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Coalition Transformation: An Evolution of People, Processes and Technology to Enhance Interoperability

Topic: Coalition Interoperability

Evaluation of Organisational Interoperability in a Network Centric Warfare Environment

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Abstract

Recent trends and developments in operations mean that military organisations are increasingly being required to interoperate with a larger number, and wider range, of non-traditional partners. These include military, government and non-government agencies both national and international. At the same time, some military organisations are examining how they might best use the recent advances in information communications technology including the adoption of different approaches to warfare such as network centric warfare (NCW).

The Organisational Interoperability Model (OIM) was developed for the evaluation of interoperability at the human-activity or organisational level. The opportunity has been taken to re-examine the model in light of the changes outlined above. In

particular, this paper examines the suitability of the OIM for conducting evaluations in this wider context, and introduces a new version of the model.

This paper also discusses the analysis of interoperability in individual organisations, starts to identify some potential stand-alone indicators and foreshadows the development of additional models based on the OIM.

1. Introduction

Recently, there have been significant changes in the nature, scale, scope and diversity of military operations. There is an increased tempo of operations and Defence Forces are now often involved in several concurrent operations. Unilateral operations are rare; joint, combined and coalition operations now predominate. Coalitions are often formed on an *ad hoc* basis and at short notice. They can be fluid, with partners joining and leaving or re-scaling their commitments during the course of the collaboration. Coalition members are rarely equal; the contribution of some may be limited to providing specialised skills or services. There is an increase in military operations other than war (MOOTW) such as peacekeeping, restoring law and order, and border protection. In addition, new war-fighting concepts such as network centric warfare (NCW) and Effects Based Operations (EBO) are being explored and used.

Some of these trends are illustrated in two recent operations involving Australia as lead nation.

International Force East Timor (INTERFET) was a coalition of military forces from twenty two disparate nations, tasked to restore peace in East Timor. The ADF provided initial mandatory force preparation for the troop contributing nations and the force was then assembled in the field. As a number of contributing nations operated under dissimilar protocols and were constrained by national caveats, there were many organisational interoperability difficulties (Ryan 2000).

In 2003, the ADF participated in a regional assistance mission to assist the Solomon Islands government to restore law and order (Department of Defence 2004; Howard 2004). The lead and overall coordinating agency for this mission was the Department of Foreign Affairs and Trade. The Australian Federal Police, supported by Australian Protective Services, had a lead role in the establishment of law and order and disarmament. AusAid focused on stabilising the country's financial systems, revitalising the courts and rebuilding the prison system. In this operation, the role of the ADF and military personnel from Fiji, Tonga, New Zealand and Papua New Guinea, was to stabilise the environment and provide physical presence and security as well as logistic and operational support.

There are many implications for military organisations flowing from these trends. For example, there is a need to sustain operations across a number of theatres. The increase in coalition operations and their often dynamic nature means that military organisations now need to collaborate with varying numbers of, and more diverse, military organisations and with a range of non-military partners. They may also need to be prepared to do this at short notice and, in some cases, to form, co-ordinate and manage novel collaborations. In this environment, having the ability to work with different sets of partners, including non-traditional ones, and being able to provide a wide range of services would be an advantage. The development of new approaches to warfare such as NCW means that military organisations may need to adopt very different approaches when they collaborate with certain partners. Network centric

organisations are expected to be capable of organising differently. For example, the ability to network dynamically means that such organisations could be more agile in structure than non-networked organisations (Alberts & Hayes 2003). This might result in the use of both centralised and decentralised command arrangements according to need. The nature of personnel in an NCW organisation may also be very different. They may be selected, recruited and promoted based on different criteria and trained to work and organise in very different ways (Warne *et al.* 2004).

These changes have heightened the need for a greater understanding of and an increased need for studies of organisational interoperability (OI). The Organisational Interoperability Model (OIM) (Clark & Jones 1999; Fewell & Clark 2003) was developed to evaluate interoperability at the human-activity or organisational level. The opportunity has been taken to re-examine the model and underlying issues in light of the trends outlined above.

The enabling NCW characteristics considered in this paper are agility, distributed functionality and the ability to network dynamically. Alberts and Hayes (2003) have identified six possibly interdependent characteristics to describe agility, namely: robustness (the ability to maintain effectiveness across a range of tasks, situations and conditions), resilience (the ability to recover from adversity), responsiveness (the ability to react in a timely manner), flexibility (the ability to use multiple ways to succeed and move seamlessly between them), innovation (the ability to do things in new ways) and adaptation (the ability to change things in response to environmental change). For the purposes of this paper, distributed functionality means having the ability and authority to separate out functions and thus perform them at many geographic locations and at many different levels within an organisation. NCW is therefore more than just technology; organisational and human-activity aspects are crucial.

Section 2 of this paper discusses the background to the development of the OIM. Section 3 looks at the issues that arise from an NCW perspective, and the OIM is reviewed to determine whether it is generally applicable. Section 4 presents the revised OIM and Section 5 discusses a possible further model based on agility.

2. Background to the Development of the OIM

2.1 *Interoperability*

In rare circumstances, it may be possible for an organisation to achieve its objectives by working in relative isolation. However, organisations will usually need to interact and collaborate with other organisations. There are many ways to collaborate. At the simplest level, the task can be divided into discrete and non-intersecting parts; this approach only requires low levels of interoperability. This approach was taken by Australia in East Timor demonstrating that a mission can be successful without correspondingly high levels of interoperability between all collaborators. Other approaches to warfare, such as NCW, may require closer interaction and thus higher levels of interoperability between collaborators.

Australia and its allies have adopted the NATO definition of interoperability, i.e.

> "Interoperability is the ability of systems, units or forces to provide services to, and accept services from other systems, units or forces and to

use the services so exchanged to enable them to operate effectively together."

A high level of interoperability does not necessarily result in a high level of performance. A single organisation operating alone may be able to optimise performance, whereas one which needs to operate with other organisations – which may differ in several ways such as technology – may need to compromise it's approach in order to achieve a high level of interoperability. The ideal would be for an organisation to have the ability to work just as effectively and efficiently in collaborations as it does alone and without necessarily changing or compromising the organisation itself.

Various factors make it desirable to interact and collaborate with other organisations. These include increased economy of effort. Sharing the burden reduces costs and some partners may have particular skills or capabilities that other partners lack. Ryan (2000) points out that very few nations have the capability to meet all contingencies on their own. There are also wider political considerations e.g. coalitions are often used to convey legitimacy (Rice 1997). Improving interoperability is concerned with improving the effectiveness (or seamlessness) of interactions and thus is not directly related to performance and military outcomes. It is therefore not measured in this way. Although not guaranteed, it is generally accepted that a high level of interoperability is one of a number of factors that can contribute to improving military outcomes. Organisations may also choose to operate at different levels of interoperability with different organisations based on the perceived need to collaborate.

There is no requirement for reciprocity of effort in improving interoperability. Effort may be asymmetric i.e. *A* is interoperable with *B* mainly due to efforts of *A*. Also interoperability is not necessarily transitive, i.e. *A* being highly interoperable with *B*, *B* being highly interoperable with *C*, does not necessarily mean that *A* is highly interoperable with *C*. *B* may act as the interface between *A* and *C*, in which case *B* is certainly more interoperable in a generic sense as it can interoperate at a high level with a couple of organisations. However, it is also possible that *B* may be able to adapt to be interoperable with either *A* or *C*, but not both simultaneously. These issues are currently not taken into account in inter-organisational evaluations of interoperability.

2.2 *OIM*

The OIM was developed by Clark & Jones (1999) to address interoperability at the organisational or human-activity level as understanding these issues was seen to be vital for effective command and control. Kasunic (2001) also recognised the importance of issues such as culture noting that they were not adequately covered by more technically oriented interoperability models (see Section 5).

The OIM has been developed as a framework for inter-organisational evaluations and not for single organisation evaluations against a standard. This recognises the transactional nature of interoperability and allows interoperability to be evaluated within a particular context. There are also no obvious standards for many of the factors identified as important, such as language and culture. The definition of interoperability used in the original model was 'the need of one group to interact in some way with another group' (Clark & Jones 1999). There was not a specific focus on the exchange of services or the scope of services provided; instead the focus was on human-activity factors affecting the exchange of information.

Development of the original model was not predicated on any particular approach to warfare but occurred in the context of a perceived need by the Australian Government for greater interoperability between forces, with key allies, and in *ad hoc* coalitions – in that order of importance. Hence, when developing the original model, jointness, integration and homogeneity were chosen as defining characteristics at the higher levels in the model. Interactions with non-military organisations were considered, but, at the time, it was not envisaged that they would ever achieve more than low levels of interoperability with military organisations.

The model was revised in 2003 (that model now to be known as OIM2003) based on experience in the application of the model in the field. A detailed description of sub-attributes was also compiled. This version was used as the starting point for discussion in this paper. The model developed in this paper will be referred to as OIM2004.

The OIM has five levels of interoperability described by four attributes namely: Preparation, Understanding, Command and Coordination, and Ethos. Preparation examines the degree of formal preparations including doctrine, the establishment of a legal framework, training and experience. Understanding examines the level of information exchange and the degree of shared understanding developed. Command and Coordination examines issues related to command structure, command and leadership styles. Ethos covers socio-cultural factors such as goals, values and trust. These four attributes are described in more detail in the Appendix.

3. Review of the OIM

The network construct has been driven by exponential advances in technology and increasing environmental complexity. To deal with these changes, organisations need to develop flexible organisational structures and compatible processes (Chisholm 1996). Military organisations, like their civilian counterparts, will have to develop new, more decentralised structural forms, with more open boundaries and flatter hierarchies. The old traditional, centralised and routinised structures, that were suitable for relatively stable and predictable conditions, may need to be replaced by flexible organisations, better adapted to the new, uncertain and changeable environment of the new century (Manigart 2003). The breaking down of traditional structures has already begun.

The OIM should be able to evaluate interoperability when one or both organisations are taking an NCW approach or are a non-military organisation. To date, however, much of the related work done by the military on future concepts has been from a technological and operational perspective. The military is now looking at new possibilities for shared understanding and situational awareness, the potential for improved, better informed and faster decision making, and better command, control and coordination of different force elements. A study of historical operations has identified six forms of command and control with varying levels of control and planning.[1] Those with the least control and planning and most emphasis on command intent require highly skilled and trusted personnel, and the availability of high quality and timely information to the distributed decision makers (reported in Alberts & Hayes 2003).

[1] The six forms of command and control identified are Cyclic, Interventionist, Problem-Solving, Problem-Bounding, Selective Control and Control Free (Alberts & Hayes 2003 pp20-26).

A top down approach was used to identify changes at the lower levels. An outcome of this process was increased insight into, and understanding of, organisational interoperability.

3.1 *General Organisational Interoperability Issues*

3.1.1 *Strategies for Improving Organisational Interoperability*

As a result of examining the characteristics of NCW organisations, it became evident that there is a range of strategies for achieving high levels of OI on an organisation to organisation basis. At one extreme, organisations can become integrated with, or very similar to, a particular organisation or group of like-minded organisations in key areas e.g. sourcing equipment from the same suppliers as key allies; standardisation of concepts, doctrines, procedures and design (Ryan 2001). At the other extreme, organisations such as NCW organisations, may have the capability to be very agile if required, to be able to quickly and easily change procedures, command and coordination to, for example, easily adapt to interoperate with a new partner (Alberts & Hayes 2003). Agility was not considered as an attribute in the original OIM. Instead the organisations were evaluated as though they were static in form and the OI level evaluated was regarded as a snapshot in time. It is now recognised that organisations may also be changing and adapting in response to a dynamically changing environment and that it would be useful to measure how well organisations can do this.

In order to accommodate the range of different methods of achieving a high level of OI, the seamlessness of interactions, rather than the degree of similarity or integration of the organisations themselves, was chosen as the key measure in OIM2004. Firstly, this removes any perception that there is a need for organisations to be similar in order to be interoperable and secondly, it generally covers the situation where one organisation may be able to adapt quickly and effectively. This means that there is more focus on the interactions and interfaces between organisations e.g. on whether any processes are in place to accommodate human-activity differences that are likely to have an impact on OI.

3.1.2 *The provision of services*

The definition of interoperability adopted by Australia and its allies is focused on the exchange of services whereas OIM1999 and OIM2003 largely examine the information exchanges between organisations and factors that influence this. Another approach would be to consider the ability to provide other services, the comprehensiveness and quality of services provided and accepted and how quickly and easily the organisation can change from providing one set of services to another set. Shifting the focus towards seamless interactions acknowledges that organisations can contribute different services and that it is human-activity that addresses and provides these services.

3.2 *Attribute Issues*

3.2.1 *Preparation*

The doctrine, including tactics, techniques and procedures, developed for NCW concepts is likely to be substantially different and may be incompatible with

traditional doctrine. For example, traditional doctrine is likely to be more rigid, that of NCW more dynamic, with fewer procedural constraints and predicated on levels of networking capability. This raises the question of how doctrine built on NCW can support and accommodate organisations only able to operate in a traditional way. Will it be possible for organisations using either massing of forces or massing of effects to operate together in an effective way? Furthermore, given the expected performance advantages of NCW, will NCW organisations be prepared to compromise their approach and give up some of the advantages? Does this mean that non-NCW forces will be limited in functionality, for instance, to that described by Ryan (2000) as geographically dispersed/bounded non-combat, policing, security and logistic supporting roles – a strategy successfully employed by Australia in East Timor.

While NCW capable units will have little difficulty in determining the location of the non-NCW units, the reverse does not necessarily hold. One solution to low levels of interoperability might be to limit non-NCW functional combat units to their own area of operation as already discussed above. Even this may constitute a vulnerability to the force as a whole, if real time information from this area of operations cannot be obtained by other means. In order to achieve high levels of OI, doctrine must address the means of working with other organisations. Although these are important issues, the OIM evaluates the degree to which this has occurred, but does not prescribe the means by which this is achieved.

Until recently, non-military organisations operated in a support role, however, more recently this has changed e.g. the ADF has provided support to offshore operations led by other government agencies. Non-military organisations are not likely to have doctrine in the military sense but would be expected to have established business rules, procedures and processes under which they operate.

Accommodating differences in training has the potential to be a major factor in considering OI between NCW and non-NCW organisations. For example, personnel in an NCW organisation may be trained to think and operate cooperatively rather than in a platform centric manner. While this might facilitate NCW trained personnel interoperating with non-NCW trained personnel, the reverse may not be the case. Non-military organisations did not usually exercise with military organisations but may have gained some operational experience though supporting roles. Following on from recent international and regional coalition missions, there has been an increased involvement of non-military organisations in exercises and operations.

The short lead time of *ad hoc* coalitions points to an increased need to train and develop a whole of government and, in the longer term, a whole of nation approach. The approach should include the ability to adapt quickly to work with personnel from different cultures, including civilians, and an ability to communicate and speak different languages effectively. It may also require accelerated training techniques that can be implemented once potential national and regional partners are identified.

The OIM already broadly covers issues relating to doctrine and training. Some clarifying changes in wording have been made such as from the original requirement at higher levels for common doctrine. This covers situations where some organisations have developed doctrine and procedures that are sufficiently flexible for coalition operations with a variety of partners, with varying levels of capability.

3.2.2 *Understanding*

NCW seeks to exploit the recent advances in technology to gather, store, process and distribute information. NCW forces might be set up so that they can communicate, share and exchange information with anyone. Real time sharing of information should facilitate a greater shared understanding of, for example, the military situation. Non-networked organisations cannot expect to receive the same level of information exchange and will therefore only be able to achieve low levels of OI with highly networked organisations. It is however noted that NCW organisations need a fallback mechanism for operating at lower levels with regard to communication and information systems, that is a common baseline procedural and technical framework which will guarantee optimal and timely information exchanges.[2]

Although, some non-military organisations may be highly networked, other considerations such as need and information disclosure policies will determine the type and level of information shared between national, regional and international agencies. Non-networked forces also have less opportunity to increase their level of familiarity and shared understanding with other forces during exercising or operations. Increased levels of networking may help mitigate cultural and other differences by enabling personnel to establish informal and social networks.

Language could be a significant issue between organisations from different nations, cultural backgrounds and professional sectors, especially when there has been little combined training, operational experience or other forms of interaction.

These issues are already covered by the OIM.

3.2.3 *Command and Coordination*

Command and Coordination under NCW conditions is about conveying, understanding and synchronising the command intent and managing the operating space. Command intent, within an NCW context, can be defined as that vision of a prospective operation that informs planning and decision making. Furthermore, because networking reduces the significance of location, the possibilities for cooperation, integration and interoperability increase. Virtual organisations can bring together participating troops, weapon systems, sensors, decision-makers, and other specialists, as required, for the task. Virtual organisations should shorten the command and control process, and increase the operational tempo to obtain a competitive advantage. They hold the potential to reduce non-productive time in processes and enable them to run in a more parallel way than would otherwise be possible (Schulz 2003). In the high stress tempo of combat this would require personnel who can deal with ambiguous, sometimes overwhelmingly voluminous and occasionally misleading information (Warne *et al*. 2004).

While operating within command intent is not a totally new concept within warfare (Caforio 2003; Pratten & Harper 1996), the likely extent and ubiquity of it within the future context *is* new. The devolvement of the locus of decision-making requires independence, empowerment and confidence in the decision-makers, and the requisite intelligence and skills for continual self-synchronisation; a paradigm shift in tradition and culture for both senior officers and junior commanders (Warne *et al*. 2004).

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[2] This necessitates agreed, tested and practiced operating and procedural standards and a common or baseline information exchange architecture.

NCW may result in a range of command and coordination approaches being used, often simultaneously in the battle-space. For example, while self-synchronisation may be possible in some areas, increased public awareness of military operations means that some actions may need to be closely controlled. Non-NCW organisations may not be able to be so tightly coordinated. The organisations' understanding of the command intent affects their ability to interact.

These issues are already broadly addressed in the OIM. Some wording changes were required in the model in recognition of the fact that, in NCW organisations, command chains may be flatter and multiple command chains may be acceptable. Similarly, non-military organisations are not likely to have a single chain of command or necessarily be structured hierarchically. In order to broaden the model, more emphasis was given to coordination, the comprehensiveness and harmonisation of command arrangements and the accommodation of differences in command and leadership styles.

3.2.4 *Ethos*

Future warfare will require creative people management (Jans 2002; Defence 2003). Traditional paradigms may be less appropriate. For example, the US armed forces are now mindful that their long term metric for climbing the promotion ladder, largely based on the number of people an officer commanded, is incompatible with the thrust of future war-fighting (Scott 2003). The military of the future is likely to consist of fewer people, flatter hierarchies and smaller combat units, so the reward and incentive structures need to adapt, or there will be resistance to these changes. Arthur K Cebrowski has said "Successful transformation hinges on creating a culture of innovation … that culture must foster leadership, education, process, organisation, values and attitudes that encourage and reward those who embrace innovative risks" (Scott, citing Cebrowski, 2003). To establish a military culture that rewards risk takers and innovators will require changes to established processes in NCW organisations.

This is also likely to have an impact on selection, recruitment and training policies. Personality traits and skills likely to be important in future operations are adaptability and flexibility; being able to make sense out of complex and sometimes contradictory information flows; being capable of dealing with ambiguity and with the lethality and accuracy of the new technology; being comfortable with change, including cultural change, and with information sharing; having skills in diplomacy and having the ability to innovate (Warne *et al*. 2004).

The most important aspect of organisational ethos for interoperability is human cooperation. The future battle-space will demand that personnel cooperate to a far greater extent than ever before. Yet, the factors affecting the achievement of this outcome are more social and psychological in nature than they are technological. For that reason, efforts must be made towards understanding the psychological underpinnings of interpersonal and inter-group cooperation in military contexts, with subsequent changes in military training processes.

From the earliest stages of an individual's career the development of confidence, initiative and trust rests on education, training and experience in the application of mission command. Military activities that place a heavy emphasis on unthinking obedience will be counter-productive to the development of initiative and trust. Ideally, all participants in a future force will be: skilled, confident, adaptable, intuitive, innovative, independent (within the context of command intent), and good at

building and sustaining relationships in the workplace. Trust underpins knowledge development and knowledge mobilisation. It is also an essential element in devolving command and in willingness to share information, which lies at the core of interoperability and future military operations (Warne *et al*. 2004). Where differences in external constraints preclude total trust between the interoperating organisations, processes must be put in place to minimise the impact of these constraints as transparently and harmoniously as possible.

The existing versions of the OIM do not address the specific methods or policies that could be adopted to accommodate differences in personnel selection and training. Instead, they evaluate the impact of any differences in these areas (changed to seamless accommodation of these differences, in OIM2004).

4. Changes to OIM Levels and Attributes

This section summarises the changes made to the OIM to take account of the issues raised in the previous section.

The major outcome of this review is changes to wording in the OIM2003 Levels and Attributes Table which remove any impression that it was predicated on a particular approach to warfare and which make it more generally applicable (Table 1). In summary this involved:

- a change in emphasis in what is being evaluated i.e. the degree of seamlessness of interactions rather than the degree of integration/ commonality/ similarity of the organisations. Thus wording changes give less emphasis to commonality and more to compatibility e.g. common doctrine changed to compatible doctrine, harmonisation e.g. of training, experience and command arrangements, and accommodation e.g. of differences in command and leadership styles.
- changes to give less emphasis to hierarchy and command and more to coordination. Any reference to a single chain of command has been removed.

Table 1: OIM2004 Levels and Attributes.

	Preparation	Understanding	Command and Coordination	Ethos
4 Seamless Transparent and flexible interfaces.	Comprehensive and congruent preparations resulting in normalised day-to-day working arrangements. Compatible doctrine covers all aspects of interactions. All other necessary formal agreements are in place. Harmonised training and experience using compatible doctrine, communication and information system, tools and agreed operational processes.	Seamless and comprehensive sharing of information. Harmonised knowledge building. Shared interpretation.	Comprehensive, harmonised co-ordination and command arrangements in place. Seamless accommodation of differences in command and leadership styles.	A high level of commitment to shared goals, allegiances and values throughout the organisations. Harmonised processes in place to minimise the impact of differences in external constraints. Very high levels of mutual trust and respect that enable rapid support for interactions outside of the scope of pre-existing arrangements. Seamless accommodation of differences in personnel arrangements and organisational culture.
3. Associative Interfaces facilitate interaction.	Conjoined preparations. Most arrangements covered by formal agreements. Compatible doctrine covering most aspects of interactions. High levels of harmonised training and experience using compatible doctrine, communication and information system, tools and agreed operational processes.	Extensive sharing of information and mutual knowledge building. Shared interpretation.	Extensive co-ordination and command arrangements in place. Extensive accommodation of differences in command and leadership styles.	A high level of commitment to shared goals throughout most of the organisations. Processes in place to minimise the impact from differences in external constraints. High levels of trust and respect that support efficient interactions including some informal and unanticipated interactions. Extensive understanding and accommodation of differences in personnel arrangements and organisational culture.

	Preparation	Understanding	Command and Coordination	Ethos
2. Collaborative Interfaces control interaction.	General doctrine in place. Some arrangements covered by formal agreements. Some combined training and experience.	Sharing of information and knowledge limited to specific topics.	Some agreed co-ordination and command arrangements in place. Some accommodation of differences in command and leadership styles.	Some shared purposes. Moderate level of commitment to shared goals at some places in the organisations. Some accommodation of differences in external constraints. Moderate levels of trust and respect that are sufficient for interactions covered by agreements. Some accommodation of differences in personnel arrangements and organisational culture.
1. Cooperative Limited and orchestrated interfaces.	General guidelines and some informal agreements in place. Little combined training and experience.	Limited exchange of information Limited shared understanding.	Isolated co-ordination at some levels. Little consideration of differences in command and leadership styles.	Some known shared purposes, with bounded level of commitment to these shared goals. Accommodation of some differences in external constraints. Moderate levels of confidence, trust and respect that are sufficient for bounded interactions. Some accommodation of differences in personnel arrangements and organisational culture.
0. Independent Little to no interfaces.	Essentially no preparation.	Almost no exchange of information. Little shared understanding.	Separate command with minimal co-ordination. No consideration of differences in command and leadership styles.	Limited shared purpose. Trust limited to home organisation. No specific allegiance or commitment to other organisations. No consideration of differences in personnel and organisational culture.

5. Future Model Development

Some models of technical interoperability, such as LISI (C4ISR 1998) can be used, not only to evaluate interoperability between pairs of systems, but also to evaluate an individual system to provide a 'prescription' of the interoperability to be achieved and a check of the 'generic' level the system could operate at. These models rely on an underlying reference model which specifies the required standards to be achieved.

A similar approach was considered for the OIM. However, to prescribe specific modes of human behaviour that are required to achieve a certain level of organisational interoperability would be difficult, owing to differences in organisational ethos, rules and culture. While it makes sense to denote the presence of a WAN as a prerequisite in a model of technical interoperability, the OIM would be looking at prescribing the presence of certain organisational internal processes, business rules, approaches or behaviours as a prerequisite to achieving a certain level of interoperability. Such a model could be accepted as the static reference model for the OIM, but in practice it is not feasible. Organisations may achieve their mission in many different ways, employing a number of diverse strategies and employing approaches that are culturally acceptable within the organisation.

What could, however, be useful, is some means of evaluating the degree to which a single organisation is structured and prepared to interoperate with other agencies before the operation and coalition are known. This means that the organisation must have agile interoperability. This may require an Organisational Interoperability Agility Model (OIAM) that incorporates the attributes of agility, namely: robustness, flexibility, responsiveness, resilience, adaptability and possibly innovation (Alberts & Hayes 2003).

- Robust OI provides for OI in a variety of environments, including a range of physical environments, coalition partners, tasks and services, operational tempos, commitments and threats. This includes the ability to be interoperable in missions across the operational continuum such as peace keeping operations, peace enforcement operations, national support and higher intensity national and regional security missions.
- Flexible OI means that an organisation has multiple ways of achieving OI with other organisations. For example, an organisation that could use automated translation systems or liaison officers and had units that spoke multiple language would be more flexible than one with only one method of translation.
- Responsive OI means that an organisation is able to respond in a timely manner to changes in the environment, including changes in coalition partners. For instance, a responsive organisation could have techniques and procedures to fast track training and force preparation once coalition partners have been identified.
- Resilient OI means that organisations are able to recover from and resolve OI difficulties that arise as a result of changes in the operational environment. For example, a resilient organisation could have the ability to recover from hostile action targeting critical interoperability services.
- Adaptable OI means that organisations are able to adapt to changes in the environment. For example, an adaptable organisation could have the ability to

adapt seamlessly to working with different, and new, coalition partners during the course of the collaboration. It also includes the ability to adapt to frequent changes in a highly agile coalition partner.

- Innovative OI means that organisations are able to develop and adopt new ways of operating together during operations.

As with the attributes in the OIM, many of these cannot be completely assessed by examining an organisation against a static reference model. Instead the concept of 'baseline indicators' could be introduced, which would support assessment of an organisation's interoperability agility based, say, on their historical ability to achieve different levels of intensity, operate in a variety of partnerships and conduct concurrent operations. It would also be necessary to develop a method and metrics for assessing and monitoring the impact of organisational changes, such as changes in procedures, organisational structure, training and recruitment. This would identify focal areas for evaluating the degree of agility an organisation can maintain over time and across multiple activities.

6. Conclusion

The major outcome of this review is to update and generalise the OIM and its component Levels and Attributes Table. The revised model stands alone and is not predicated on any particular approach to warfare. The changes made make OIM2004 more generally applicable. These include a different emphasis in what is being evaluated i.e. the degree of seamlessness of interactions rather than the degree of integration, commonality or similarity of human-activity elements. This means that different means of achieving interoperability e.g. by becoming very similar to likely future partners or becoming very agile, are both covered. To accommodate NCW organisations there is a further increase in emphasis on coordination rather than control. The model now also accommodates increased flexibility and versatility in command arrangements.

Further research will capitalise on this general applicability and the OIM will be used as the basis for future analysis and the development of spin-off models. The first stage will be the development of an OIAM, as discussed in the previous section, and investigation of approaches using a series of baselines or contexts, resulting in a series of baseline indicator checklists.

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References

Alberts, D.S. and Hayes, R.E. (2003) *Power to the Edge. Command and Control in the Information Age,* CCRP Publication Series, ISBN 1-893723-13-5.

C4ISR AWG (1998), 'Levels of Information Systems Interoperability (LISI)', C4ISR Architecture Working Group Interoperability Panel, United States, 30 March.

Caforio, G. (ed.) (2003). *Handbook of the Sociology of the Military*. New York, Kluwer Academic/ Plenum Publishers

Chisholm, R. F. (1996) 'On the Meaning of Networks. Group and Organisational Management', *Sage Publishing*, Vol **21** pp 216-235.

Clark, T. and Jones, R. (1999) 'Organisational Interoperability Maturity Model for C2' *Proceedings of the 1999 Command and Control Research and Technology Symposium*. United States Naval War College, Newport, RI, June 29-July 1.
Department of Defence (2003) *Report of the Strategic Workforce Planning Review*, Dept. of Defence, Canberra, Australia.

Department of Defence (2004) [online access 10 Feb, 2004; URL: <http://www.defence.gov.au/opanode>]

Fewell, S. and Clark, T. (2003) 'Organisational Interoperability: Evaluation and Further Development of the OIM Model' *Proceedings of the 2003 International Command and Control Research and Technology Symposium,* National Defense University, Washington DC, 17-19 June 2003.

Howard, J. (2004) Transcript of the Prime Minister's announcement of the arrangements for Australia's contribution to the RAMSI [online access 10 Feb 2004; URL: <http://www.pm.gov.au/news/interviews/interview382.html>]

Jans, N. and D. Schmidtchen (2002) *The real C-Cubed: Culture, Careers and Climate and how they affect the Military Capability*, Canberra, Strategic Defence Studies Centre, Australian National University.

Kasunic, M. (2001), 'Measuring Systems Interoperability: Challenges and opportunities', Version 1.0, Software Engineering Institute, Carnegie Mellon University.

Manigart, P. (2003) 'Restructuring of the Armed Forces' in *Handbook of the Sociology of the Military*, G. Caforio, New York, Kluwer Academic/ Plenum Publishers.

Pratten, G., and Harper, G. (ed.) (1996) *Still the same: reflections on active service from Bardia to Baidoa*, Georges Heights, NSW, Dept of Defence (Army), HQ Training Command.

Rice, A. (1997) 'Command and Control: The Essence of Coalition Warfare', *Parameters* Spring 1997, pp 152-167.

Ryan, A. (2000) 'Primary Responsibility and Primary Risks: Australian Defence Force Participation in the International Force East Timor,' *Land Warfare Studies Paper*, No. 304, November 2000.

Ryan, A. (2001) ‘Achieving C3I Interoperability In Multinational Operations’, a paper delivered to the *Campaign Planning Course,* ADF Warfare Centre, Williamtown 14 November 2001.

Schulz, G. (2003). *Network Centric Capabilities and Transformation - on the Relevance of Armed Forces,* R. Theile, Bonn/Waldbröl.

Scott, W. B. (2003). ‘Promotion Systems Could Upset NCW’, *Aviation Week & Space Technology*, January, 59.

Warne, L. Ali, I., Bopping, D., Hart, D., and Pascoe, C. (2004) *The Network Centric Warrior,* Client Report, DSTO, Canberra, Australia, Dept. of Defence [in process of publication].

Appendix

Preparation: Examines the degree to which there are comprehensive and congruent preparations. This includes:

(i) whether a comprehensive legal framework has been developed and whether there is compatible doctrine covering all expected interactions. The definition of doctrine is very general and is taken to cover the rules and practices that will apply. In order to make the evaluation, government guidance and policies, guidelines and administrative procedures, war-fighting philosophies, organisational missions and the standard operating procedures of the organisations involved are examined to establish whether necessary areas are covered in the framework. This includes whether provision has been made for liaison and interpreters (if required), whether there is agreement on the official language(s) to be used, on terminology, acronyms, agreement on the command and coordination structure and arrangements to be employed. It also evaluates whether comprehensive formal agreements covering information, knowledge and intelligence sharing, education, training and experience (e.g. exercising), logistics and finances are in place.

(ii) the degree of harmonised education, training and experience. Whether there has been adequate training and experience in the use of doctrine, operating procedures, processes and tools to be used. Other factors that may be considered, if relevant, include general education, training, experience to carry out assigned roles and any education and training that would mitigate, for example, cultural differences. This could include training for work in a multinational environment generally, cultural awareness training, language training, and whether there has been any training designed to improve working with this specific partner organisation.

Understanding: Examines how seamless and comprehensive the sharing of information is and the degree of shared understanding developed. This includes:

(i) evaluation of the level of shared interpretation of information (including of common agreements and doctrine) and communications. This covers language issues e.g. whether there is a common language unaffected by differences in accent, phraseology, word meaning etc. and if there are any unresolved issues with regard to terminology, acronyms, definitions and jargon.

(ii) the scope and degree of cooperation and collaboration including the development of common or compatible doctrine, processes, tools, cooperation in experimentation, degree of personnel exchange, combined meetings, exercising and training and the level of long term working relationships, level of long-term friendships and social interaction.

(iii) the level of information exchange, how seamless and comprehensive this is, its value/quality and the degree of harmonisation in knowledge building.

Command and Coordination: Examines how well the participating organisations fit into the command structure and adapt to the command style. This includes:

(i) the degree to which there is seamless accommodation of differences in command and leadership styles. Differences could occur in the degree of control (e.g. discipline, rules of behaviour, latitude given) or the degree of formalism (e.g. detail in orders, command intent or directive control).

ii) the degree to which comprehensive and harmonised coordination and command arrangements are in place, and the resilience of command arrangements. The degree of unity of command achieved, including the scope for dual lines of reporting and home nation influence.

Ethos (socio-cultural factors): Examines any impacts due to differences in socio-cultural factors, goals and trust. This includes:

(i) the degree of commitment throughout the organisations to the goals of the collaboration and the nature of the mandate. This includes evaluating the degree of congruence in broader goals (e.g. national, economic, political and military strategic).

(ii) the degree of mutual trust, respect and loyalty.

(iii) the degree to which harmonised processes are in place to minimise or mitigate against any differences in external constraints that could impact on the collaboration. External constraints include legislation and constitutional arrangements, political and economic environments and goals (e.g. strategic interests, budgetary constraints, scope of mission, operational constraints), public opinion (e.g. business and special interest groups), information sources (e.g. nature and freedom of the media) and the nature of society which includes national culture (e.g. customs, rules of behaviour and values such as the value placed on human life) and historic, ethnic or religious connections and groups.

(iv) the degree to which there is understanding and seamless accommodation of differences in personnel arrangements and organisational factors likely to impact on the collaboration. These include consideration of factors such as ways of operating and the operational culture within each organisation (e.g. ways of structuring tasks and working together, methods of reaching decisions, level of professionalism, workload and work ethic, organisational traditions, customs and values, criteria for promotion, reward and incentive structures, and recruitment and training policies and use of personnel such as women, mercenaries, older personnel and conditions of work).