

2006 CCRTS

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An Australian Approach to Assessing Force-Level Network-Centric Warfare (NCW) Readiness

Topics: Network-Centric Metrics, C2 Architecture, Lessons Learned

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ABSTRACT

The Australian Defence Force (ADF) plans to invest a sizeable portion of its ten-year Defence Capability Program (DCP) budget in migrating to a Network-Centric Warfare (NCW)-capable combat force. But what defines being NCW-capable? And how do we measure how ready the ADF is to adopt NCW?

The NCW Prioritisation and Integration (NPI) methodology has been developed to enable characterisation of the NCW readiness of individual planned military capabilities and how well they are likely to integrate into the planned force-level systems-of-systems.

Individual capabilities are assessed against metrics covering support for human-centric military business processes, sophistication of information management and support for applicable standards. Force integration is assessed through analysis of how well communications and other infrastructure services will support each capability.

The methodology was initially developed and successfully applied to address the tactical land domain, and has now evolved to include the air and maritime domains. This has required broader consideration of human-centric military business processes and of what integration into an NCW-capable force actually demands.

This paper provides a description of the NCW Prioritisation and Integration methodology, how it was applied in the initial review of land combat-related projects, and its evolution to address the wider joint capability domain.

1 INTRODUCTION

1.1 Migrating to a Networked Force

The Australian Defence Force (ADF) is undertaking a major program of capability enhancement through the implementation of the Australian Defence Capability Plan (DCP) to 2015 [1]. This plan will deliver a variety of new and upgraded capabilities across the Land, Air and Maritime forces in order to enhance warfighting effectiveness, force survivability and overall adaptability. A key feature of the DCP is the significant level of investment in the areas of communications, networking, and information systems that have the potential to generate a quantum leap in information related capabilities and lay the foundations for an Network Centric Warfare (NCW) capable force. In order to facilitate the implementation and integration of these information related capabilities, the Australian Department of Defence has published an NCW concept [2] and released the *NCW Roadmap 2005* [3], the latter outlines how the ADF's future NCW capability requirements are to be realised and identifies the key milestones to be achieved by 2015.

The inherent interdependence of these information capabilities requires a high degree of interoperability, both in the physical systems and in the human dimension of the systems (doctrine, TTPs, force structures, training, ...). This presents a number of challenges to the capability development process. In the past, capability development had been undertaken through the efforts of a large (by Australian standards) number of largely independent projects across Army, Navy, Air Force and the Joint domain. Although these projects endeavoured to be cognisant of the wider ADF requirements, they have generally been optimised to deliver capability within the scope of individual projects. The move to a networked force dramatically increases the need to effectively identify and manage the interdependencies of the NCW-capable systems being introduced.

In response to the challenge of migrating to an NCW-capable Land force, the Australian Army established the *Networking the Land Battlespace* (NLB) initiative. This initiative seeks to implement the information and networking capabilities being delivered by the DCP into a knowledge-based, automated and network-centric force capable of delivering superior battlespace effects. This initiative has evolved from the Land 5000 [4, 5] concept first proposed in 2002. It seeks to prioritise, schedule, coordinate and deliver Land related projects to create an effects-based, NCW-capable Land force operating within a Joint / Coalition battlespace. It offers the opportunity to evolve the development of Land force combat systems from their current stovepipes to an integrated system-of-systems. Advanced command, control, communications, and computing (C4) technologies, future warfighting concepts, and training systems will need to be combined across key acquisition projects and a number of legacy systems to achieve the aim of a future, dynamically integrated Land NCW-capable force. As such, NLB will identify and develop a migration path for the networking and integration of Land combat capabilities to support the implementation of the Hardened and Networked Army (HNA) [6] and elements of the 2025 Objective Force.

In support of Army's NLB initiative, Australia's Defence Science and Technology Organisation (DSTO) in partnership with Aerospace Concepts Pty Ltd undertook an assessment of the NCW readiness of key Land force projects (including selected Joint, Air and Maritime projects) [7]. Its objective was to assist the Department of Defence in the integration of the Land combat capabilities, by providing an initial analysis of the capacity of the key Land projects to integrate with and contribute to the future NCW-capable Land force. This review was focused at the Land tactical level and was intended to complement some of the elements of the higher-level ADF NCW Roadmap. The methodology developed for this review became the basis for what has now evolved in to the NCW Prioritisation and Integration (NPI) methodology.

1.2 Approaches to Assessing NCW

A literature review [8] was undertaken in order to assess the relevance and relative maturity of the NPI methodology, and identify areas for future growth. This review, based on information published up to mid-2005, covered the mechanisms and methods used around the world to analyse and assess NCW, including:

- Australian NPI methodology – See below.
- US Net-Ready Key Performance Parameter (NR-KPP) – A performance-based compliance assessment against a defined architecture and a variety of standards and guidelines,
- UK Network-Enabled Capability (NEC) Benefit analysis – A chain analysis to understand the relationships between NCW-related investment and force effectiveness, and
- Scandinavian Network-Based Defence (NBD) analysis – Another chain analysis to, again, identify the relationship between investment in network capability and force effectiveness.

This review also covers several areas indirectly related to NCW that potentially contribute methods or mechanisms to NCW assessment, including:

- Interoperability assessments – Originally surveyed due to previous use in NCW assessments found technical interoperability models were being applied to organisational interoperability,
- Military effectiveness assessments – Often based on games theory to assess the worth of military systems and evolving from simple unit value algorithms to agent-based models and simulations that may play a role in NCW analysis,
- E-Commerce and M-Commerce assessments – Surveyed due to the similarities between NCW and the Internet and e-Commerce, and the m-Commerce analogy to the military Land operating environment, and
- Computer network assessments – Surveyed due to the network primacy in NCW identified several Internet-based protocols for network management, including Quality of Service and Service Level Agreement models.

In reviewing other national NCW assessment approaches, as well as analogous approaches in the military and civil domains, no specific improvements to NPI prior to completion of Phase 2 appeared to be warranted. However, the review did identify several aspects with the potential to be integrated into future versions of the NPI methodology.

The review also identified a fundamental problem that Australia faces in implementing a compliance-based NCW assessment. Without force-level NCW-focused design, Australian NCW assessment is limited to checking how well broad concepts are defined and how well the capability complies with various technical standards.

2 CONCEPTUAL FOUNDATIONS FOR NPI

2.1 Objective and Scope of NPI

The NPI methodology is a systems-of-system analysis approach to assess the degree to which projects under development and capabilities being introduced, or already in service, are able to be integrated into, and contribute to, an NCW-capable force. Instead of taking a purely standards and compliance based approach, the methodology seeks to identify how the project or capability under review will meet the wider system-of-system requirements, addressing both the project itself and its interdependencies in the wider NCW-capable system-of-systems. It attempted to take a whole of capability approach that focuses on the areas of: physical and standards based systems integration, the

capacity of the systems to support the management of the information, and the ability of the systems to support the user command and control needs. The complexity of these areas means that the analysis will be a combination of hard analytical evaluation and human judgements. Where possible the methodology seeks to identify the wider capability implications across areas such as warfighting concepts, doctrine, training and personnel. However, further refinement of the NPI methodology is required in these areas.

The NPI methodology has been designed to support the analysis of capabilities at the tactical level of military operations. It can also be extended to address issues at the operational and strategic levels. However, the greatest need for this system-of-systems analysis capability was seen to be at the tactical level, where a large number of independently driven capabilities were in the process of being developed or introduced across the Land, Air, Maritime and Joint domains. It was also perceived as essential to support the integration of these capabilities in order to ensure that their introduction increased (rather than undermined) the effectiveness, survivability and adaptability of the warfighters.

NPI methodology does not seek to address all aspects of the NCW implementation problem. It should ideally be coupled with parallel efforts to deliver the underlying NCW concepts, integrated system-of-systems design, and NCW performance analysis (experimentation, field trials, lesson learnt from operations, ...). A practical NCW concept was found to be critically important in order to underpin the development of the analytical framework. Unfortunately, most of the 'concepts' available were at such a high level of abstraction that they were of little practical assistance. As a result it was necessary to develop a practical conceptual framework for tactical NCW¹ to support the development and application of the NPI methodology, which is summarised by the set of 10 characteristics for NCW located in [Appendix A](#).

2.2 Information Grids versus Systems Layers

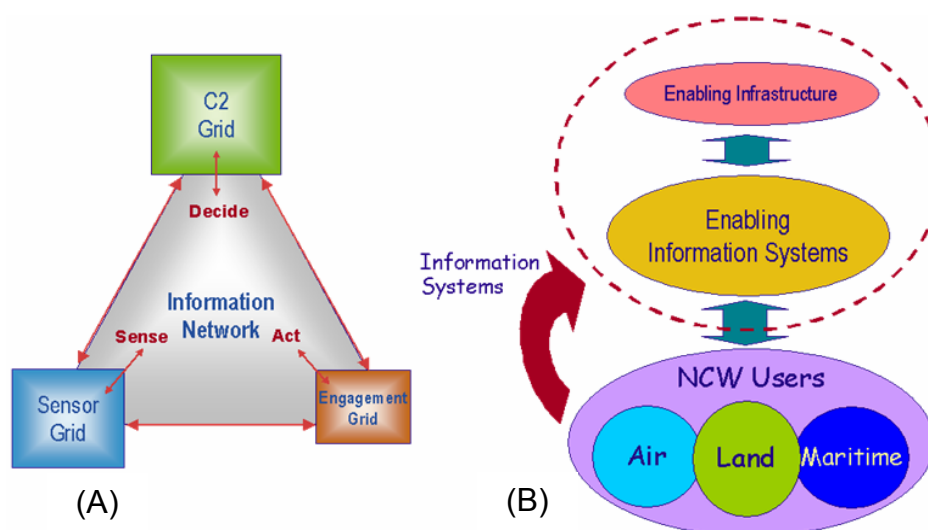


Figure 1. Alternative approach to using the grids to support NCW readiness analysis

NCW is commonly described as the integration and synchronisation of four key interdependent elements: command and control (C2 Grid), sensor systems (Sensor Grid), engagement systems (Engagement Grid) and the network. Figure 1-A depicts a model used to show the relationships between these components [3]. Although this representation is useful in conceptualising the nature of NCW it is not as effective for analytical purposes. The grids are not always distinct, with the same entity potentially appearing in more than one grid element. This is particularly evident in the tactical domain, where it is common for a single battlespace entity (such as a combat vehicle) to play a role in

¹ This was undertaken from a Land warfare perspective, but is equally applicable to the Air and Maritime domains.

several if not all four components simultaneously. As a result an alternative model, Figure 1-B, was used for the NPI analysis. In this model the networking and information systems are grouped into systems layers: enabling infrastructure, enabling information systems, and NCW users. This model aligns well with the Australian Defence Information Environment (DIE) architecture and has been subsequently accepted as a core component of NCW capability integration [3]. To simplify the analysis and representation of the relationships between the elements, this model is often further simplified by including the embedded information capabilities of the NCW users (combat vehicles, helicopters, infantry, logistics) within the enabling information systems layer.

2.3 A Force-Level Design Framework

In order to understand the function and potential of the NPI methodology it is necessary to understand its relationship to the wider force-level design process. Figure 2 illustrates a simple framework for force-level capability development from a systems engineering design perspective. On the horizontal axis it divides the problem space into analysis and design, while on the vertical axis it is divided into the systems-of-systems level and the individual systems or project level.

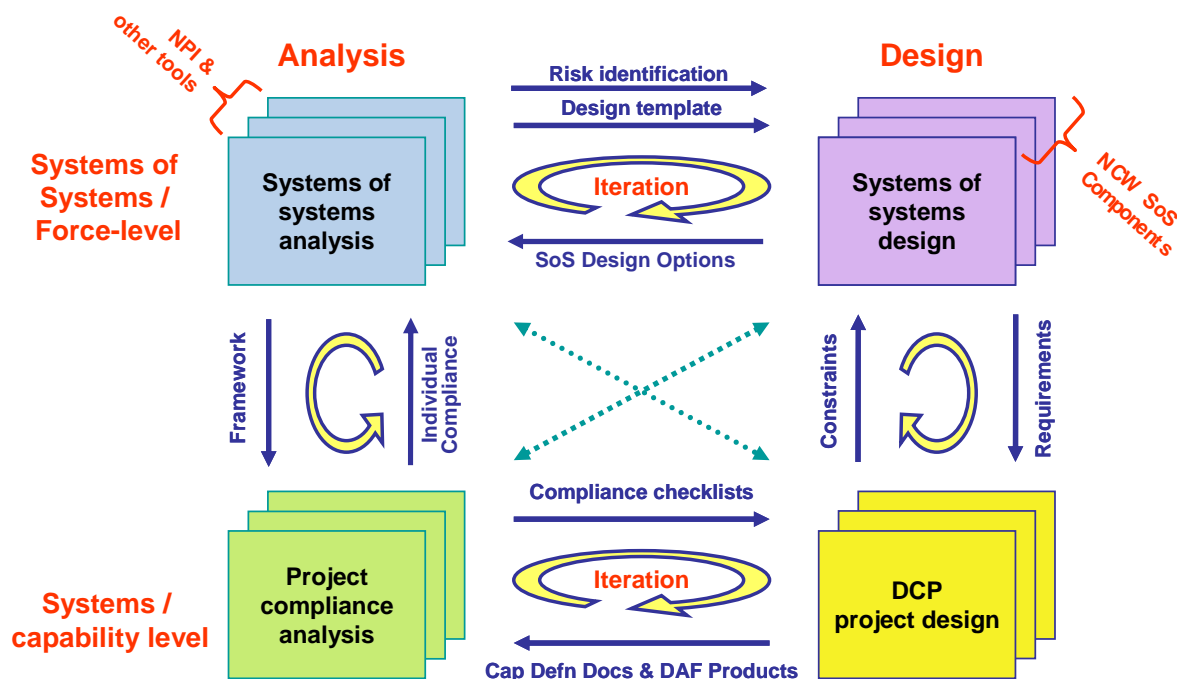


Figure 2. Force-level design framework

At present the Australian capability development organisation (Capability Development Group) has a mature and effective process for the development of individual capabilities through a series of largely independent projects. This creates the potential for the pursuit of local project optimisation at the expense of better systems-of-systems capability. Interoperability between these projects is also a major issue, and has tended to be addressed through processes of formal documentation and adherence to standards. Unfortunately, there are a variety of standards to choose from, and the actual integration of the capabilities has tended to be undertaken by the warfighters as a post-project activity.

The increasing level of project interdependence resulting from the migration to a NCW-capable force has made this approach increasingly difficult. This has led to a greater requirement for analysis of the individual project through a process of compliance analysis and management using a structure assessment approach combining standards implementation and Defence Architecture Framework (DAF) products. This also encourages the projects to look at their relationships with other projects to reduce the tendency for the formation of 'stovepipes'. The compliance requirements give the projects

guidance on what they must implement in order to achieve a base-level of interoperability and NCW potential. Similarly, the analysis of the individual project designs provides feedback to manage the interoperability between the various projects. However, on its own, the compliance feedback processes will only achieve a base-level of modular interoperability and capability deconfliction. For simple systems this might be adequate, but for complex, highly interdependent NCW-capable forces, this is analogous to enforcing the standards of building blocks without an overall design to provide guidance on what types will be needed in what combinations, let alone how create the desired product.

Systems-of-systems design is needed to provide the overall integration, tradeoffs and synergies required in order to achieve the levels of effectiveness and adaptability required for future operations. This force-level design can then provide the guidance to shape the direction of the individual projects. Unfortunately, until recently there has been little in the way of force-level design across the capability development process [7,8], effectively transferring the systems integration risk from the capability developers to the warfighters who will need to integrate the individual systems into a warfighting force.

Recent initiatives by the Australian Defence Department, in particular the *NCW Roadmap 2005* and Army's *Networking the Land Battlespace* initiative, have laid the groundwork for force-level systems-of-system design. The milestones identified in the Roadmap identify a series of force-level capabilities that will be delivered by Army, Navy and Air Force within an integrated Joint capability development framework. The owners and integrators of these milestones have the opportunity to undertake the required force-level design that will move these milestones from a collection of broadly interoperable parts to an integrated and adaptive force.

A critical component to effectively implementing the systems-of-systems design is the final quadrant – systems-of-systems analysis, which is also where the NPI methodology is focused. Systems-of-systems analysis provides the feedback / verification mechanism on the effectiveness and risks of the system-of-systems design options. The framework of measures within the NPI also provides design guidance to achieve NCW-capable forces and force elements. This is in effect running the NPI in reverse to its original design, providing a design template for what is required to achieve an NCW-capable system.² The NPI can also provide a framework to the compliance analysis process to ensure overall consistency of the processes and to facilitate the provision of suitable source data to assess individual capabilities within the overall force-level design. The NPI is of course not the only component of the system-of-systems analysis process. There are other potential approaches, and in particular the complementary capabilities of experimentation and field trials to test and evaluate the force designs, although how to effectively evaluate system-of-systems capabilities is a challenge yet to be fully addressed.

3 NPI METHODOLOGY

3.1 Methodology Basis

The NPI methodology is based on the concept that a complex military capability or capabilities can be modelled as a nodes-and-links network with the nodes being the capabilities, often in the form of the physical combat platforms, and the links being the information interactions between them.

² This has proved to be an effective approach, at least at the individual project level.

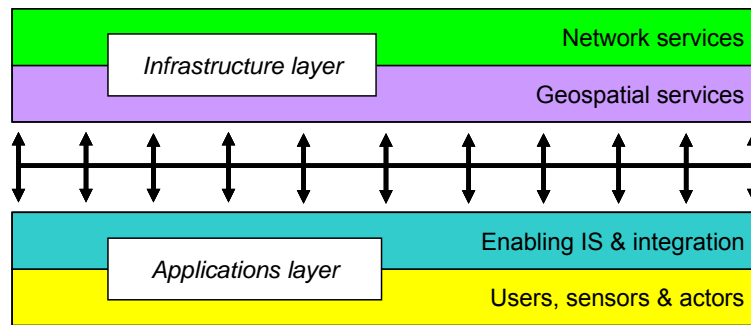


Figure 3. Force modelling in layers

Furthermore, all capabilities are considered to be part of a multilayered information environment, shown in Figure 3, which has been adapted from the Australian Department of Defence's Defence Information Environment (DIE). This interpretation of the DIE divides the information space into:

- **Applications Layer** – Those capabilities that provide enabling information systems, along with the supported users (warfighters), sensors and actors (shooters), are considered to be the application layer.
- **Infrastructure Layer** – Those capabilities, primarily communications but also niche capabilities such as space-based navigation (GPS), that exist only to support those in the application layer are considered to comprise the infrastructure layer.

3.2 Acquiring Assessment Information

When the NPI activity first began in mid-2003, the Australian military capability development process was undergoing a period of considerable change with the introduction of much more stringent, and standardised, documentation than had previously been required. Also, an Australian version of the US C4ISR Architecture Framework, known as the Defence Architecture Framework (DAF), was in the throes of being introduced and, with a few exceptions, DAF products (Operational Views – OVs, System Views – SVs and Technical views – TVs) had not yet been incorporated into capability project documentation. This situation provided a challenging environment in which to conduct whole-of-force assessments and often required interviews with key project staff to 'fill the gaps' in the documentation with respect to the information required for NPI assessment.

The situation today is markedly different with project documentation typically being much more robust and incorporating at least the 'essential' DAF products, although not yet in a standardised format. DAF products are now key to capability expression during definition and acquisition (and should be during in-service management) and are thus a prime source of information for NPI assessment.

This improvement has resulted in a reduction in the need for staff interviews to complement documentation analysis. Indeed, DAF products have now become a key source of assessment information, particularly when assessing information interactions; for example:

- Information exchange needs in OV-2 and OV-3;
- Business processes in CV-1, OV-1, OV-4 and OV-5;
- Potential constraints on solution architecture concepts in SV-1 and SV-6;
- Technical systems form and behaviour in SV series; and
- Technology base in TV-1/2.

A full assessment of the utility of the various DAF products for NPI assessment is provided in [Appendix B](#).

In turn, NPI is useful in shaping DAF products to improve the NCW readiness of the capability being assessed and can thus be used to inform DAF product remediation:

- Failure to support identified missions and tasks,
- Poor or missing NCW concept implementation,
- Lack of information management,
- Solution architecture not compatible with related capabilities, and
- Failure to support mandated technical standards.

Note that depending on the where a capability is in the lifecycle, there may not be a material solution identified, or even a solution concept developed. This is especially the case for capabilities intended for introduction into service a decade or more in the future. Consequently, not all documentation or 'essential' DAF products may have yet been produced.

In some cases, capability projects are complex enough that they must be treated as systems-of-systems in their own right and decomposed before being assessed. Whilst this can produce better assessment outcomes in that the capability is understood in greater detail, getting access to the necessary information on a systems-of-systems basis can be problematic in that the capability development process has not yet enforced development of definitional documentation to a suitable level of detail to support the analysis.

Finally, an important issue that arose at the beginning of our NPI work was how to assess the veracity of information presented in project documentation. Due to the age of some documentation, and a fast-changing world, some ideas presented therein appeared out of date or inconsistent with other projects. However, due to the risk that the views of the assessment team might taint the assessment, an assumption was made that the concepts and plans presented in source documentation were both reasonable and accurate once that documentation had become reasonably mature through the project approval process. Any issues that did crop up were typically noted for later assessment (which is why NPI includes a risk assessment component). Only in the most severe cases of concern was further investigation undertaken through interview or search for other, usually more recent, documentation.

3.3 Methodology Elements

The NPI methodology comprises five analysis elements, one for resource prioritisation, one focusing on capabilities-as-nodes, two assessing interactions-as-links and the last considering risk from a holistic perspective. These five elements are defined as follows and described below:

- **Capability cross-impact analysis** – for prioritisation of analytical effort.
- **Capability qualification analysis** – NCW 'fitness' of projects and capabilities in isolation.
- **Capability-in-context analysis** – Support for project-level capability missions and tasks.
- **Organisational analysis** – Support for organisational missions and tasks.
- **Holistic risk and vulnerability analysis** – Risks at the whole-of-capability and force-levels.

3.4 Capability Cross-impact Analysis

At the very heart of NCW is the idea of connectedness. Consequently, in undertaking any form of NCW-related assessment, one challenge is how to limit the assessment effort to what is affordable and

appropriate. While identifying a system boundary is helpful, often this is not enough since the complexity of what lies inside the boundary is still enough to make exhaustive analysis untenable.

Consequently, the NPI methodology includes a specific element for prioritising overall analytical effort. This answers the question '*which capabilities are most important to the force from an NCW perspective?*' and thus most deserving of the analysis resources.

Of course, this element of NPI is not always used. If an assessment of a single capability is made, then there is no need for analysis prioritisation, although the system boundary must still be identified with some care.

The NPI approach to analysis resource targeting and prioritisation is based on an issues cross-impact analysis method developed by Schlange and Juttner [9] to identify the long-term driving forces in complex business environments. In this case, Schlange and Juttner's method is used to identify which individual capabilities have the greatest influence on the overall force and which of these can themselves best be influenced. Our assumption is that these are, in the first instance at least, those capabilities most worthy of NCW assessment.

3.5 Capability Qualification Analysis

3.5.1 Purpose and Scope

The purpose of the capability qualification analysis is to assess the NCW readiness of individual military capabilities to integrate into, and contribute to, a future NCW-capable force. This analysis element assesses capabilities (projects) in isolation and thus does not require any knowledge of larger force-level design intentions. In essence, this element makes the NPI a project-level design analysis tool (standalone 'fitness')

3.5.2 Three Sets of 'Key Enablers'

When the NPI methodology was first being developed, the concepts and metrics for NCW identified in the literature were typically at a high level of abstraction and aimed at providing a description of the nature of NCW and the ultimate benefits that will be derived from NCW enabled forces, not at describing detailed technical characteristics. This made it difficult to make a direct comparison between the current and planned NCW-related systems capabilities and needed NCW systems end states.

As a consequence, an alternative approach was applied: Instead of defining specific future NCW systems needs, technical systems are characterised by a number of 'key enablers' that encompass the likely needs and applications of NCW in the future combat force. These 'key enablers' seek to assess the following aspects of the capability:

- **How well the system supports military business processes** – A plethora of specific military business processes are employed across a combat force making assessing all of them impractical. However, there is a core of processes common to all of the niche communities that comprise a modern military force and it is support for these that the NPI methodology seeks to assess. Of particular interest are situational awareness, planning and mission execution as well as the force flexibility and sustainment capability. This group of key enablers is generally referred to as command and control (C2) with the methodology.
- **How well the system manages information** – Whilst the production and consumption of information in the battlespace is often a focus of capability design, there is usually far less emphasis on the management of this information, particularly dissemination and deconfliction. Consequently, a specific group of key enablers exists to address this aspect of NCW

capability. This group of key enablers is generally referred to as Information Management (IM) with the methodology.

How well the system integrates technically into the overall force – The long and, in relative terms, very separate evolution of many contemporary military capabilities in Australian service has left them poorly situated to be integrated into an NCW force, thus raising the prospect of them becoming islands of isolation in a future sea of information. Consequently, there must be a greater focus on ensuring that capabilities are planned from inception for integration into the larger force. This group of key enablers is generally referred to as Systems Integration (SI) with the methodology.

Each key enabler is broken down into 3 layers of increasing resolution, with the third (most detailed) layer composed of elements capable of being assessed from the project or capability documentation. Table 1 shows the first level decomposition of the three key enablers.

Table 1. Capability qualification key enablers

Military business processes support (C2)	Information Management (IM)	Systems Integration (SI)
Situational awareness Combat identification Fixation and orientation <ul style="list-style-type: none"> • Inertial navigation • Space-based navigation techniques Deliberate planning Immediate planning Mission execution Sustainment Organisational structures	Collection and processing, including fusion and deconfliction Dissemination Administration Information assurance <ul style="list-style-type: none"> • Availability • Confidentiality • Integrity • Authenticity • Non-repudiation 	The <i>generic</i> level of interoperability as measured using the Level of Information Systems Interoperability (LISI) Capabilities Model. Currently-mandated and emerging technical standards considered applicable to enabling an NCW-capable force as identified in the departmental technical standards profiles (TV-1/2). ‘Capability evolution’ to cover planning for system change over the lifecycle. Various Internet protocols, including IPv6.

The importance of assessing ‘maturity of thought’ in capability definition with respect to specific issues is now recognised throughout the key enabler groups. This represents a change, and learning on our part, from when this work first commenced in mid-2003.

Additionally, whereas we had originally intended to create separate sets of key enablers for applications capabilities and infrastructure capabilities (refer Figure 3 above), we quickly realised that different sets would markedly complicate systems-of-systems assessment. We also realised that, by judicious abstraction and generalisation of the key enablers, what was already a significant overlap could be extended such that a single set of key enablers was applicable to all forms of military capability. For example, the military business processes being supported at the application layer are typically command and control of combat activities whereas at the infrastructure layer they are typically management of the infrastructure itself. The military business process support key enablers are now couched to be applicable to both circumstances; in particular, in both cases there is deliberate and immediate planning carried out.

3.5.3 *Planned versus Needed*

When the original assessment work was undertaken, and the NCW concept was barely established within Australian military circles, we were pessimistic that much detail would be found in capability definition documentation. Therefore, to provide a larger base of information from which to work, two parallel assessments of key enablers were conducted:

- **Planned** – To capture what Defence plans to implement for a given capability and represented by ‘formal’ capability definition documents such as the project Operational Concept Document (OCD), associated specifications, business case analyses and other definition study outputs.
- **Needed** – To capture what, based on professional military judgement, is actually needed by a given capability and obtained by interview with desk officers and reference to ‘informal’ documents such as independent studies and unapproved concept papers.

3.5.4 *Data Collection via Questionnaire*

Characterisation of individual systems/capabilities/project against the key enablers is accomplished via questionnaire with the results fed into a database. One questionnaire for each capability system is completed through review of documentation, principally OCD, and interviews with requirements and acquisition staff.

Within the questionnaire, each question is structured such that an assessment of what is both planned and needed in the 2010, 2015 and 2020 epochs is made as defined in Table 2, thus providing information about capability development trends. Each assessment includes the source of information (document or person), a short summary, and a ‘traffic light’ rating.

Each question also includes a remediation description, which describes how to change from the ‘planned’ to the ‘needed’ state, and an estimated remediation cost.

Table 2. Questionnaire assessments by epoch

	Planned	Needed
2010	Planned and funded ... will happen.	Assessed as needed for NCW in this timeframe, whether formally planned or not, but not funded.
2015	Formally proposed, whether funded or not ... might happen if money available.	Assessed as needed for NCW in this timeframe but not yet formally planned (nor funded).
2020	Formally proposed, whether funded or not ... might happen if money available.	Assessed as needed for NCW in this timeframe but not yet formally planned (nor funded).

Where appropriate, assessments will attempt to take into account the NCW benchmarks being developed for the Defence NCW Roadmap for 2010, 2015 and 2020. These benchmarks increase in each successive epoch, meaning that a particular capability may rate differently in different epochs despite not changing over time.

3.5.5 Presentation of Outcomes

The outcome of the ‘key enablers’ characterisation for capability systems is presented as a high-level ‘map’ of readiness across each key enabler for each epoch. This map will be in the form of a ‘traffic light’ display as shown in the example in Table 3.

Various taxonomies are used, most based on qualitative scale. Where a domain-specific taxonomy is not evidently in widespread use, the taxonomy typically used is as follows:

- **None** – Required but not present.
- **Some** – Partial implementation of the concept or standard.
- **All / full** – Full implementation of the concept or standard.
- **Not applicable** – None but also not applicable in this case. This is different from an assessment of ‘none’.
- **Unknown (blank)** – Could not be ascertained from either documentation or interview.

Table 3. Example characterisation against NCW key enablers

Capability system [examples only]	C2			IM			SI		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
Artillery	●	●	●			●	●	●	●
Armour	●	●	●			●	●	●	●
Combat aviation							●	●	●
Field logistics		●					●	●	●
C2 support systems	●	●	●						
● Poorly		● Unknown		● Some support		□ Not applicable			
● Well									

The scores at all three levels of the key enablers were able to be displayed in a ‘traffic-light’ form with green at the highest level, amber for mid level and red for lowest level.

3.6 Capability-in-context Analysis

3.6.1 Purpose and Scope

The purpose of the capability-in-context analysis element is to assess the level of support for project-level capability missions and tasks; that is, those military capabilities that are solely or primarily to be delivered by the planned capability. This assessment is done by asking the questions:

- *Are the OCD-specified missions and tasks realised in the operational interactions in the OVs and, as applicable, in other project OVs?*
- *Are these operational interactions in turn realised in the systems interactions in the SVs and, as applicable, in other project SVs?*

This element of the assessment methodology makes the NPI a project-level design analysis tool ('gap identifier').

3.6.2 Operational Interactions

The approach to doing the capability-in-context analysis is based on the graphical analysis framework shown in Figure 4. The operational interactions between or within capabilities are identified from the OVs and characterised as per Table 4. The data collection method also allowed values of 'unknown' and 'not applicable' to be assigned to interactions.

Table 4. NCW readiness frequency of interaction ratings

	Warfighting impact	Frequency of interaction	Timescale of interaction
1	Nice to have	Rare / by exception	Planning
2	Useful	Common	Manoeuvre
3	Significant / key to success	Nearly constant	Target engagement

In common with the capability key enablers analysis, 'planned' and 'needed' assessments are conducted where necessary to compensate for deficiencies in formally-documented interactions information.

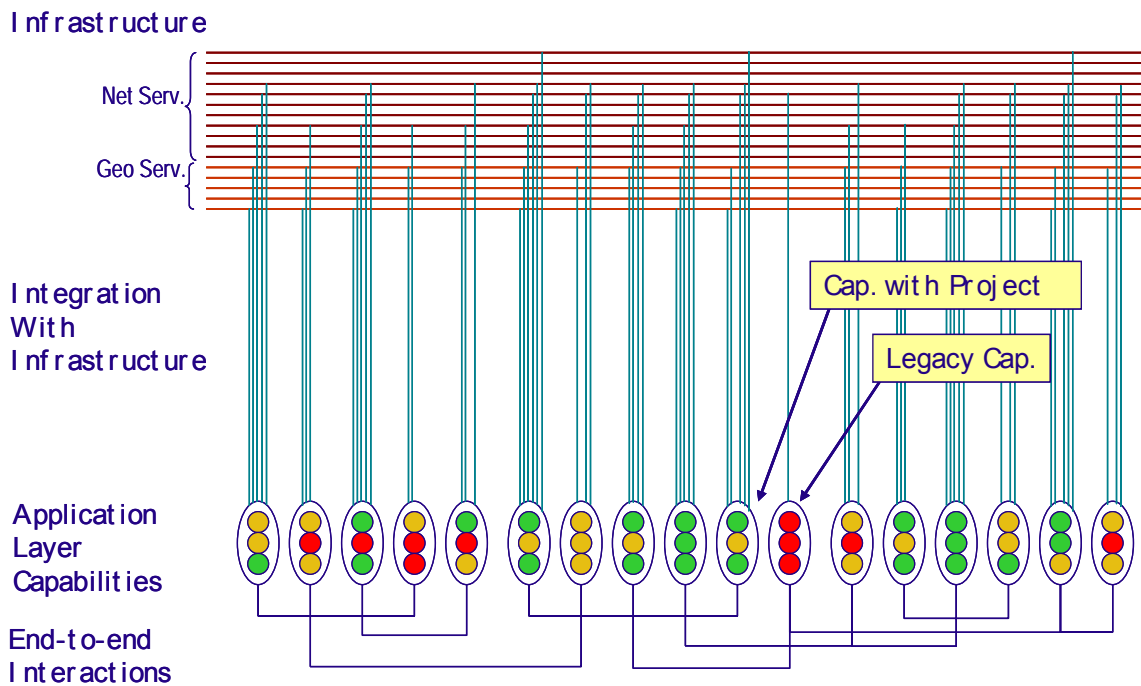


Figure 4. Graphical analysis framework for capability-in-context analysis

3.6.3 Supporting System Interactions

Based on the identified operational interactions, the required end-to-end technical interactions are then identified using the SVs, as shown in Figure 5.

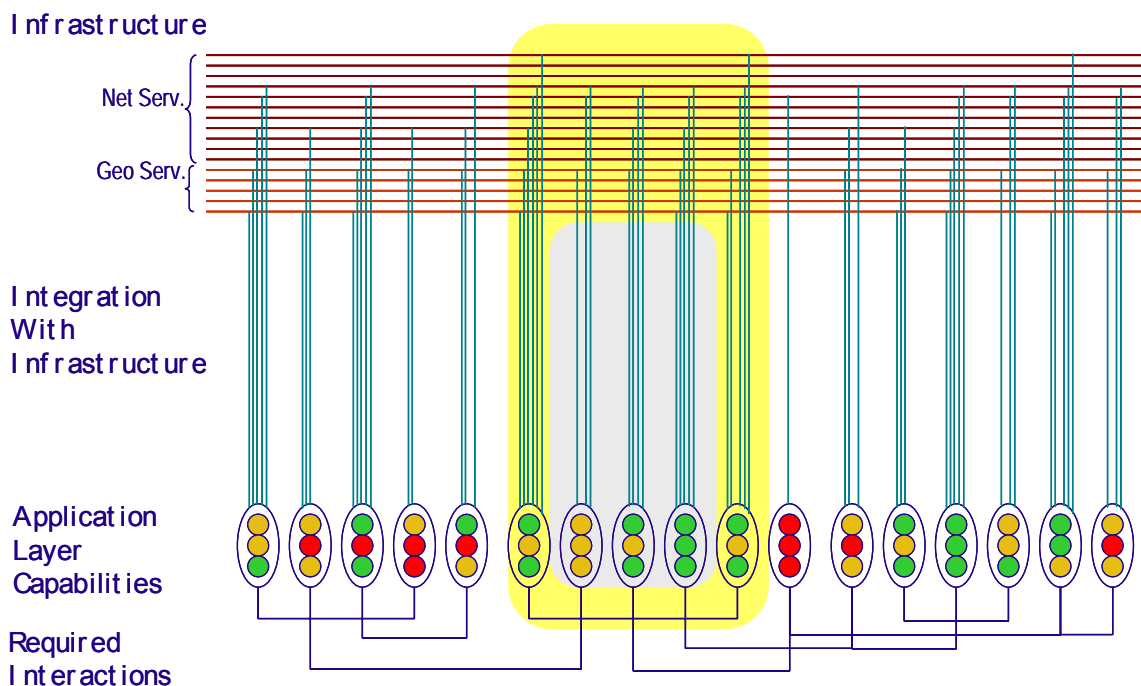








Figure 5. Required end-to-end technical interactions identified

For each system interaction identified, a key issue is discriminating ‘how well’ versus ‘how much’; that is, how well a particular interaction is supported by the implemented systems versus how broadly this interaction is supported across the applicable community-of-interest. Consequently, two attributes

are used to record these, as shown with their graphical representations in Table 5. Of course, additional attributes could be captured and increased granularity provided in the rating scales, although the we have found that the three-step scale works well when considering the force as a whole at senior management level; that is, many of the decisions that could flow from this form of analysis are of a broad nature (allocate more money, people, etc) and thus amenable to reasonable simplification.

Table 5. System interaction attribute rating scheme

How well is the (intermediate) capability supporting the (planned or needed) interaction?	How much of the (planned or needed) interaction set across the force does this support extend to?
 Not supported	 < 30% of the force
 Supported but slower	 30% to 70% of the force
 Supported	 > 70% of the force

3.7 Organisational Analysis

3.7.1 Purpose and Scope

The purpose of the organisational analysis element is to assess end-to-end support for force-level (organisational) missions and tasks. This is done by asking the questions:

- *Are the organisationally-specified (force-level from the Future Land Operational Concept [10] etc) missions and task realised in the collective operational interactions described in applicable project OVs?*
- *Are these operational interactions in turn realised in the systems interactions described in applicable project SVs?*

This analysis element would be used to assess defined larger capability ‘blocks’, such as Australia’s planned-for-2009 digitised battlegroup (battalion group) construct or an air defence ‘system of systems’ comprising fighter aircraft, airborne early warning and control aircraft, surface-to-air-missiles and ground-based radar.

This element of the NPI methodology is thus a ‘gap identifier’ at the force / organisational level (if the higher-level needs are actually documented) and hence a force-level design analysis tool. Indeed, this element of the NPI methodology could be (but has not yet been) used as a tool to support force-level capability options assessment in a manner similar to this British NEC benefits analysis method or Sweden’s NBD engine.

3.7.2 Approach

The basis of the organisational analysis element is the graphical framework, shown in Figure 4, used for the capability-in-context analysis. As shown in Figure 6, an organisational capability is modelled by grouping up all of the affected capabilities and associated interactions, thereby producing a ‘capability-of-capabilities’.

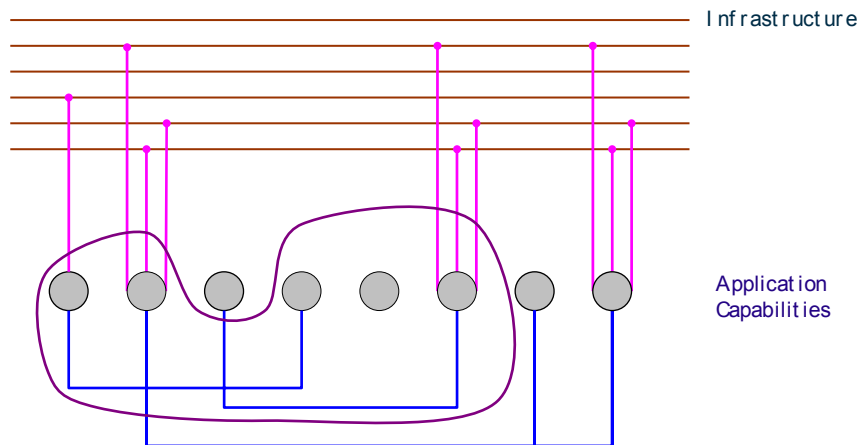


Figure 6. Formation of organisational groupings from individual capabilities

3.7.3 Organisational Analysis Challenges

This element of the NPI methodology is, by far, the most challenging to undertake for the simple reason that the currently project-focused nature of the Australian military capability development and acquisition system means that most thought and documentation is also project-focused. This results in a paucity of documentation defining higher-level force capabilities and then only in broad terms.

Although significant efforts are being made to address this issue, including the comparatively recent *NCW Roadmap 2005* [3], there is still much to be done. Indeed, we hope that the NPI focus on the higher-level capabilities has highlighted to senior decision-makers the need for force-level design work to occur.

Our interim answer to the lack of detailed force-level capability definition documentation has been to focus on key high-level battlespace functions such as joint fires and joint manoeuvre that have received some recent attention. In addition, the original NPI analysis team contains individuals with considerable recent experience in the joint fires domain, thus compensating somewhat for lack of formal definition.

A nagging issue is whether or not this interim functionally-focused approach is adequate to support analysis of those ‘capabilities-of-capabilities’, such as Australia’s new amphibious warfare program, that have, to date, been defined more in equipment solution terms than in pure capability terms. Again, we hope that NPI can highlight the need for a greater focus on functional design and the supported information exchange and infrastructure definition.

3.8 Holistic Risk and Vulnerability Analysis

The purpose of the risk and vulnerability analysis element is to identify and assess what vulnerabilities are created by improved force integration. This includes not only identification and assessment of holistic risks and vulnerabilities, but identification of treatment options and drafting of associated implementation plans. Being holistic, the scope of the assessment reaches to all aspects of a given capability, not just the technical systems component, as shown in Figure 7. Note that facilities and supplies receive less attention because these are typically more easily corrected should the need arise whereas some of the other aspects of a military capability take much more time and effort.

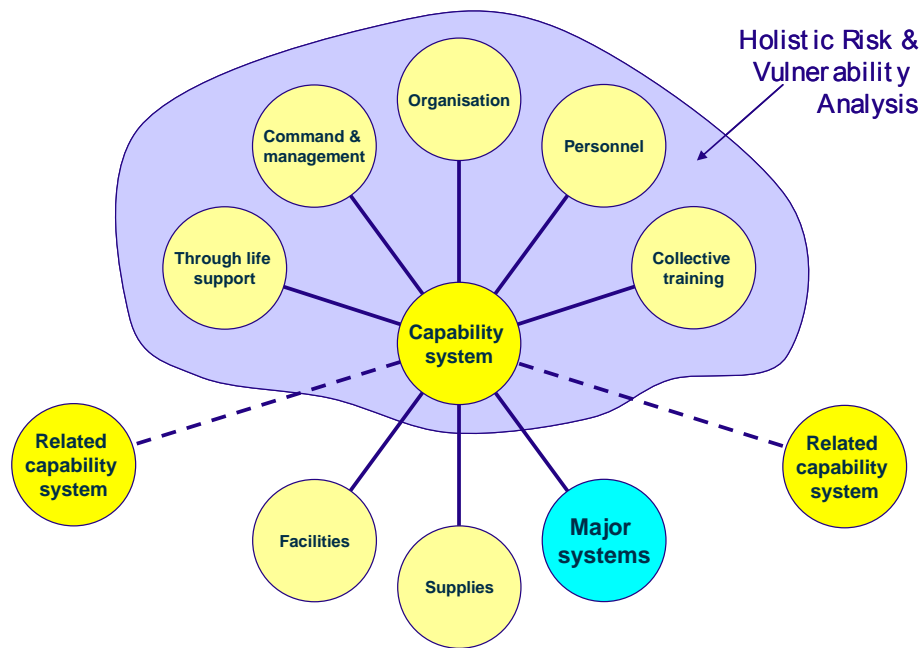


Figure 7. Scope of holistic risk and vulnerability analysis element

Where applicable this analysis extends to force-level risks and vulnerabilities that affect more than just a single capability even if the root cause is a single capability project. This higher-level view makes the NPI useful for force-level design analysis; that is, for identification of risks and vulnerabilities arising from particular force architectures or implementation decisions.

The risk and vulnerability analysis process is drawn directly from standard commercial risk management practices [11] as follows:

- Undertake other NPI assessment elements;
- Identify issues that could negatively impact Australian Defence NCW aims;
- Assess consequences at both system and force level and across all aspects of the affected capabilities;
- Prioritise issues based on consequences;
- Identify treatment options, including proposed owners and estimated implementation resources;
- Identify residual consequences, at both system and force level and across all aspects of the affected capabilities;
- Refine prioritisation of issues; and
- Draft treatment implementation plans.

4 APPLYING THE NPI

4.1 Initial Evaluation of the NCW Readiness of the Land Force

4.1.1 *Capability-specific deficiencies*

In 2003 and 2004, the initial version of the NPI methodology was used to assess the NCW readiness of a total of 41 different Land and associated Air, Maritime and Joint projects, with 21 of these projects assessed in detail.³

Although possibly better than expected, the review found significant shortfalls in the NCW readiness of the projects reviewed. Planning for the digitisation and networking of combat capabilities to facilitate sensing, engagement and manoeuvre of the tactical war fighters was just emerging. Most of the effort was focused at providing effective C2 capabilities (both Land and Joint) at the operational and high-end tactical levels. As a result the review identified a major area of concern to be the immaturity of concepts and planning for networking and digitisation for the warfighting level. Almost all aspects had major or significant issues, ranging from shortfalls in the underlying supporting infrastructure, communications, for example, through to the immaturity of planning for the battle management systems, and the ability to build information systems with sufficient responsiveness to meet the needs of the tactical warfighter. The situation was found to be even more severe across the service boundaries.

The review of the NCW readiness of the individual projects and the analysis of the relationships between them identified approximately 100 major issues within and between the projects reviewed. These issues included:

- Significant gaps in planning for NCW readiness within many individual projects and in particular the relationships between the projects;
- Inadequate or nonexistent planning for information management within most projects; and
- A lack of understanding and poor articulation of the complexity and scope of the relationships between the capabilities to be delivered by the projects.

The relationships between the NCW related projects or project components are schematically illustrated in Figure 8. It shows a simplified map of the key interactions and dependencies of these NCW capabilities, only showing those interactions within the Land. It leaves out most of the myriad additional Joint and coalition interactions. Note also that although Land TIE is a complementary fusion of voice and data based information exchange, the primary focus of this review is on the data exchange, and this is reflected in the figure. It rates the interactions as:

- **Black** – representing those inter-project interactions that are both planned and have no known issues;
- **Dashed pink** – representing planned interactions, for which major issues or limitations have been identified; and
- **Dotted red** – representing interactions the review has identified as required, but for which there are at best only limited intention for implementation within the current capability plans.

³ Note that building on the outcomes of this review (as well as other Department of Defence key initiatives), many of the issues identified in this initial application of the NPI have been addressed or are being addressed.

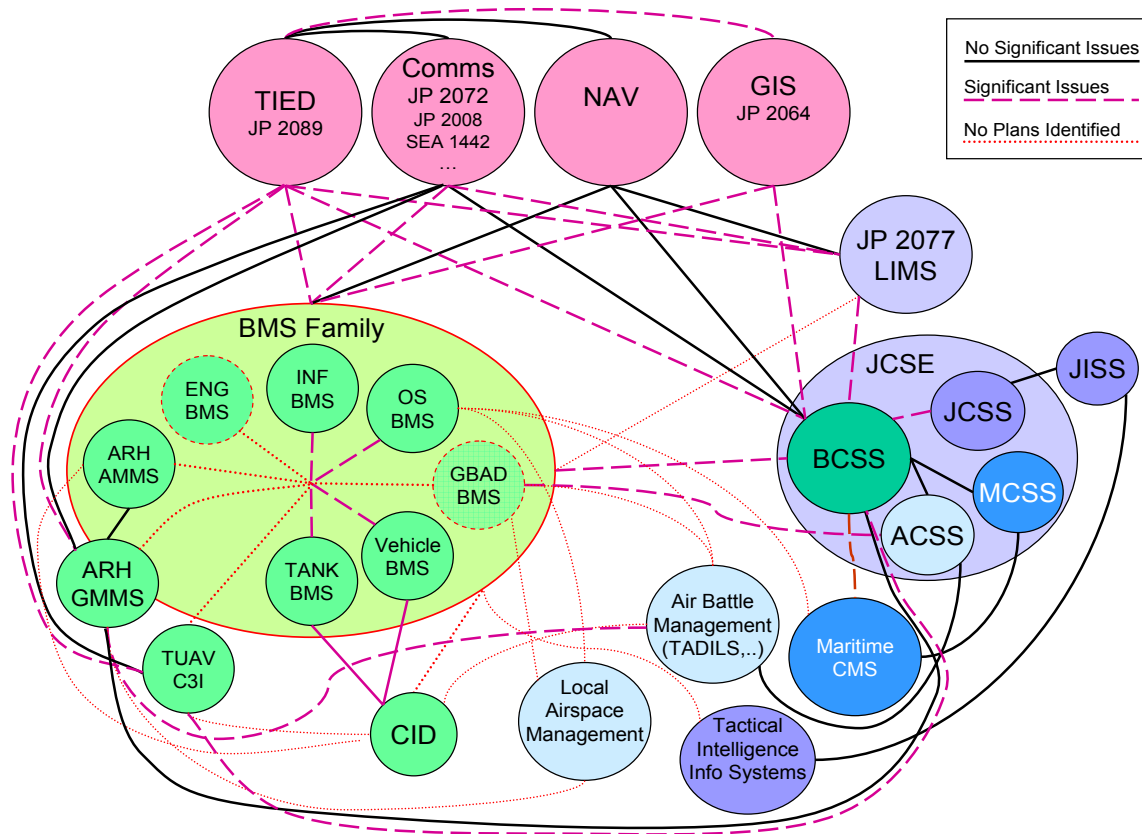


Figure 8: Status of the high priority tactical interactions between the major Land NCW enabling projects (at the time of the 2004 review)

A couple of examples (that have been subsequently addressed) may serve to illustrate nature of the issues as identified at the time of the review:

- Planning for the Armed Reconnaissance Helicopter (ARH) data interoperability only extended to a link between the ARH and its Ground Mission Management System (GMMS) and from there to the tactical planning system. No plans were in place to allow the ARH GMMS to communicate with the emerging battle management system (BMS), airspace management, or joint Link 16 capability.
- For Ground-Based Air Defence (GBAD) there was a requirement to receive the Recognised Air Picture (RAP) Yet no plans were in place for the required communications links or for a suitable information system to utilise this information should it reach the GBAD units.

4.1.2 Holistic Issues

The review also identified over 60 significant holistic and systemic issues that transcended the scope of individual projects. Most of these issues could be wrapped up in the area of systems-of-systems design and integration. This was seen to be essential if the migration to an NCW-capable force was to deliver more than a collection of potentially interoperable and collocated components. It included consideration of the need to develop suitable architectures and the implementation of what are known as the fundamental inputs to capability (FIC)⁴ with a particular focus on:

⁴ FIC: organisation; personnel (incorporates individual training); collective training; major systems; supplies; facilities; support; and command and management (incorporates doctrine).

- Developing effective warfighting concepts, doctrine and TPPs that utilise the potential of the networked capabilities, while retaining the human focus of warfighting;
- Development of suitable individual and, in particular, collective training that could turn the NCW potential into actual warfighting capabilities; and
- Addressing the personnel issues involved in moving to a network force in the context of completion from industry and underlying demographic trends (such as an aging population).

Human factors were seen as one of the key risk areas for the networked force. In general the emphasis of the capability development process had been on the technological components of NCW. This tended to lose sight of the fact that conflicts are fought by people, supported by technologies, not the other way around. Issues of how individuals will establish suitable levels of trust for the networked capabilities, how team formation and action will be modified, and how the underlying cultural changes will be managed were all seen as potentially high risk areas.

The review highlighted the critical importance of information management to ensure that the relevant information is available when needed, which underpins the value to of networking to the force. However, poor or non-existent planning for information management was identified as the most pervasive failing across the reviewed projects. Information management was often simply overlooked, as it is currently undertaken predominately within the minds of the war fighters supported by largely manual processes. Secondly, the capability development process has been focused on the acquisition of physical systems and interoperability rather than the actual information and its management. Finally, information management often transcends individual projects and as such is often not regarded as the responsibility of any particular project.

The review also identified the need to support the migration to an NCW-capable force with an integrated program of experimentation and trials. This would form a complementary feedback mechanism to the NPI methodology for the system-of-system analysis to support the overall design and implementation of the networked force.

4.2 Development of NPI Phase 2

4.2.1 A Complex Validation Case

In order to refine and validate the proposed enhancements to the NPI methodology, a relatively complex system-of-systems project, spanning Land-Littoral-Joint battlespace, was selected as a test case. The relationships between the project's internal nodes are complex as are its relationships with other projects, capabilities and platforms. As the project itself was at a reasonably mature stage near its final stage of concept approval, there was good reason to expect that the requirements documentation and associated supporting products would be well developed and therefore assessable. Application of the NPI methodology to this major project identified a number of associated issues that required further enhancement of the NPI methodology and highlighted some significant shortcomings in the current process of capability development. The most significant shortcoming was the lack of an adequate force-level, system-of-systems design.

4.2.2 Lessons for the NPI Methodology

The NPI methodology is able to more effectively assess complex systems-of-systems when the project is broken into logical project subsystems. The project subsystems have differing requirements that are more logically examined as separate capabilities within the overall project context. This also enables the NPI methodology to consider the important interactions that need to be supported between project subsystems as well as interactions between the subsystems and external platforms. The project subsystems can be weighted but only if the overall design gives the information essential to make these judgements

4.2.3 *Lessons for Force-Level Design*

If a capability or project is to be effectively defined, some context is required to enable the projects to understand the processes that are to be supported. This context should come from some kind of force-level or system-of-systems design. Force level design would enable capability developers to logically organise project system components to align with the force level concepts and requirements. With properly developed high level concepts, military business processes can be determined and capability developers can design systems that support these processes without having to justify all of their project requirements themselves. Importantly, military business processes that will not be supported can be understood alongside the processes that the project intends to support. Force-level design will enable relationships between projects and between project subsystems to be properly explored enabling the capability developer to more effectively prioritise them. Prioritising of a project's interactions and subsystems helps the NPI methodology when it seeks to perform its assessments by logical project subsystem. Currently projects often use scenarios to assist in the determination of their requirements but without force-level design, the scenarios are not necessarily comprehensive enough to support the identification of the relationships between the project subsystems and other projects.

Without force-level design, projects will tend to adjust their scope to fit within the resources available. While this is not a problem in itself, this does not clearly show the high-level requirements that are not being met. It is also very difficult for the projects to determine why relationships are needed and what high-level requirements they will choose to support. Without force level design, projects will tend to pursue local optimisation which may impede the realisation of optimal force-level capability.

5 THE WAY AHEAD

5.1 Evolving the NPI Methodology

It is intended that the NPI methodology continue to be refined and extended over time, incorporating the lessons learnt from its implementation, insights gained from other approaches, and to meet the continually evolving capability development process. Three areas of development have been identified for the next phase (phase 3) of the NPI methodology development:

- Extension of the NPI methodology beyond the current identification of implications from the technical systems analysis, to explicitly address other key elements of FIC such as: warfighting concepts, doctrine and tactics, individual training, collective training, organisation, and personnel. This broadening would require the development of new techniques and frameworks, and would draw upon elements of some of the assessment methodologies examined in the literature review [8].
- Increasing the integration of the NPI methodology with the emerging compliance framework (Section 2.3), in order to both shape the compliance analysis processes and modify the NPI to provide a consistent approach to assessment across the force level design framework.
- Apply the tools and techniques of complex adaptive systems [12] to enable the NPI to more effectively identify and assess the ability of individual capabilities and force-level designs to be adaptive. This will require the identification of those fitness functions or their 'proxies' that will enable the capabilities to adapt to meet the challenges of future complex operations across a range of environments (urban, jungle, open country, ...) and operational contexts (from peace keeping, through counter-insurgency, to high-intensity warfare). They will also need to facilitate the ongoing adaptation of the capability throughout its in service life.

5.2 Application of NPI to More Complex Organisations

The next major application of the NPI will be an assessment of Army's planned networked battlegroup being raised as the first stage of the 'Hardened and Networked Army' (HNA) initiative. This will be a

complex system-of-systems composed a variety of projects and capabilities with varying levels of NCW capability, as well as a range of legacy systems. The emergent nature of the networked battlegroup will mean that the NPI methodology will not only be used in its assessment role, but also be used to provide guidance to the force level design and integration of the battlegroup.

6 CONCLUSION

The NPI methodology has the potential to become one of the key tools to guide ADF implementation of NCW concepts. This potential is centred on system-of-systems analysis that takes a pragmatic approach to answering the questions:

- *How well does the system support military business processes?*
- *How well does the system manage information?*
- *How well does the system integrate technically into the overall force?*

In doing so, the methodology establishes an ability to assess the NCW readiness of both individual projects and the wider networked system-of-systems. This ability has been demonstrated in its assessment of the NCW readiness of the projects and capabilities that will form the future networked Land battlespace. Lessons from this initial application, as well as subsequent validation exercises, have refined the method to be able to be more generally applied across the spectrum of Joint capability.

The methodology also has the potential to be a key component in a force-level design framework, providing analysis of force-level design options, and providing the force-level designers with a template outlining what is required to achieve an integrated, NCW-capable system-of-systems. Recent analysis, and the outcomes of an associated literature review, has demonstrated the risks to achieving an effective networked force from a collection of independent projects without an overarching force-level design to pull them into a system-of-systems. The NPI has the potential to be used as both a guide and as a feedback mechanism to accelerate the development of force-level designs of networked warfighting capability.

Similarly, the NPI methodology has the potential to establish a consistent analysis framework with the compliance monitoring processes and architectures to provide a coherent analysis framework for the development of integrated NCW-capable projects and force-level capabilities.

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APPENDIX A – LAND NCW CHARACTERISTICS

Australian NCW is based on five premises [2] as shown in Figure 9:

1. Professional mastery is essential to NCW.
2. Mission command will remain an effective command philosophy.
3. Information and intelligence will be shared if a network is built by connecting engagement systems, sensor systems and C2 systems.
4. Robust networks will allow the ADF and supporting agencies to collaborate more effectively and achieve shared situational awareness.
5. Shared situational awareness will enable self-synchronisation, which helps warfighters to adapt to changing circumstances and allows them to apply ‘multidimensional manoeuvre’.

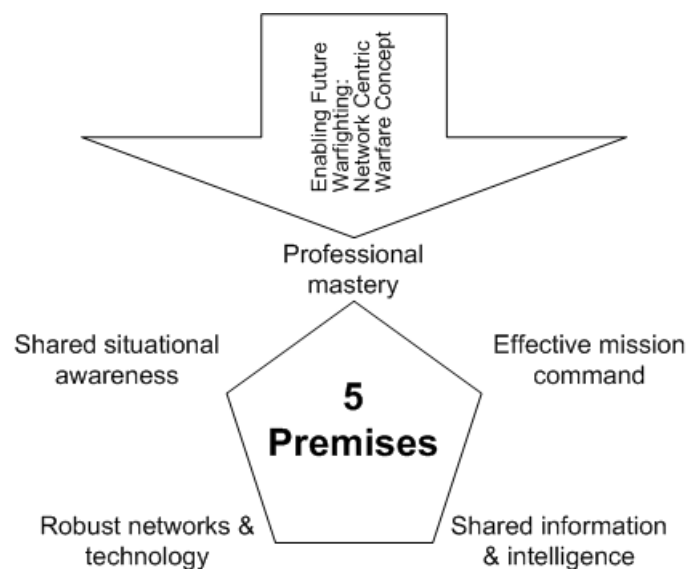


Figure 9. Australian NCW premises

Although the five NCW premises, and associated concepts, provided some high-level insight into NCW, they did not in general provide sufficient depth to guide the development of the concepts and requirements for Land NCW or development of the JP 5000 Land NCW readiness assessment method [7]. Consequently, ten characteristics of Australian NCW were developed to provide sufficient depth to shape the direction and implementation of NCW capability within the Land force:

1. *Application of mission command built on a foundation of professional mastery.* The successful and ubiquitous mission command philosophy must remain the primary focus around which the NCW capability is developed to support humans and their abilities, rather than a centralised command model focused on technology.
2. *Increased ability for the commander to develop and implement options, via appropriate collaboration and combination of capabilities, to generate required effects.* The NCW capability needs to enable commanders to develop warfighting options that are more numerous, more flexible, easier to manage and simpler to apply in the generation of the required effects.

3. *Exchange of complementary voice and digital information across a federated and integrated network.* Voice and data are essential complementary components of the tactical information exchange. This exchange will occur across an integrated network built of many elements (federated) in order to allow independent operation and flexible design and implementation.
4. *Sharing of mission intent and relevant battlespace information to enhance team formation and the effectiveness of fighting as teams – single arms, combined arms, Joint or coalition.* The aim of information sharing is to facilitate a common understanding of intent, supported by the required information (not a common operating picture) to support the formation and effectiveness of fighting teams. These teams span single arms groupings, combined arms teams (single service and Joint), up to coalition alliances. This characteristic encompasses the concept of self-synchronisation as one element (amongst others) of effective team operations.
5. *Effective information management to ensure the required information is provided to the relevant decision-makers in a timely, robust, reliable and secure manner.* The volume and scope of information will increase dramatically in the future, therefore effective information management is critical to ensure that the relevant information is available when needed. It includes dissemination, prioritisation, storage, security, redundancy / robustness, assurance, filtering and fusion.
6. *Flexible management of time and tempo in order to facilitate quality decision-making.* Rather than focusing narrowly on faster processes, the focus of an NCW-capable force should be on managing time and tempo to allow more time for the decision-making component of the OODA loop in order to increase the quality and timeliness of the decisions made.
7. *Enhanced cooperative engagement through the networking of the engagement, sensor and C2 systems.* Land forces currently utilise cooperative engagement methods, particularly in the area of offensive support. However, an NCW-capable force should enhance the level of cooperative engagement between the sensors, actors and controllers in order to increase the effectiveness and responsiveness of the force in generating the required effects.⁵
8. *Broadening the spectrum of operational capabilities from traditional warfighting by facilitating geographically dispersed multi-faceted and concurrent operations.* An NCW-capable force will need to be able to operate as a cohesive force even when geographically dispersed and undertaking a number of different but concurrent activities. This capability will increase the survivability, flexibility and adaptability of the force. This characteristic attempts to capture some the key features of the USMC three-block war concept⁶ and the need for NCW to facilitate such operations.
9. *Enhanced warfighting concepts, doctrine and TTPs to effectively utilise networked capabilities in order to increase force survivability and undertake more complex operations at the same or lower levels of risk.* Warfighting concepts, doctrine and TTPs will need to evolve in order to realise the potential of an NCW-capable force. These concepts should not be limited to trying to achieve small linear enhancements to traditional ADF operations, but rather focus on making the future NCW-capable Land force effective and survivable in complex operations.
10. *Training (both individual and collective) designed to realise and sustain the potential capabilities of a networked force.* Individual, and in particular, collective training will need to be designed and implemented in order to harness the potential of the NCW-capable force.

⁵ This implies that the enhanced cooperative engagement capabilities will need to be able to operate in near real-time as a safety critical system and be S3 accredited as required.

⁶ 'Three Block War' – USMC warfighting concept where forces will be undertaking a wide range of operational functions either concurrently or within a few hours/days, ranging from feeding refugees and providing other humanitarian relief through to separating fighting warlords and mid-intensity, highly lethal conflict -- and all this will take place within three city blocks.

APPENDIX B – DAF PRODUCT RELATIONSHIP TO NPI

View	View / Product Name	Potential Relationship to NPI	Pri
CV-1 [Essential]	Overview and Summary Information	Identification of group relationships for organisational emergent properties analysis.	High
CV-2 [Essential]	Integrated Dictionary	Definitions to support analysis activities.	High
CV-3 [Essential]	Architecture Compliance Statement	Nil	Nil
CV-4 [Supporting]	Capability Maturity Profile	May provide information on maturity of NCW-relevant functionality.	Med

Australian Common Views (CV) = American All Views (AV)

View	View / Product Name	Potential Relationship to NPI	Pri
OV-1 [Essential]	High-Level Operational Concept Graphic	Identification of end-to-end and group relationships for organisational emergent properties analysis.	High
OV-2 [Essential]	Operational Node Connectivity Description	Identification of end-to-end and group relationships for organisational emergent properties analysis. High-level guidance on interactions between capabilities. May provide some guidance on the business processes supported by the capability.	High
OV-3 [Essential]	Operational Information Exchange Matrix	Identification and characterisation of capability interactions, including internal interactions between different nodes.	High
OV-4 [Essential]	Command Relationship Chart	Guidance on nature of end-to-end and group relationships.	Med
OV-5 [Essential]	Activity Model	Guidance on nature of end-to-end and group relationships.	Med

View	View / Product Name	Potential Relationship to NPI	Pri
OV-6A [Supporting]	Operational Rules Model	Guidance on operational constraints on business process support and information management key enabler characteristics.	Low
OV-6B (Supporting)	Operational State Transition Description	May provide some guidance on business process support and information management key enabler characteristics.	Low
OV-6C [Supporting]	Operational Event / Trace Description	May provide some guidance on business process support and information management key enabler characteristics.	Low
OV-7 [Supporting]	Logical Data Model	Guidance on capability information management characteristics.	Low

View	View / Product Name	Potential Relationship to NPI	Pri
SV-1 [Essential]	System Interface Description	Identification of support for end-to-end relationships.	High
SV-2 [Supporting]	Systems Communication Description	Identification and characterisation of support for end-to-end relationships.	High
SV-3 [Supporting]	Systems to Systems Matrix	Guidance on identification and characterisation of capability interactions at a system level, including internal interactions between different nodes.	High
SV-4 [Supporting]	Systems Functionality Description	Guidance on support for military business processes and information management key enablers.	Med
SV-5 [Supporting]	Operational Activity to System Function Traceability Matrix	May provide some guidance on how systems implement business process support and information management key enablers characteristics.	Low
SV-6 [Supporting]	System Information Exchange Matrix	Identification and characterisation of capability interactions at a system level, including internal interactions between different nodes.	High

View	View / Product Name	Potential Relationship to NPI	Pri
SV-7 [Supporting]	System Performance Parameters Matrix	May provide guidance on performance in business process support and information management key enablers.	Low
SV-8 [Supporting]	System Evolution Description	Guidance on potential changes over time (epochs) in key enabler characteristics and support for end-to-end relationships.	High
SV-9 [Supporting]	System Technology Forecast	Guidance on potential changes over time (epochs) in key enabler characteristics, particularly systems integration, and support for end-to-end relationships.	High
SV-10A [Supporting]	Systems Rules Model	Guidance on system design constraints on business process support and information management key enabler characteristics.	Med
SV-10B [Supporting]	Systems State Transition Description	May provide some guidance on business process support and information management key enabler characteristics.	Low
SV-10C [Supporting]	Systems Event / Trace Description	May provide some guidance on business process support and information management key enabler characteristics.	Low
SV-11 [Supporting]	Physical Data Model	May provide some guidance on information management key enabler characteristics.	Low

View	View / Product Name	Potential Relationship to NPI	Pri
TV-1 [Essential]	Technical Architecture Profile	Identification of systems integration key enabler technology standards mandated for the capability.	High
TV-2 [Supporting]	Standards Technology Forecast	Identification of systems integration key enabler technology standards forecast for the capability.	High