCCAR's role consists mainly of offering management services to the participating states for each system under its umbrella.

6.1 OCCAR's Procurement Strategy

In order to better understand OCCAR's approach to in-service support management, a look at how it carries out the procurement of defence systems is useful, as third-party ISS

contractors are usually the manufacturers of the intermediate and finished products themselves. To ensure long run minimization of costs in supporting a given defence system, it makes sense to ensure that certain aspects are considered in the initial procurement phase. According to the OCCAR management procedure for contract placement in procurement, a few important considerations are apparent:[87]

- Procurement processes must take into account entire life cycle costs of each given system, as well as assessing risks and considering possible contingencies.
- OCCAR seeks to fill operational requirements with its defence systems, and as such can consider competing systems to fill a given role.
- Since OCCAR procurement aims to achieve the best value for every dollar spent, competition among contractors is encouraged whenever possible.
- Whenever it is cost-effective to do so, OCCAR has a preference towards sourcing from whole system providers; this allows the whole transfer of system responsibility to the contractor.[88]
- Through-Life Management is to be considered *prior* to the procurement of any system, and efforts are made to minimize "Whole Life Costs", from development, to delivery, to in-service operations, through to obsolescence.[89] [90]

[87] Information obtained from the OCCAR Management Procedure guide on procurement, OCCAR (2009).

[88] This is not unlike the current desire in Canada to adopt a "Single Point of Accountability" in ISS whenever possible.

[89] It seems likely that systems are evaluated individually in order to determine when obsolescence and replacement should occur, though a needs-based approach is always first considered.

[90] As discussed in Section 2.1.2 this can also lead to cost savings from the countries being in a stronger negotiating position at the time of procurement.

OCCAR has as a main tenet the abandonment of the "juste retour" principle,[91] which was, essentially, a requirement of offsets in armament development agreements between European nations. The principle of "Global Balance" replaces the requirement of offsets with an apparently more flexible, market-based approach,[92] though it does seem to require a nation to participate in the procurement of systems in order to have its industry participate in development. The implications of Global Balance appear to be handled on a case-by-case basis as there are no hard and fast rules specified in the OCCAR ISS manual. Given this, there does appear to be a preference towards member-nation production; a look at current procurement projects shows that in all but a few cases, manufacturers based within participating countries are sourced as primary manufacturers.

6.2 A Look at OCCAR Development Projects

Current platforms, along with their associated primary countries of origin, being managed under OCCAR include:[93]

- Airbus A400M: Tactical and Strategic Airlift - France.
- Boxer MRAV: Multi-Role Armoured Vehicle - Germany, Netherlands.
- COBRA: Counter Battery Radar (Weapon Locating System) - Germany.
- ESSOR: European Secure Software defined Radio - Finland, France, Italy, Poland, Spain, Sweden.

[91] OCCAR-EA (2006).

[92] The OCCAR-EA (2006) Policy Statement on Global Balance describes the approach as "pursuit of an overall and flexible multi-programme/multi-year balance of work share against cost share".

[93] Information obtained from OCCAR (2013).

- FREMM: European Multi-Purpose Frigate - France, Italy.
- FSAF, PAAMS: Surface-to-Air Anti Missile Systems and Munitions - France, Italy, U.K.
- MUSIS: Multinational Space-based Imaging System - France, Italy.
- Eurocopter Tiger - France, Germany, Spain.

Of the eight above-listed programs, only the ESSOR involves partners that are not official member-states of OCCAR; this program is a six-nation effort including Finland, France, Italy, Poland, Spain, and Sweden, with leading domestic manufacturers Elektrobit, Thales, Selex-Comms, Radmor, Indra, and Ericsson involved on the project.

As OCCAR's primary purpose involves armament development and cooperation amongst partner nations, it is only natural that systems are usually manufactured within partner nations. This has an inherent spillover into support contracts. Particularly in the case of spares, maintenance and other ISS aspects, original equipment manufacturers are most often awarded the long-term support contracts. It therefore remains to be seen whether this emphasis on a market-based approach to procurement and ISS is more of an empirical reality than an optimistic policy goal.

6.3 OCCAR's Approach to In-Service Support

This section examines aspects of OCCAR's approach to in-service support activities as described within the official OCCAR ISS guide.[94]

[94] OCCAR-EA (2010).

The “ISS phase” of a given defence system’s life cycle is considered to have begun from the time the first unit enters service and ends when the last piece of equipment is disposed. This phase is preceded by “ILS”, or Integrated Logistics Support, and is a subset of the “TLM” or Through-Life Management procedure adopted by OCCAR.

OCCAR recognizes ISS to be the longest and most costly phase in a defence system’s life cycle when compared to development, procurement, service and obsolescence. Its ISS management philosophy is therefore based on ensuring management processes, oversight, the maintenance of accountability and standards, and adopting performance measures so that trouble areas can be evaluated and corrected. As mentioned, a core concept in OCCAR’s armament philosophy is that, prior to the development of a given defence system, whole life costs (WLC) are borne in mind, and efforts need be made from even the initial design phase in order to minimize these costs.

ISS management activities are largely performed by OCCAR staff in conjunction with the participating nations, with some activities contracted out based on OCCAR guidelines. Direct work on the systems, such as maintenance, spares, warehousing, refits and so on, are contracted out to industry entities. Maintenance activities generally seem to be awarded to the original equipment manufacturers, though a policy of a commercial-based approach[95] is adopted as a means to provide a greater level of efficiency and competitiveness in support and maintenance operations.[96]

[95] Such as allowing bidding opportunities on support contracts for non-OEM firms.

[96] This trend of adopting the OEM as the prime contractor in maintenance activities follows the discussion in Section 2.1.1

Performance Measures and Management of Risk Tolerance in ISS support

OCCAR ISS management places a large emphasis on being able to effectively measure performance of its management ability and the performance of its contractors. An in-depth performance measurement system is in place and helps quantify overall effectiveness. On this last point, there is mention of incentive structures being built into procurement and ISS contracts from a policy perspective. In the context of the Airbus A400M,[97] relevant performance measures include operational reliability, which is contractual, and operational availability, which is not. The ISS contractor is required to maintain a 98.7% operational reliability rating, and a 90% availability rate is targeted; it is not clear however whether financial penalties or incentives exist as a means to incentivize the contractor.

Regarding the concept of contracting measures that can be implemented in order to take into account risk tolerance, particularly in the area of operational availability, an example can also be found in the case of the Airbus A400M. OCCAR has recommended that, to capitalize on cooperation between nations and efficiencies of scale, support activities should be increasingly contracted out to industry; naturally, this brings about a certain degree of risk in terms of operational availability and supply interruption. To mitigate this, participating nations have looked into potential ways of using contracts to allocate responsibility for aspects such as *operational availability*, *management of "deployment kits"*[98] to be used in operation, and the coverage of *changing conditions in contract prices*, between industry and government.

[97] A more in-depth discussion of the support concepts pertaining to the Airbus A400M follows in section 6.4.

[98] 'Deployment kits' consist of transportable spare parts often used in maintenance activities for a given system.

6.3.1 Description of OCCAR's ISS Activities

OCCAR's management activities associated with in-service support are as follows:[99]

- Configuration Management; consisting of "*all tasks necessary to direct and control the functional characteristics of a Defence System*".
- Maintenance Management; consisting of "*all tasks taken to retain the Defence System or restore it to a specified condition*".
- Supply Support Management; consisting of "*all activities and sub-activities necessary to determine, acquire, catalogue, codify, receive, store, transport, issue, repair and dispose of spares and components (...)*" needed to support a given defence system.
- Technical Support Services; consisting of all tasks "*necessary to monitor and control the reliability and maintainability of a Defence System, to maintain agreed performance levels and enhance them.*".
- Obsolescence Management; consisting of all activities "*necessary to minimize the impact of the lack of supply or supportability due to obsolescence*".
- Technical Information and Data Services; consisting of all "*tasks necessary to produce, give access, utilize and maintain information and data necessary to operate, maintain, repair, support, train and dispose of equipment*".

[99] As described within the OCCAR-EA ISS Guide, OCCAR-EA (2010).

- Training Support Services; consisting of "*the whole training environment, including facilities, simulators, training resources, Computer-Based Training, and distance learning, syllabi, manuals, plans and procedures*".

It is important to note that when tasked with the management of the ISS of a given defence platform, OCCAR has the ability to make use of third-party subcontractors for some of the specific activities listed above. The OCCAR ISS management guide expressly indicates and makes provisions for the use of these third-party contractors, and they are barred from participating in certain management activities as deemed appropriate by OCCAR guidelines.

6.4 Case Study: Support of the Airbus A400M

The A400M program, initially launched in 2003, represents the first joint development effort undertaken by OCCAR nations and has been seen as a test of the viability of the organization as a whole.[100] The aircraft is meant to respond to essential military needs shared by all partner nations, including personnel and cargo transport, air-to-air refueling and performing airdrops; it is therefore intended to replace aging C-130 and C-160 transport aircraft currently employed by the participating OCCAR states.[101] The program, despite being plagued by delays and cost overruns which has led some partners to reduce their orders or bow out entirely,[102] has currently 174 aircraft on order, with deliveries set to begin this year (2013).[103]

[100] Lange (2009).
[101] Airbus (2013).
[102] Defense Industry Daily (2009b).
[103] Fight Global (2012).

This section will detail support and systems management concepts aimed at increasing overall availability and cost effectiveness, largely drawing upon OCCAR's own sources.[104]

6.4.1 Availability Measures and Optimized Support Modelling

There are two key measures of availability that are essential to program evaluation, particularly in the context of strategic airlift. The first is "Operational Reliability" (OR), which is defined as the percentage of flights without "mission loss". Mission loss refers to those situations where technical issues result in either either (1) a mission being canceled or otherwise interrupted, or (2) a delay of more than 15 minutes in the departure time. The A400M program has a contractual obligation of an Operational Reliability requirement of 98.7%. While this figure is relatively high, it is based on previous experience of Airbus-developed military aircraft fleets, including the A320, A321 and A319 platforms.

The second measure of availability is "Operational Availability" (OA), defined as the amount of time in which he aircraft is mission-ready, including time either on standby or on mission, divided by total time. This measure takes into account any type of down-time, from maintenance for either corrective or preventive measures, as well as administrative delays; as such, it is inherently linked to the efficiency of the support system of the aircraft. In contrast to the "Operational Reliability" figure, Operational Availability is non-contractual. The target for most participating states is a 90% overall Operational Availability rate for the A400M, a figure that is cited as a considerable improvement over

[104] In particular, a report prepared by Heuninckx (2011), a A400M Logistic Support Officer at OCCAR at time of publication.

most existing systems.[105]

In order to maximize Operational Availability and ensure cost-effectiveness of the in-service support phase, Airbus has provided to the participating states a sophisticated modelling tool that allows the planning of human resources and spare parts availability based on a user-defined level of Operational Availability of its fleet. The model can essentially derive optimal levels of spare parts and man hours needed in order to achieve a desired level of Operational Availability, offering the participating state a clear picture of what costs would be necessary in order to support this target. This allows for better predictions of whole-life costs of the A400M platform, and gives users the ability to explore alternative operating assumptions if budgets or cost tolerances change.

While Airbus subjected the modelling tool to rigorous third-party robustness testing, alternate modelling software is also used along with expert analysis as a means to provide an alternate perspective and ensure that budgeting decisions are thoroughly researched and supported.

Of course, efforts aimed at optimizing availability and cost-effectiveness must necessarily start during the development phase of any given system, and is not solely limited to spares and maintenance optimization after delivery. To this end, Airbus made use of an "Operational Reliability Analyser" model in supporting system design in order to evaluate consequences of system architecture, components reliability, maintainability and testability (RM&T) characteristics have on operational availability. This allows supportability

[105]This availability measure is a popular *Key Performance Indicator* amongst many nations, including Australia's use for its F-18s, France's use for its Navy, and the UK's use for its Astute Class submarines. See sections 3, 4, and 5 for more details on these measures.

engineers to influence system design in order to meet availability requirements early on in the development phase.

6.4.2 The Commercial Approach to Systems Development and Support

From the onset of the A400M program, there has been a keen emphasis on maintaining an open, commercial approach. This is in line with OCCAR's principle of ensuring openness and competitiveness in procurement and support, and enables Airbus Military to pursue manufacturing sources for various components that maximize value per dollar spent while ensuring that performance and quality standards are met. This is in contrast to policies that were in place prior to the emergence of OCCAR, in particular the "juste retour" principle that would otherwise require work be conducted in participating countries due to their involvement in the program. Though the new OCCAR principle of "Global Balance" does provide these countries the opportunity to participate in design, production and support on a case-by-case basis, this is done on the condition that their respective industry participants are internationally competitive and are selected by the prime contractor based on merit. Airbus is thus encouraged to employ commercially competitive business practices in all aspects of the program, while allocating work to sub-contractors competitively.[106]

[106] Section 2.1.2 discussed how domestic industries can still benefit from ISS if they are competitive enough to be in the global supply chain.

6.4.3 Maintenance Optimization Aspects

Three key aspects are cited within OCCAR's A400M support study[107] as being instrumental in mitigating costs while ensuring availability. These are, in turn: the "Optimized Scheduled Maintenance Program"; the use of "On-Condition Maintenance" and the objective of a 15-day "Maintenance-Free Operating Period". A synopsis of these concepts follows; the emphasis here is how efficiencies and operational availability gains are achieved.

Optimized Scheduled Maintenance Program - Developed by drawing upon analysis obtained through the collaboration between Airbus, OCCAR and airworthiness authorities from the participating states, the goal of the optimized scheduled maintenance program is to increase efficiencies in scheduled maintenance by conducting analysis as to which components are absolutely necessary for these activities, taking into account cost-effectiveness and, above all, safety. This process leads to the development of a maintenance program for the A400M that can then be customized to meet the operational requirements of the participating states. By eliminating redundancies and focusing periodic maintenance on those components that require attention based on the expert analysis provided, gains in efficiency and availability and decreases in downtime are expected.

Use of On-Condition Maintenance - By employing the use of on-board monitoring systems that automate certain inspection aspects, inspections of components at pre-determined intervals can be omitted, rendering the scheduled maintenance process more efficient. These monitoring systems are cited as being capable of detecting the degredation of mission-critical systems and can suggest a schedule interval during which a maintenance action

[107] Heuninckx (2011).

should take place; as such, this action can be deferred to a more convenient time. This system further allows the continuation of service of the aircraft with a degree of confidence that mission failure or further damage to the affected components can be avoided.

The Maintenance-Free Operating Period - Airbus Military has as a goal the provision of a 15 day "Maintenance-Free Operating Period" to users of the A400M; this is defined as a period of operation during which an aircraft is able to be operational without need of special maintenance (this does not include pre-defined flight servicing or role-change activities). Faults may occur during this period, but they cannot interfere with the operational capability of the aircraft and must be able to go without correction for the defined period. A maintenance recovery period may follow.

6.4.4 The Common Support Approach

As the operational requirements, size of fleet and capacity vary significantly between participating states, an effort is being made in order to have all participants reach an agreement to perform support services in common. Possible shared aspects could include common maintenance, the pooling of spare parts, configuration management and training. Cross-maintenance activities, where one participating state agrees to maintain an aircraft of another, may also be part of such an agreement. The gains that would be made from this type of collaboration are potentially quite large, as eliminating redundancies and increasing economies of scale in these areas between partner nations should lead to decreased overall costs; OCCAR cites a potential whole-life cost savings between 3.98 (expected) and 7.15 (maximum) percent, with support costs decreasing substantially, between 7.96

and 14.3 percent. It is also believed that gain in operational availability would result from the adoption of this “common support” approach.

6.4.5 Moving Towards an Industry-Based Approach to Maintenance

Another method of optimizing availability and lowering support costs deals with the allocation of support activities between military and industry. Historically, nations handled a majority of systems maintenance through the use of military depots. It is thought that most of the repairs of line-replaceable units could now be contracted out to industry. While placing a greater dependency on industry to ensure aircraft availability, changes in the nature of the multinational security environment in recent years are believed to be conducive to a more active role of industry in military system support.

If multiple nations moved towards this industry-based approach, maintenance activities would likely see an improvement in terms of downtime and cost-effectiveness. Participating states are to look into ways to limit risk in terms of aircraft availability, and a key method of accomplishing this is tying in availability, pooling and leasing into contracts with industry. OCCAR could have a leading role in negotiating these contracts as a means to provide the expected gains of common support.

6.4.6 Short-Term Contracts as Off-Ramps

A final support aspect of the A400M that bears attention is the employment of short-term contracts in ISS support. Recently, France has signed a relatively short 18-month deal

with Airbus Military for support services of the A400M.[108] As discussed in Section 2.2.5, the potential for contract renewal can incentivize the contractor to provide optimal effort. In this sense, the signing of such a short-term contract can act in a similar manner as an off-ramp clause. It should be noted, however, that given the fact that the A400M is a very new aircraft, not much competition can be expected from the private sector in the early stages of its life cycle.

6.4.7 Discussion of the A400M Case Study

The measures outlined above bring about some very interesting and innovative ideas. A more efficient projection of spare parts requirements should lead to reduced costs in inventory and maintenance while bringing about peak operational availability. The commercial approach emphasized by OCCAR should also lead to efficiency enhancements due to increased competitiveness in industry and the greater freedom allowed to the prime contractor. Improvements in efficiency and the removal of redundant or otherwise unnecessary maintenance checks should likewise prove beneficial. Finally, a mindset of moving towards a common support approach whereupon cooperation amongst partner nations is encouraged, while according more responsibility towards industry in support and maintenance activities, should yield important improvements in terms of cost effectiveness due to economies of scale.

There are, however, some risks to be considered in implementing these initiatives. Regarding the commercial approach to manufacturer and sub-contractor sourcing, it is stated by OCCAR that these should be based upon a principle of Global Balance, which allows na-

[108] Airbus Military (2013).

tions involved in a given program the opportunity to participate industrially. While perhaps not as rigid as the prior "juste retour" concept, it remains to be seen just how much more "open" the concept of Global Balance is by comparison, and whether efficient producers from non-participating nations would be considered in sourcing initiatives.

It is still possible that potential efficiency losses due to the application of forced reciprocal trade brought about by the Global Balance principle are ultimately outweighed by the efficiency enhancements associated with specialization and comparative advantage in international cooperation. From an economic theory perspective, there are a few key considerations. Classical theory[109] states that countries trading goods in which they have specialized in production would result in mutual gains in national income, and thus greater overall efficiency. However, actual benefits would largely depend on multiple factors such as transportation costs and relative levels of specialization.[110]

Another consideration that merits attention is the proposal of increasing the participation of industry in support and maintenance activities, particularly the recommendation that nations should move away from in-house maintenance operations. Certainly, deployed operations require some level of "in-house" maintenance capacity, as the role of industry might not be suitable in such situations, especially those that are time-sensitive or when operational availability is an important consideration in the short term. It seems that in order to mitigate potential issues such as supply interruptions or decreased operational availability, some balance between industry participation and in-house capability will have

[109] In this case, the Ricardian Trade Model.

[110] For example, is it necessarily better for the Netherlands to carry out cross-maintenance activities in France simply due to its increased capacity? This would largely depend on the efficiency and cost-effectiveness of such operations.

to be employed.

7 Conclusion

When we compare the policies across the three countries studied in the paper, we see that despite some clear motivational differences, the end results are somewhat similar.

Australia's policy is driven by their desire to be self-sufficient, so they can stand on their own in a relatively unstable region of the world. Their policy for the next 20 years involves investing in domestic firms so that they can perform all the necessary ISS. They currently lack this ability due to years of underinvestment.

France also wishes to maintain a domestic presence in all the various support industries. Their policy differs from Australia's in that they will only reserve contracts exclusively for domestic firms if these firms could not otherwise survive without them. France is willing to have its ISS services performed in foreign countries if the market is thick enough and if it helps them further European integration. However, there are certain national champions, such as nuclear and aerospace, that France singles out for extra support.

Finally, the UK has committed itself to only supporting specific military industrial sectors. To do this, they will reserve ISS contracts in these sectors for domestic firms. They will also actively and aggressively acquire all the necessary IP that these firms require to provide the necessary support.

Despite these different motivations, these countries all use similar policy tools. Firstly, they have all committed to a more open communication with industry, in what is termed 'public private partnerships'. By providing domestic firms with the overall strategy of the

military, these firms can better respond to the needs of the military.

Secondly, these countries have all begun using performance based contracts and key performance indicators to measure success. Gone are the days of contracts that specify inputs. These were bureaucratically intense, and did not necessarily provide the desired outcomes. These new contracts exploit the profit motive of firms to allow them to make their own decisions on the best methods to satisfy the contracts. The trend of moving away from servicing done by the military to servicing done by firms can be seen in all three countries. In fact, in Australia there are concerns that the pendulum has swung too far, and that the military no longer has the necessary skills for maintaining deployed equipment. The similarities between the countries even extend to them choosing similar KPIs, which usually include some measure of availability and some measure of reliability.

Third, we see that the countries are keen on obtaining the necessary IP to provide domestic support. The UK traditionally relies on military spending to provide a boost to the R&D of the economy. If they can acquire the IP when negotiating for the initial purchase of the equipment, this should provide them with the best price since this is when the government holds significant bargaining power over the OEM. Australia also finds it necessary to acquire IP for its domestic firms so that it can maintain domestic ISS capabilities.

Lastly, we observe some consideration as to how much freedom firms need to be given. Australia especially struggles with this question as they wish to maintain a veto to unilaterally cancel contracts whenever they wish and for almost any reason. They hope this will encourage the firm to act in a competitive manner to keep costs low. Firms on the other hand say that this threat keeps them from investing in equipment that could lower costs

further.

So, even though the motivational forces behind these countries' policies are different, many similarities emerge. The practices of these countries suggest that increased cooperation with the private sector can allow the government to reap significant cost savings. The overall theme that emerges is that the profit motive is a strong force in achieving efficiency. The government can tap into this by minimizing the constraints it imposes on firms. This includes providing the firms with the necessary IP purchased from OEMs, allowing them to decide optimally what inputs to use to achieve the KPIs, and giving them the security they need to invest in the capital that can lead to substantial cost savings. If the purpose of outsourcing support services to the private sector is to capitalize on their efficiencies, then interference with this process should be minimized, while still maintaining proper oversight of the process.

OCCAR's approach to ISS support activities has also moved towards a more market-based, competition-oriented perspective, with the overarching goal of minimizing life-cycle costs for any given defence system. To this end, the organization maintains a keen focus on management practices, enforcing guidelines on performance measures and system availability, and optimizing support processes. Further, the recently-implemented 'global balance' principle, which replaces the antiquated 'juste retour' concept, is designed to ensure competition amongst industry entities in the member nations; while a balance of work-sharing is followed, there is more potential for competition, which should serve to ensure more optimal levels of effort and drive down long-run support costs.

In analyzing the support activities undertaken by OCCAR for the A400M tactical and

strategic airlift, a few important considerations are apparent. The maintenance optimization aspects – in particular, the 'optimized scheduled maintenance program', the use of 'on-condition maintenance' and the implementation of a 'maintenance-free operating period' requirement – should all serve to reduce downtime by eliminating inefficiencies in standard maintenance practices. The move towards an industry-based approach to maintenance, meanwhile, mirrors that which has been undertaken by the Australian, British, and French governments. Perhaps most significant, however, is the common-support approach espoused by OCCAR for the support of this system; the pooling of spare parts, the sharing of training responsibilities, and cross-maintenance activities are expected to result in significant decreases in support costs.

Beyond the availability and reliability of defence equipment, ISS matters critically in terms of the overall ownership cost of a platform. In fact, the ISS cost over the lifetime of equipment far exceeds its procurement cost. Therefore, any policy conclusions reached must reflect two aspects of the lifetime of equipment: use value and cost. There are two relevant factors in the Canadian context. First, apart from Leopard tanks and Search & Rescue helicopters, Canadian Forces equipment is overwhelmingly American. Second, Canadian defence industry capabilities are narrow and significantly integrated with American primes. Moreover, many Canadian contractors are American primes' subsidiaries.

Canadian ISS contracts for legacy fleets included Victoria class submarines with Babcock Canada, a subsidiary of the British Babcock International, with facilities in Halifax and Victoria; Halifax class frigates' modernization with a Lockheed-Martin led team with CAE Systems and L3; CC-130H Hercules with Cascade Aerospace of Abbotsford which has

also a contract for the new C-130J Hercules as a subcontractor to Lockheed Martin; CP-140 Aurora with IMP Aerospace of Halifax; and CH-124 Sea Kings with IMP. The recent procurement of CH-149 Cormorants, CH-148 Cyclones, CC-177 Globemasters, CC-130J Hercules and CH-147F Chinooks illustrates the two categories of ISS prime contractors, namely OEMs and domestic contractors. The Cyclone, Chinook and Hercules purchases basically bundled up ISS with OEMs whereas the Cormorant ISS will be performed by IMP Aerospace, a domestic contractor. In this latter case, some technical data (TD) and intellectual property (IP) contractual issues arose as expected.

Perhaps the most interesting case is the Scan Eagle Unmanned Aerial Vehicles (UAVs) purchased from Boeing/Insitu. Insitu's partner ING of Ottawa turned this UAV capability into a complete service, from maintenance to training. Since ING involvement looks like an "embedded ISS contractor", perhaps it constitutes an example of deployed ISS, in fact a new frontier in outsourcing ISS. Another interesting case involves the Globemasters where Canada participated in "the Globemaster Sustainment Partnership", a Boeing-led initiative which resembles a private version of the European OCCAR partnership. The assortment of Canadian experiences suggests that, regardless of the circumstances that led to different types of ISS arrangements, there is no overarching policy regarding ISS and the issue as to whether there should be one is debatable. However, given the strong Canadian aerospace sector the question is critically relevant.

Integration to global supply chains is undoubtedly desirable. In two recent cases, IMP Aerospace expanding their Aurora ISS to generate work in Norway and L3's exports based on their Hornet ISS, we can observe the potential of the Canadian aerospace, a sector

that has roots in 1950s' production sharing agreements with the US. Generalizing, an ISS policy has to be nuanced and take into account the export potential of existing branches of the Canadian defence industries.

The lessons learned in this report, summarized above, from Australia, France, the UK and OCCAR, complemented by a collection of Canadian experiences, are relatively recent. Further evidence should shed light on potential policy directions.

Annex A: A Simple Model of Relational Incentive Contracts

The key ingredient of relational contracts' self-enforcement is the power of the long-run benefits outweighing short-run cheating or exiting benefits. A methodological remark regarding the principal's objective function is in order. Since the principal is a government agency, it maximizes its net benefits, i.e. overall benefits to the project minus costs of contractor compensation. Whereas costs are easy to compute, benefits are multidimensional - unlike the case of private firms where a single synthetic measure, namely profits, corresponds to benefits.

Consider a repeated-game with a bonus based on a subjective assessment of a contractor's contribution 'y' to firm value. This contribution is not objectively measurable but can be subjectively assessed by a manager of the principal who is capable of observing the contractor's opportunity set as well as his behaviour. Thus 'y' is observable but not verifiable.

A.1 The Single-Period Game

In each period, the contractor chooses an unobservable action 'a' that stochastically determines the principal's asset value 'y' that can take binary values $y_L < y_H$. We adopt the assumption that 'a' falls between 0 and 1, so $0 \leq a \leq 1$. This is a standard assumption in the literature and it serves to drastically simplify the exposition; we can now interpret

'a' such that $P(y = y_H|a)$ and $P(y = y_L|a = 0)$ such that $P(y = y_H|a) > P(y = y_L|a = 0)$ for all 'a' such that $a > 0$. The contractor's increasing and convex effort cost is $c(a)$ with $c'(a) \uparrow$ to ∞ as $a \uparrow$ to 1. This last assumption makes sure that $P(y = y_H|a)$ does not rise to the upper bound of its support.

The contractor's compensation is as follows. First, the principal offers a compensation package (s, b), where 's' is a baseline transfer when the contractor accepts the offer and 'b' is a relational-contract bonus meant to be paid when $y = y_H$. Second, the contractor's alternative opportunity yields payoff 't_A'. Third, if the contractor accepts the contract then she chooses the action 'a' at cost $c(a)$. The principal does not observe the contractor's action but both the principal and the contractor observe the realization of the contractor's contribution to the principal's value, y. Finally, if $y = y_H$ then the principal chooses whether to pay the contractor the bonus 'b' specified in the relational contract or an equivalent as a higher level relationship that can take the form of a promotion if the contractor happens to be a person. Though relational contracts with promotions may be more prevalent than the pay-for-performance or bonus-based relational contracts studied here, these latter mechanisms are analytically easier to solve.

In a single-period relationship with this timing (or in the final period of a multi-period relationship with a known, finite duration), the firm would choose not to pay a bonus, so the contractor (anticipating the principal's decision) would choose not to supply effort. The principal, anticipating the contractor's choice, would not pay a bonus greater than y_L. Whether the contractor accepts this contract would then depend on a comparison of y_L to t_A such that if $t_A < y_L$ then the contractor would accept the contract but work only when

$a = 0$. To make the problem interesting, it must be assumed that $t_A > y_L$.

A.2 The Repeated Game

In an ongoing relationship, the principal may value its reputation for honouring its relational contracts. To capture this, we analyze what is formally described as an infinitely repeated game but which is better interpreted as a repeated game that ends randomly. For simplicity, trigger strategies are adopted; i.e., parties begin by cooperating and then continue to cooperate unless one side defects, in which case they refuse to cooperate forever after. The trigger-strategy equilibrium maximizes the principal's expected payoff subject to making the terms of the relationship sufficiently attractive that the contractor chooses to work with this principal.

The key issue is how large a bonus the contractor can *trust* the principal to pay. The answer depends on the principal's interest rate, 'r', and on its expected net benefit per period.

If the contractor believes the principal will honour the relational contract (i.e., it will pay the bonus 'b' after observing performance $y = y_H$), then the contractor's optimal effort $a \in [0,1]$ solves:

$$max_{\{a\}}\{s + a \cdot b - c(a)\} \tag{A.1}$$

where the total transfer to the contractor is $t = s + b$. The solution to the contractor's

problem is given as $b = c'(a)$. For an arbitrary b, $a^*(b) = c'^{-1}(b)$ is the contractor's optimal action. Thus the principal's expected net benefit or payoff function, assumed to be a single-variable function for simplicity, becomes:

$$\pi^e(b) = L + a^*(b) \cdot [H - L] - [s + a^*(b) \cdot b] \tag{A.2}$$

The contractor will work for the principal if her expected payoff exceeds her alternative payoff t_A:

$$[s + a^*(b) \cdot b] - c(a^*(b)) \geq t_A \tag{A.3}$$

Assuming that the alternative payoff is not so high to prevent the principal from both attracting the contractor and realizing a positive payoff, the optimal baseline transfer offered by the principal is the lowest sufficient to induce the contractor to work with the principal, i.e.:

$$[s + a^*(b) \cdot b] = c(a^*(b)) + t_A \tag{A.4}$$

Given this baseline transfer, the principal's expected profit per period with the relational-contract bonus 'b' is:

$$\pi^e(b) = L + a^*(b) \cdot [H - L] - [c(a^*(b)) + t_A] \tag{A.5}$$

This expression for the principal's expected payoff per period allows us to determine how large a bonus the contractor can trust the principal to pay.

Given the contractor's trigger strategy, if the principal does not pay the bonus'b' when the contractor's contribution is $y = y_H$ then the principal's payoff is $(y_H – s)$ this period but *zero* thereafter. For $t_A > L$, the contractor will not work for this principal if trust[111] collapses. Yet, if the principal pays bonus 'b' then its payoff is $(y_H - s - b)$ this period but $\pi e(b)$ thereafter. Thus, it should pay the bonus if and only if:

$$(H - s - b) + \frac{\pi^e(b)}{r} \geq (H - s - 0) + \frac{0}{r} \tag{A.6}$$

or, simply,

$$\pi^e(b) \geq r \cdot b \tag{A.7}$$

where $\frac{1}{r}$ is the present value of \$1 received next period and every period thereafter. In other words, $\frac{\pi^e(b)}{r}$ is the present value of future profits with the bonus 'b' paid to the contractor. The efficient relational contract sets 'b' to maximize expected payoff per period, $\pi^e(b)$, subject to the principal's own reneging constraint $\pi^e(b) \geq r \cdot b$.

[111] This relates to off-ramping the contractor or, alternatively, the contractor off-ramping itself. Moreover, it is critical to understand "(...) how these switches depend on the length of the relationship, the number of suppliers, and the shocks to the economy" (Board (2011).

For high enough values of 'r', such as r_H, no value of 'b' generates enough expected profit to dissuade the principal from reneging, i.e. no value of 'b' satisfies $\pi^e(b) \geq r \cdot b$. For small enough values of 'r', such as r_L, first-best incentives can be provided through a relational contract with bonus b_{FB}. Finally, for intermediate values of r, such as r_M, the efficient relational-contract bonus b^* is the largest value of 'b' that satisfies the reneging constraint. In this case, a larger value of 'b' (but still less than b_{FB}) would improve incentives (if the contractor believed that such a bonus would be paid) but is not credible (because $\pi^e(b) < r \cdot b$ for all such larger values of 'b').

For interest rates in the intermediate range, the efficient bonus falls as 'r' increases, because the higher value of 'r' makes future profits less valuable, so the principal is more tempted to reneg on paying the bonus. Similarly, as t_A increases, the firm's expected payoff falls, so the largest feasible relational-contract bonus falls.

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In-Service Support (ISS) provides operational value to defence management in terms of the availability and reliability of equipment during missions and training and it extends the overall life of the equipment. This paper takes a two-pronged approach to analyzing ISS activities: firstly, key theoretical aspects are considered, with in-depth analysis on long-term and relational contracts in ISS provision, considerations pertaining to in-house contracting versus private sector subcontracting, and issues in long-term contracts. Secondly, the approaches to ISS management employed by three countries - Australia, France and The United Kingdom - are examined, along with a detailed analysis of the European multinational armament organization OCCAR. This analysis finds, among other things, a preference towards the inclusion of off-ramps in support contracts, as well as an emphasis of including the private sector in support activities whenever feasible.

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