Australian Defence NCW Simulation Support Planning - Status

Mr. Darren McFarlane, ADSO Defence Simulation Governance;
Australian Defence Simulation Office
Australian Department of Defence
Russell Offices (R1-3-B066)
Canberra 2600
Australia

darren.mcfarlane@defence.gov.au

ABSTRACT

This paper develops a framework for developing where simulation can/should support the achievement of a Netcentric Australian Defence Force. The intent of this paper is to address the analytical framework used to conduct the gap analysis and to identify priority areas for investment in NCW Simulation. This analysis will be used to assist in developing a ten year ADF NCW Simulation Support Plan.

The framework combines the guidance contained in the Australian NCW Roadmap 2007 [2], the Australian Defence Simulation Roadmap 2006 [3] and the Australian Defence Simulation Manual [4]. The Australian NCW Program Office is developing an Australian NCW Integration Plan to provide the detailed initiatives and milestones beneath the NCW Roadmap. When this NCW Integration Plan is finalised, the NCW Simulation Support Plan will be reviewed to provide greater definition to this ongoing work.

However, the broad areas where simulation could provide assistance to NCW were articulated by Australian NCW Stakeholders. These are summarised and shown below in Table 1.

Table 1 – Challenge areas in developing NCW

Articulated requirement for NCW assistance	Derived Description of Need
Force Level NCW Design	▸ The ability to **rapidly develop and manage Force Level NCW Designs**, including the ability to test business processes, interfaces and interoperability with WoG and Coalition partners
NCW Compliance	▸ The ability to **rapidly assess project and system level compliance** to the Force NCW Design, throughout the Capability Life Cycle, with a particular emphasis on the ability to assess tender responses.
NCW Programmatic Assistance	▸ Assistance with ***identification*** and ***coordination*** of what NCW capabilities to keep, cut and invest in, at the Force level with mappings to FIC, cost and schedule estimates
Support to Training	▸ The ability to rapidly train for network enabled operations.
Support to Operations	▸ The ability to rapidly plan, rehearse and execute network enabled operations.
Attribute: Usability	▸ The ability to rapidly and conveniently build, reconfigure, run and analyse NCW analyses in a timely manner which supports decision making
Attribute: Assessment of Trust	▸ The ability to assess the confidence in the various tools and methods, and how this impacts decision making

McFarlane, D. (2007) Australian Defence NCW Simulation Support Planning - Status. In *Improving M&S Interoperability, Reuse and Efficiency in Support of Current and Future Forces* (pp. 15-1 – 15-28). Meeting Proceedings RTO-MP-MSG-056, Paper 15. Neuilly-sur-Seine, France: RTO. Available from: http://www.rto.nato.int.

Detailed needs and requirements for enhanced and expanded simulation support to NCW in the 2017 timeframe were developed, and then compared against the current levels of simulation support to NCW. To achieve the desired simulation support capabilities in 2017 required focus in the following four areas:

- *NCW Enablers. A number of NCW enablers were identified, that did not relate specifically to simulation, but would enhance the effectiveness of future simulation support once they were developed.*
- *Simulation Support to Netcentric Force Development. Opportunities for simulation to test fundamental NCW hypotheses and related future business processes against potential Force level designs, and the ability of simulation to assist in testing future system level NCW compliance.*
- *Simulation Support to Netcentric Force Employment. These related to the usability and use of simulation for netcentric mission training, planning, rehearsal and execution.*
- *Governance for Simulation support to NCW. These related to recommended governance improvements to focus all relevant simulation activities towards a common end-point.*

1 INTRODUCTION

1.1 Background

Network Centric Warfare (NCW) is one of the key enabling concepts that underpins the Australian Defence Force's (ADF) Future Joint Operations Concept. Successfully integrating Defence's people, processes, systems and technology under the auspices of the NCW concept promises to enhance the conduct of operations. However, achieving the desired levels of seamless integration and collaboration is difficult, and provides a different set of challenges at each phase of the Capability Life Cycle (CLC).

Simulation is one of many tools that can support the design and implementation of a force able to leverage the network for enhanced warfighting, but it is difficult to understand where and how simulation should be applied for maximum value. Our analysis addressed the following questions:

- What are the key NCW questions that can be supported by simulation and how can these be prioritised?
- What types of simulation are required? Where should we focus the development of simulation capability?
- Where should simulation resources be invested to best support the NCW program objectives? What foundation work needs to be completed?
- What else needs to be completed to optimise future simulation support to NCW?

The derived results will help to complete an Australian NCW Simulation Support Plan that outlines a ten year evolutionary process to optimise the use of simulation to support the netcentric force. The Plan will need to relate closely to the NCW Integration Plan when it is finalised. This paper broadly summarises the analysis work completed to date and will address:

- Identifying and prioritising the need (noting that the NCW Integration Plan is not yet finalised);
- Defining the perceived 'To-Be' requirement;
- Assessing the 'As-Is' (existing) level of capability; and
- Identifying and prioritising the focus areas to achieve the future state.

2 FRAMEWORK FOR SIMULATION SUPPORT TO NCW

2.1 Introduction

A framework for simulation support to NCW was developed to support the assessment. It encompasses key aspects of NCW, Simulation and the CLC, providing a three-axis construct to enable the broad subject areas to be segmented for analysis.

The framework (illustrated in Figure 1) is based on:

- The NCW Domains[1][1] – which segments the different aspects of NCW;
- The Simulation Hierarchy [4] – which describes the level of focus of the simulation; and
- The three key focus areas of the Defence Simulation Roadmap [3] – which include 'Develop the Force', 'Employ the Force' and 'Simulation Governance'.

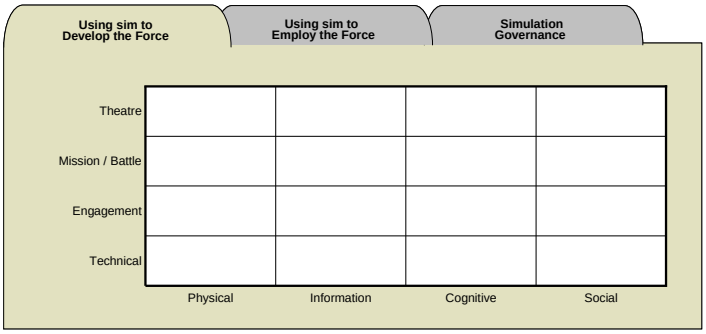

Figure 1 – Framework for Analysing Simulation Support to NCW

While there were a number of possible elements that could have been used for the framework, the following summary provides insight as to why they were selected.

2.2 The Framework

Each element of the framework is defined as follows:

NCW Domains [1] – In order to provide greater resolution around the key aspects of NCW, the four NCW domains of Physical, Information, Cognitive and Social were used. Key elements of these domains are defined in Figure 2.

[1] Based on the 'Domains of Warfare'.

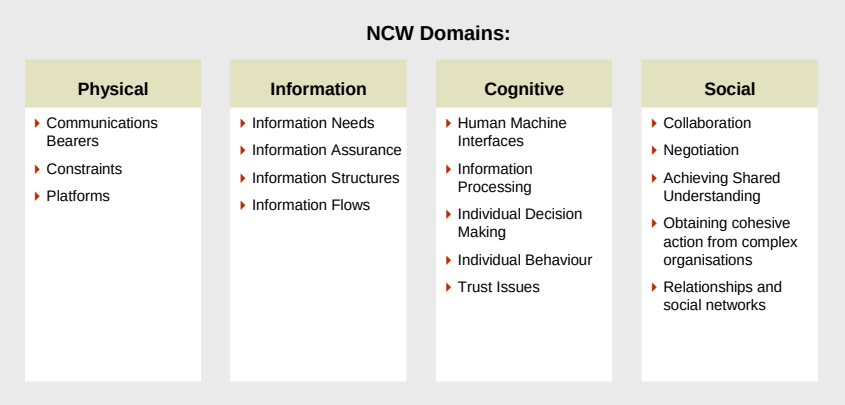

Figure 2 – Elements of the NCW Domains

- Simulation Hierarchy [4] – As described in the Australian Defence Simulation Manual (SIMMAN) Vol 1 Part 5, 'The Simulation Proposal Guide', there is an accepted simulation hierarchy to describe the focus of the simulation. This hierarchy provides a useful distinction of the levels of the force that are the primary focus of the simulation, ranging from whole-of-force or theatre-level simulations to the detailed technical elements internal to a specific system. While some simulations may span a number of these levels, they are generally optimised to support analysis at a particular level. A summary of the definition of each level is reflected in Figure 3.

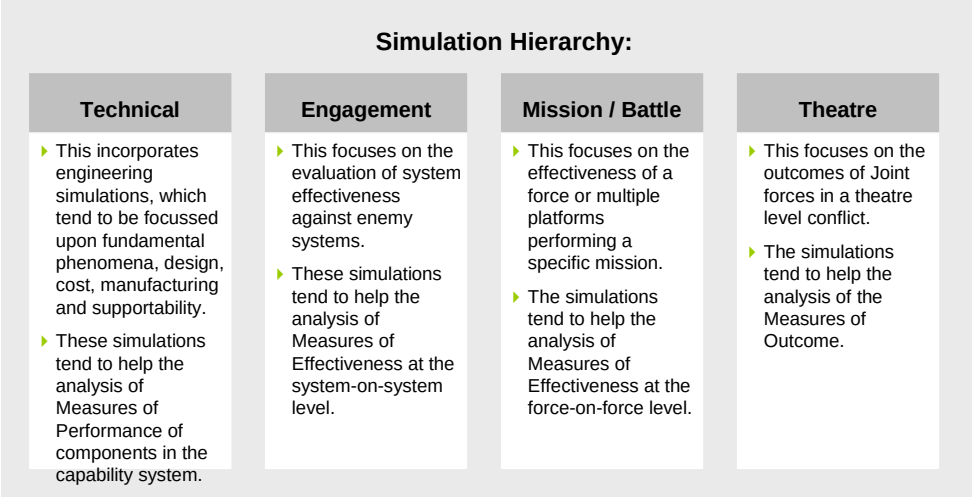

Figure 3 – Elements of the Simulation Hierarchy

- Defence Simulation Roadmap [3] – The key elements of the Australian Defence Simulation Roadmap (Figure 4) address how simulation is used and how Defence intends to achieve the vision for simulation support. Where simulation is used throughout the CLC, it is captured within the 'Develop the Force' and 'Employ the Force' constructs.

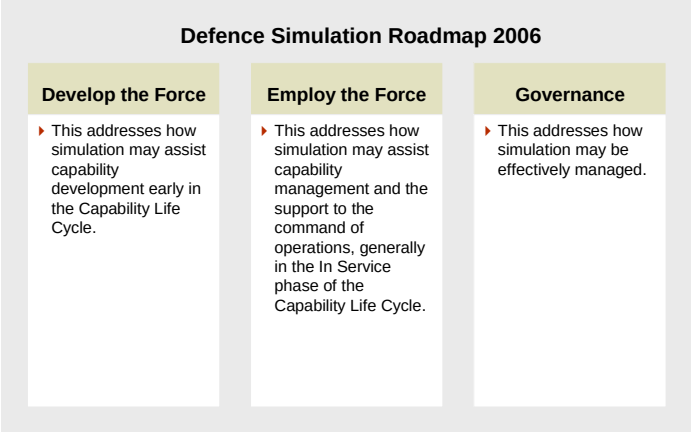

Figure 4 – Elements of the Defence Simulation Roadmap 2006

2.3 Insights from using the Framework

2.3.1 Insights from the NCW domains

When considering the transition from the physical to social aspects of NCW (the horizontal axis in Figure 5), the context focus changes from:

- The network dimension to the human dimension;
- The actual technology to how the technology is used;
- Physical networks to social networks;
- 'Harder', more repeatable data to 'softer', less repeatable data; and
- Model validation becomes more difficult, because internal human aspects such as belief and intent are more difficult to quantify and measure.

While it is easier to model the physical elements, much benefit may be realised from understanding how people may better utilise technology. Therefore, there is significant benefit in focussing on supporting the development of business processes and other social aspects; however this is more difficult to achieve.

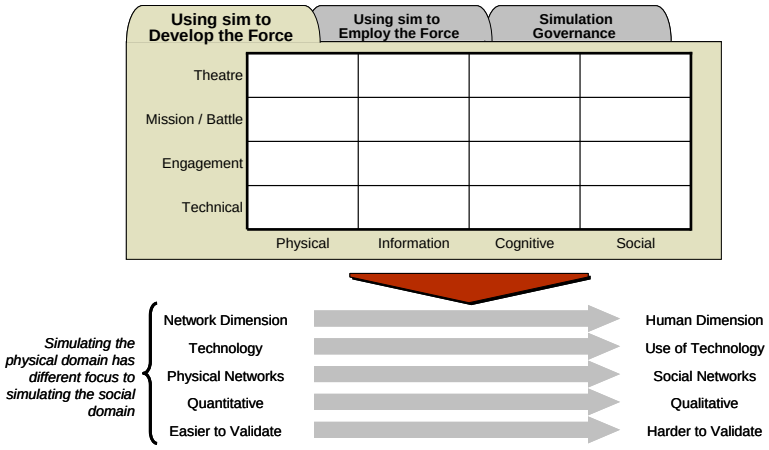

Figure 5 – Insights from simulating the NCW Domains

2.3.2 Insights from the Simulation Hierarchy

As one moves from theatre simulations to technical simulations (the vertical axis in Figure 6), the simulation focus tends to change:

- From joint and strategic outcomes to project/product outcomes;
- From simulating overall force outcomes to system outcomes;
- From scenario dependent simulations to scenario independent simulations;
- From 'softer', unstructured and qualitative data to 'harder', more structured and quantitative data;
- From assessing more ambiguous outcomes to more certain and testable outcomes;
- Simulations tend to become easier to measure and validate against actual test and performance data;
- The impact of decisions supported by the simulation tends to decrease (depending upon system architectures and redundancy); and
- Simulation emphasis moves from visualisation to virtualisation.

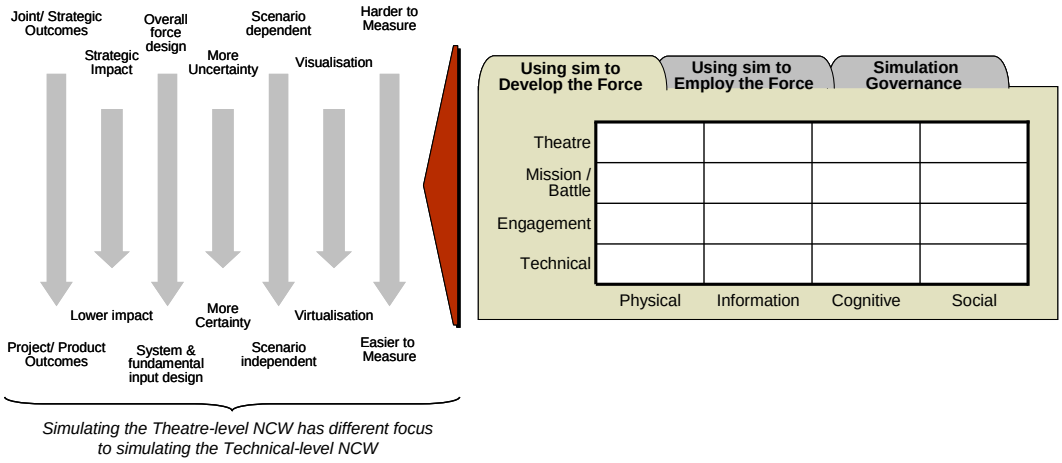

Figure 6 – Insights from the Simulation Hierarchy

The framework formed a useful basis for developing the 'To-Be' view, as well as in mapping the existing capability (the 'As-Is').

3 CONTEXT FOR SIMULATION SUPPORT TO NCW

3.1 Introduction

Before determining how to apply simulation to solving a problem, it is important to ensure a full understanding of what the problem is.

This section provides the context for simulation support to NCW including:

- A brief overview of NCW and the Australian Defence NCW aspirations; and
- Some of the key challenges faced by Defence in realising these aspirations.

3.2 Network Centric Warfare and Defence

NCW is recognised in the Australian Defence Capability Strategy as a key capability enabler. Australian Defence is therefore making considerable effort to incorporate it into capability planning, force design, force integration and implementation.

The Australian definition of NCW is:

"*NCW is a means of organising the force by using modern information technology to link sensors, decision makers and weapons systems to help people work more efficiently together to achieve the commander's intent.*" [5]

It is important to understand the difference between a force that is networked, and one that uses the network in order to achieve a fundamental advantage. The primary challenge is developing the ability to understand how people collaborate within complex networks, and to design and train a force that optimises the network to achieve its objectives.

3.2.1 NCW Target States in 2020

Australian Defence has developed a set of Target States for 2020 to communicate its aspirations for NCW [2]. These NCW Target States provide endorsed guidance on where Defence would like to be in terms of NCW development.

The six NCW Target States for 2020 are summarised below in Table 2 and provided more fully at Annex A.

NCW Target State	Summary
Force Application in 2020	*The ADF can generate a range of lethal and non-lethal effects that are both timely and appropriate and are synchronised with other partners to achieve the desired effect*
Information Superiority and Support in 2020	*Defence has continuous information connectivity to link fighting units, sensors and decision-makers in a way that increases situational awareness and the capacity to act decisively*
Command and Control in 2020	*The ADF's command and control system promotes collaboration*
Force Deployment in 2020	*Defence has continuous information connectivity to link fighting units, sensors and decision-makers in a way that increases situational awareness and the capacity to act decisively*
Force Protection in 2020	*The ADF's command and control system promotes collaboration*
Force Generation and Sustainment in 2020	*Defence has continuous information connectivity to link fighting units, sensors and decision-makers in a way that increases situational awareness and the capacity to act decisively*

Table 2 – Defence's NCW Target States to be Achieved by 2020

While these NCW Target States provide good long-term, high-level guidance on the ADF's desired NCW end states, they are currently not supported with a description of the path on how to achieve them. Effort is underway via the NCW Integration Plan to fill this void and will prove useful for the eventual NCW Simulation Support Plan.

3.3 The NCW Challenges

"*There is no science today that offers the fundamental knowledge necessary to design large complex networks in such a way that their behaviours can be predicted prior to building them.*" [6]

Whilst a number of endorsed documents on NCW exist, including the 2007 NCW Roadmap and the NCW doctrine (i.e. NCW ADDP-D.3.1 Enabling Future Warfighting: Network Centric Warfare), NCW concepts are still evolving.

Other challenges to realising Defence's NCW aspirations include:

- Developing a deeper understanding of NCW, its concepts and potential benefits;
- Designing optimal Netcentric Force structures;
- Measuring the benefits of NCW;
- Defining and measuring Defence's progress in implementing NCW;
- Training Commanders and the force to fight within an NCW context – to optimise the benefits of being a networked force; and
- Understanding how to prioritise and balance capability investment across future and legacy systems to optimise its resources whilst achieving its NCW aspirations.

How to progress NCW is a complex and challenging problem, particularly when it comes to coordinating and implementing NCW across different organisations, technology, business processes, people, politics and nation states.

3.3.1 Challenge areas in developing NCW

In meeting the NCW challenge, the areas where stakeholders articulated that they needed assistance, (which may or may not be provided by simulation) are summarised below.

Table 3 – Challenge Areas in Developing NCW

Articulated requirement for NCW assistance	Derived Description of Need
Force Level NCW Design	The ability to **rapidly develop and manage Force Level NCW Designs**, including the ability to test business processes, interfaces and interoperability with WoG and Coalition partners
NCW Compliance	The ability to **rapidly assess project and system level compliance** to the Force NCW Design, throughout the Capability Life Cycle, with a particular emphasis on the ability to assess tender responses.
NCW Programmatic Assistance	Assistance with ***identification*** and ***coordination*** of what NCW capabilities to keep, cut and invest in, at the Force level with mappings to FIC, cost and schedule estimates
Support to Training	The ability to rapidly train for network enabled operations.
Support to Operations	The ability to rapidly plan, rehearse and execute network enabled operations.
Attribute: Usability	The ability to rapidly and conveniently build, reconfigure, run and analyse NCW analyses in a timely manner which supports decision making
Attribute: Assessment of Trust	The ability to assess the confidence in the various tools and methods, and how this impacts decision making

In addition, two attributes of ‘support to NCW’ were also articulated – usability and trust.

4 SCOPE FOR SIMULATION SUPPORT TO NCW

4.1 Introduction

This section defines the scope for simulation in supporting Australian Defence to achieve its NCW objectives. It briefly describes how and where simulation can support NCW, and then describes the specific questions in the design and implementation of NCW that simulation can be used to support. This is achieved against the defined NCW Target States.

These questions and ‘application areas’ form the basis of how simulation could be used to develop NCW.

Simulations can support the general approach of ‘Learning by Doing’, by providing a complementary ‘Learning by Simulating’ approach that enables Defence to test different business processes (particularly operational activities i.e. warfighting), designs and concepts prior to investing large amounts of money in acquiring and fielding new systems.

4.2 Core Simulation Functional Capabilities

4.2.1 How simulation can support NCW

Simulation can model a large number of:

- Operational environments;
- Technical and performance parameters;
- Information flows; and
- Sensor and/or Weapons systems and their interactions with friendly, neutral and adversary forces.

This means simulation can be used to explore the capability, cost and risk drivers within the context of an increasingly networked force and support the design and implementation of a netcentric force. If simulation is trusted enough to be used, then it will complement – not displace – the evolving role of humans in decision making processes by:

- Facilitating robust and shared understanding of complex NCW related issues; and through this
- Reducing risk pertaining to NCW investment and outcomes.

4.2.2 Where simulation can support NCW

Simulation can be used to support a range of activities relating to the development of NCW capability across the CLC, as shown in Figure 7. Proposed simulation support at the NCW Target State level is detailed at Annex B.

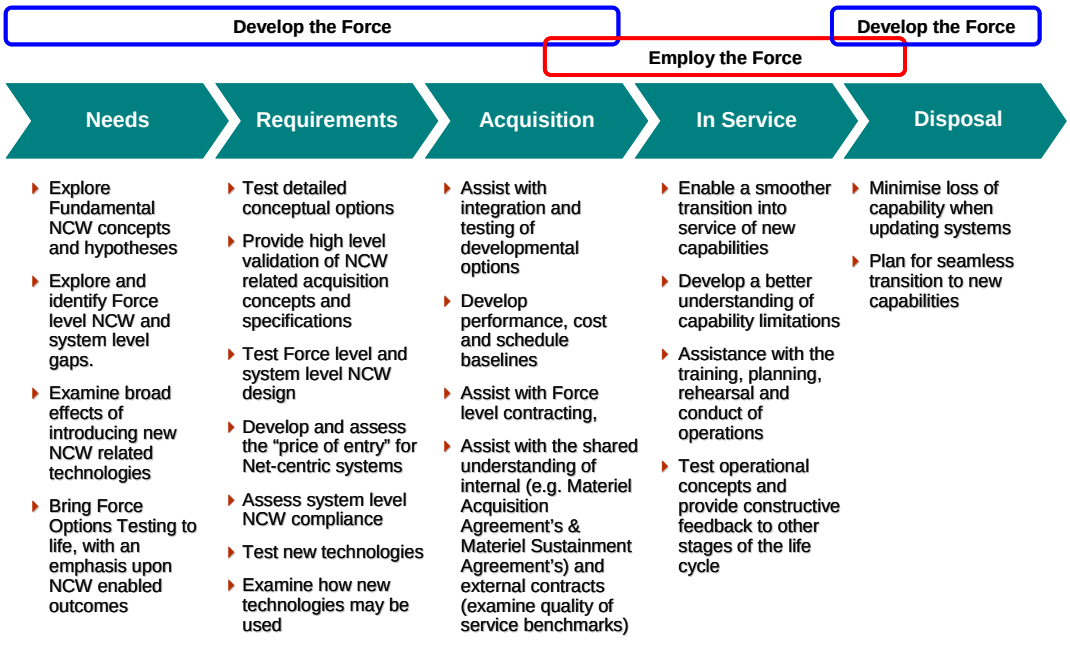

Figure 7 – Simulation Support Across the CLC

The traditional CLC has been mapped in Figure 7 to the concepts used in the Simulation Roadmap to consider the use of simulation to 'develop' the force and simulation to 'employ' the force.

The distinction between the two is conveyed in Figure 8 largely through the emphasis in the different quadrants (illustrated in the words within the ovals).

- Using Simulation to Develop the Force (Figure 8) focuses on longer-term aspects of achieving the NCW aspirations and includes force design and assessing compliance against the design.

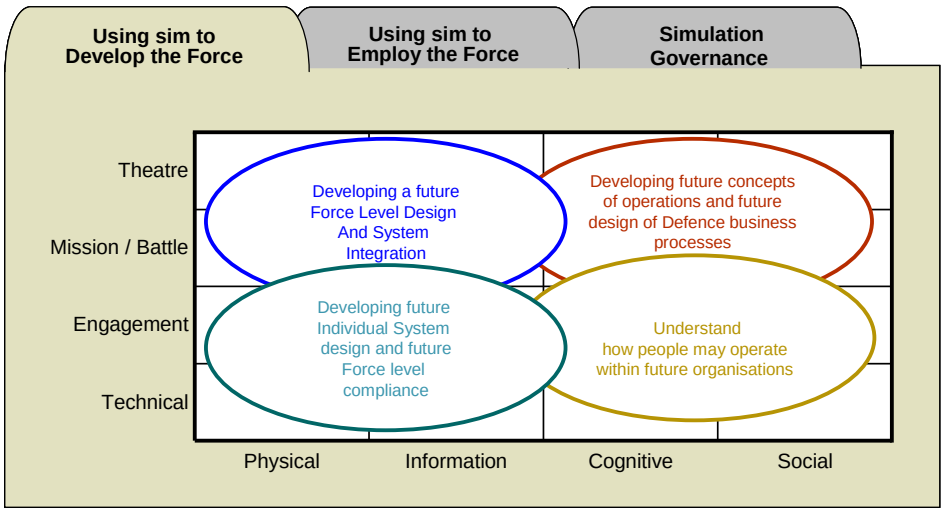

Figure 8 – Simulation Support for Developing the Force

- Using Simulation to Employ the Force (Figure 9) focuses on optimising the networked force and on how to support the development and refinement of concepts of operations, operational planning and training to optimise the benefits of NCW.

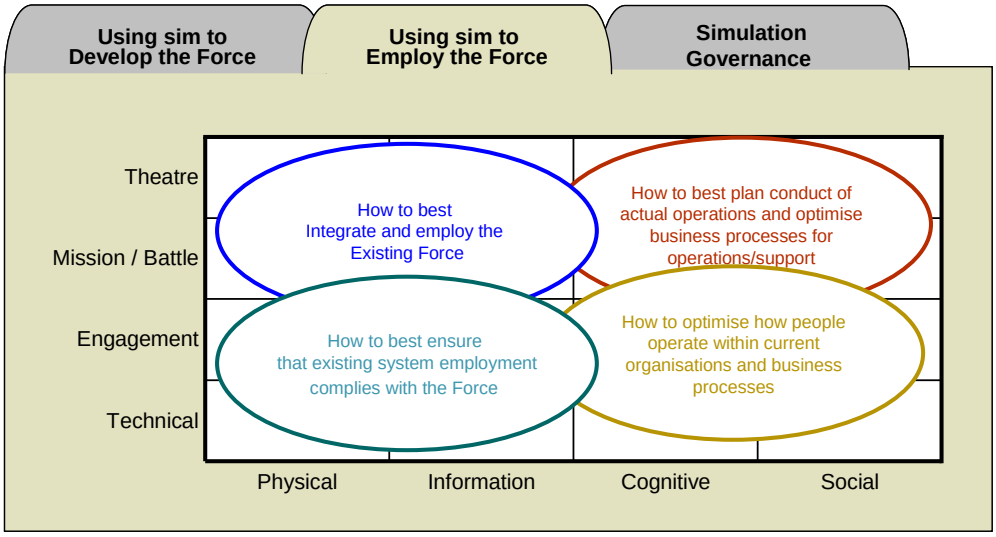

Figure 9 – Simulation Support for Employing the Force

- Simulation Governance applies to all aspects of simulation support to NCW, as it would to any other type of simulation.

4.3 Prioritising Simulation Support to NCW

While simulation could support all of the areas identified in the framework, resources are limited and need to be focused on the highest priorities and where the return on investment will be greatest.

Through analysis and in concert with stakeholders, the priorities for simulation support to the NCW 2020 Target States are reflected in Table 4.

Table 4 – Priorities for Simulation Support to NCW

NCW Roadmap 2007 Target State	Priority for Simulation Support
Force Application in 2020	2
Information Superiority and Support in 2020	1
Command and Control in 2020	2
Force Deployment in 2020	4
Force Protection in 2020	3
Force Generation and Sustainment in 2020	5

The priorities will be analysed in greater detail with the finalisation of the NCW Integration Plan.

5 'TO BE' SIMULATION SUPPORT TO NCW

5.1 Introduction

After establishing the analytical framework, defining the problem, and prioritising where simulation should be considered, a possible future for simulation support to NCW was developed. This section summarises the desired state of simulation support to NCW in the year 2017, in terms of how simulation can support:

- Developing the future netcentric force; and
- Employing the future netcentric force.

In assessing how simulation can support the development and employment of the netcentric force, the 'To-Be' requirements have been developed against each of the NCW Target States, providing insight to the subtly different emphasis of the questions and the types of simulations required to address these questions.

Finally, this section provides an overall summary of the future requirements for simulation support to NCW, incorporating insights from stakeholder engagements across Industry, Academia and Defence.

5.2 'To Be' Simulation support to Netcentric Force Development

In 2017, simulation will be used to support force development with a particular emphasis on embodying the principles and optimising the benefits offered through NCW. Simulation could be used widely to:

- Test fundamental NCW concepts and how they affect Defence warfighting business processes and the resulting force-level design;

- Perform performance assessments of different designs, especially early in the capability life cycle;
- Design and assess interfaces and the level of interoperability that can be achieved at a force level, with whole-of-government (WoG) and coalition partners; and
- Test system-level compliance to Defence business processes and force-level design. This requires engagement-level simulations to be able to interface with and map to the force-level design. Whilst this does not necessarily require integrated (seamless) simulations, common lexicon and interfaces are required.

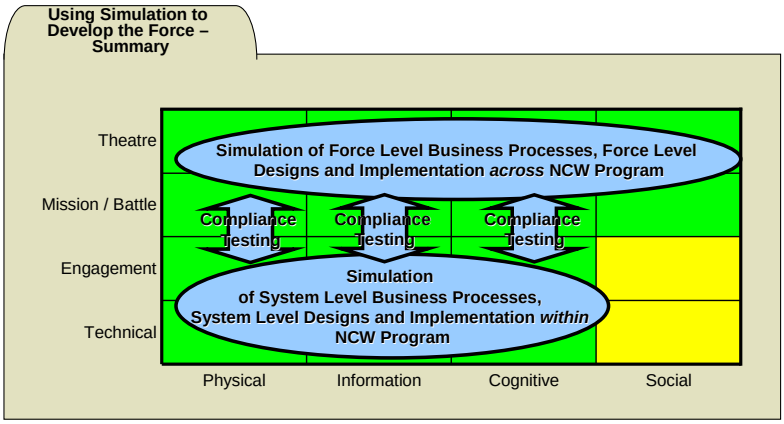

Figure 10 – 'To Be' Simulation Support to Developing the Netcentric Force

5.3 'To-Be' Simulation Support to Netcentric Force Employment

Simulation could be used more extensively and effectively to optimise the employment of a netcentric force. This will include the use of simulation to test:

- Different Courses of Action (CoA);
- The development of optimal Command and Control structures (and associated decision rights) for specific operations;
- Testing and training individual force elements on how to operate within a networked force (familiarising them with the concepts of self synchronisation, new concepts of operation, enhanced situational awareness, etc);
- Support to planning at the force level, requiring simulations at the Theatre/Mission level, extending the Physical, Information and Cognitive domains;
- Support team and individual training in the concepts and practices of self synchronisation, mission command and professional mastery across the force; and
- Extracting lessons and insights through the training and planning activities for improvements to doctrine and concepts of operation at a whole-of-force level.

Importantly, training will be conducted at a whole-of-coalition, whole-of-government and whole-of-force level, through integration of Engagement-level simulations with Mission- and Theatre-level simulations.

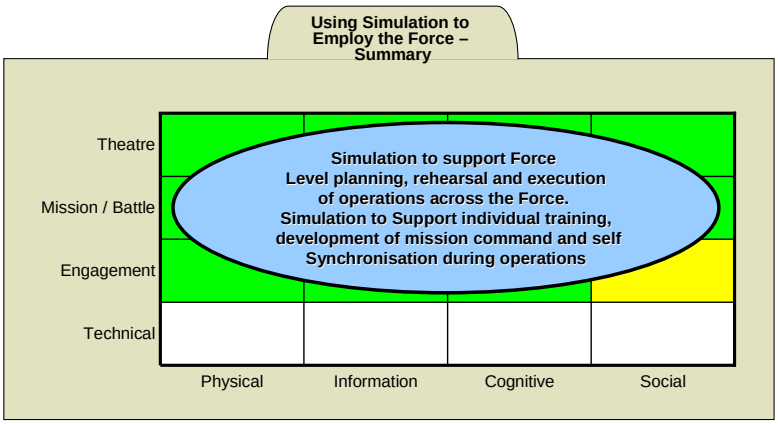

Figure 11 – 'To Be' Simulation Support to Employing the Netcentric Force

5.4 Summary of 'To Be' Simulation Support to NCW

The future 2017 vision for where simulation could support NCW is for:

- Support to better understand and test fundamental NCW concepts and hypotheses, and how these are translated into netcentric business processes, including WoG and coalition aspects;
- Better testing of netcentric business processes, and how these affect netcentric force designs, including WoG and coalition aspects;
- The ability to rapidly test system-level NCW compliance to the netcentric force design. This will be markedly improved through better integration of simulations that test force effectiveness and simulations that test system effectiveness;
- Better understanding of the NCW-related cognitive and social issues and how they may be modelled, including how to better understand and model coalition and allied interoperability issues (semantic, cultural etc);
- Simulation sophistication must better match the sophistication of the user, through simpler simulation interfaces and more sophisticated simulation users;
- Simultaneously recognising the need for diversity and flexibility for innovative R&D, and for standardised and consolidated development environments, simulation tools and infrastructure. Less is more;

5.4 Measures of Success for simulation support to NCW in 2017

Some possible measures of success for simulation support in 2017 may be expressed as the ability to:

- ***Rapidly*** test and assess existing and future netcentric force-level designs and associated project/system level compliance through a variety of architectural approaches (i.e. systems based, service based or a hybrid) and associated virtual prototyping. Note: NCW architecture development will tend to inform and provide input data to related simulations;

- ***Rapidly*** test and assess existing and future netcentric force-level interoperability and associated project/system level interoperability compliance with other government agencies (WoG), allied and coalition partners;

- ***Rapidly*** simulate, develop, test and incorporate new innovative technologies and approaches, including any future possible redefinition of NCW (i.e. to be able to rapidly understand novel new approaches);

- Test what legacies are created by introducing new NCW-related standards/technology/business processes/approaches;

- Model key netcentric capability clusters and measure whether command improves by undertaking various capability enhancements;

- Understand how organisational, workforce and C2 structures affect warfighting outcomes; and

- Obtain a better understanding of how to develop modelling and simulation of human behaviour and how it relates to trust, beliefs and other highly context specific attributes of NCW (e.g. Defence can't ***measure*** trust or ***see*** people's beliefs). This needs to include the ability to understand how underlying demographic change and social trends can affect NCW outcomes and warfighting performance. This also includes the ability to understand and develop the modelling and simulation of performance under conditions of confusion, stress and rapidly changing command and control arrangements.

- Assist overall NCW Program Management. Simulation will provide key support to the coordination of the NCW program across the ADO. Specifically, this may involve:

    - Detailed and rapid mapping of force-level and system-level NCW simulation outputs to Fundamental Inputs to Capability, cost estimation, budget planning and overall programmatic processes, in order to inform capability investment decisions, at the time of the decision; and

    - The ability to embed cost estimation methodologies within NCW simulations, in order to provide simulated value for money assessments for various force-level operational and developmental scenarios. Embedding cost estimation functionality within simulations will provide an ideal vehicle for assisting with the development of robust estimates of the cost of complex netcentric capabilities and would ultimately support decisions in terms of:

what to cut, what to keep and what to invest in across the NCW and wider Defence Program

6 'AS-IS' SIMULATION SUPPORT TO NCW

The past decade has seen a dramatic increase in the value and employment of simulation capabilities in both the commercial and defence environments. From a Defence perspective, the traditional focus upon augmenting individual training and skills development has grown to include wider ranging goals of enhancing capability, reducing risk and saving resources across the full spectrum of Defence activities; from the battlefield to the capability development and acquisition domains.

Defence has invested upwards of $2 billion in providing simulation capabilities to its users, with an annual outlay of between $150-200 million in maintenance, support, and new capability and enhancements. Industry and academia have also invested a significant amount of resources across a broad range of

modeling and simulation endeavours. Together, simulations exist to support training, provide support across all elements of DSTO, within such as the Army Simulation Wing, and are used to support the engineering and test of a range of weapon systems. Experimentation frameworks are being developed across the air, land and maritime domains.

There is also a range of simulations supporting joint and integrated capabilities, such as the recent successful trial of the Joint Decision Support and Simulation Centre (JDSSC), ongoing piloting of NETWARS by the Tactical Information Environment Integration Office, Army's Combat Training Centre, and the US/Australian Joint Combined Training Centre (JCTC).

Thus Defence is an advanced user of simulation; understands that simulation can be used to enhance capability, save resources, and reduce risk; and is continuously developing a wider understanding of the NCW context. Evidence of this is shown by the fact that Defence has a number of initiatives currently underway. These include, but are not limited to:

- The development of an NCW Integration Plan, Battlespace Architecture 2015+ and an NCW Compliance Framework;
- Investment in longer term research and infrastructure by DSTO (such as the Netwarrior program, and ongoing investment in the Joint Decision Support and Simulation Centre, among many others);
- Ongoing work by the Tactical Information Exchange Integration Office;
- The Joint Combined Training Centre;
- The Rapid Prototyping, Development and Evaluation (RPDE) initiative which seeks to build collaborative relationships across Defence and Industry.

6.1 NCW Enablers

One of the issues in using simulation and other tools is the requirement to have a solid foundation upon which to model and simulate. In the NCW context in particular, there is a requirement for an accessible, agreed, consistent language (in the form of an NCW Glossary) and metrics – to facilitate the coordination and assessment of different force designs using a common baseline. Effort is currently underway to address these issues.

For example, there has been much work over recent years (especially within the Australian Defence Science and Technology Organisation (DSTO)) on developing a hierarchical set of practical NCW metrics within Australia, but these are not yet endorsed or institutionalised.

The Defence Simulation Roadmap 2006 also recognised the need for a set of simulation metrics within Australia.

6.2 'As-Is' Simulation Support to Develop the Netcentric Force

Australian Defence is already a sophisticated user of simulations – examples are depicted in Figure 12, mapped against the framework.

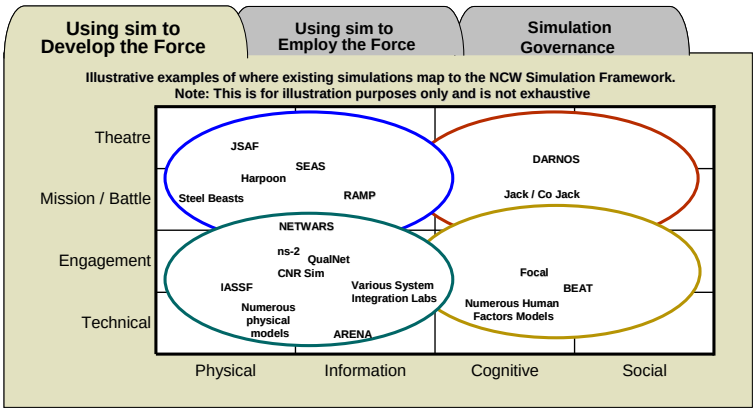

Figure 12 – Example Simulations used to develop the Netcentric Force

However, Defence's current level of simulation support to develop the Netcentric Force is assessed as 'minimal' – as illustrated in Figure 13. Areas where Defence has a 'fair' level of capability is predominantly in the Physical and Information domains at the Technical to Mission level – but only then in related clusters of capability (e.g. clusters of aircraft, clusters of ships, etc).

Defence's current investment in simulation support to develop the Netcentric Force is focussed on understanding information flows and associated connectivity requirements of individual capabilities, or small clusters of capability. Most of these models and simulations tend to be highly focussed on specific capabilities, and are not easily integrated or federated.

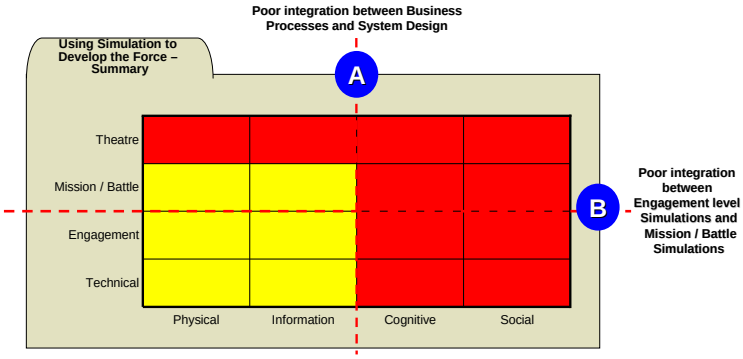

Figure 13 – 'As Is' Simulation to Develop the Netcentric Force

In summary:

- Existing simulation capability is predominantly focussed on the Physical domain. Higher-level simulations (Mission/Battle, Theatre) do not support information flows and have not been developed to address NCW-related questions (e.g. JSAF).

- Simulations that test fundamental NCW concepts and business processes are problematic to build and use because of the challenge associated with testing organisational structures/individual behaviour against doctrine and/or operational requirements. System and clusters of systems are being tested – but this does not extend to the force level due to issues of language and the absence of enterprise-level architectures, business processes, etc.

Whilst Defence has pockets of different simulations, there is limited integration of them to tie insights across the Physical/Information domains and the Cognitive/Social domains (as denoted by the dashed line marked 'A' in Figure 13). This limits the ability to use current simulations to leverage research and development in testing the fundamental hypotheses of NCW (e.g. more information faster means better decisions) to informing force-level or system-level designs.

In addition, the disconnect signified by the dashed line marked 'A' is further exacerbated by the fact that simulations that test force effectiveness (at either the Theatre or Mission/Battle level) exist but tend to be difficult to integrate with simulations that test system effectiveness (at the Technical or Engagement level). This is denoted by the dashed line marked 'B' in Figure 13. In other words, modelling force-level information flows and connectivity requirements is not well integrated with simulations that test system effectiveness and technical performance.

6.3 'As-Is' Simulation Support to Netcentric Force Employment

There is a large number of simulations that are employed by Defence to support these aspects. An example of the types of simulation relevant to supporting these activities are illustrated in Figure 14.

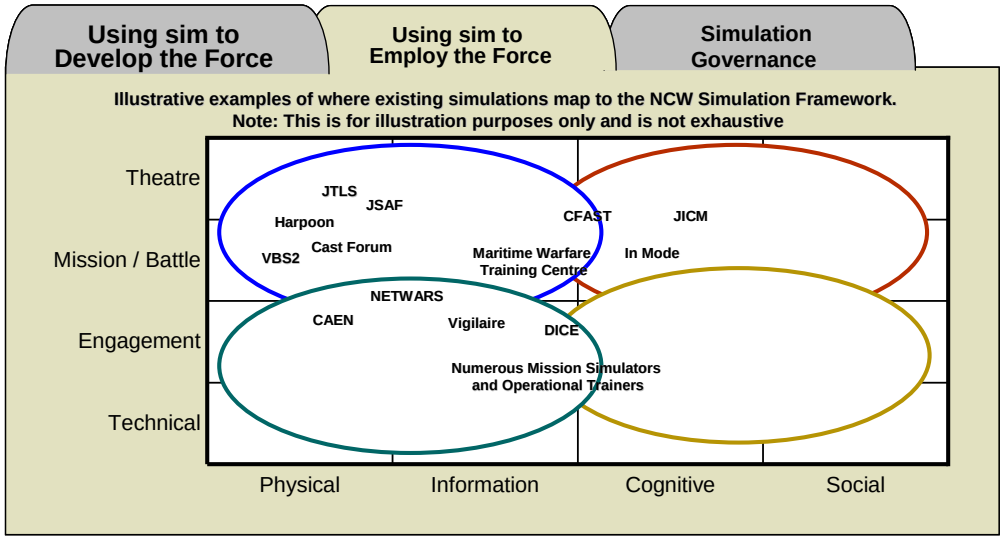

Figure 14 – Example Simulations used to Support the Employment of the Netcentric Force

There is a mature capability across Defence in terms of mission training and rehearsal simulators, with emerging capabilities in terms of team tactical and operational mission training and rehearsal. A summary of the existing level of simulation capability to support the employment of the force is illustrated in Figure 15.

In summary, Defence has a more developed capability in supporting the employment of the force, due largely to the widespread use of simulators to support system and team-based training and simulations to support training in operational planning and tactics. Defence is starting to use information-focused models and simulation (e.g. NETWARS) to support the operational planning for communications networks.

Notwithstanding, from an NCW perspective, simulations are not yet integrated or optimised to support the training and support to operational planning in terms of:

- What it feels and looks like to operate within a networked force (other than at the Engagement level where situational awareness is displayed in cockpits, etc); and
- How to plan to optimise the force for NCW operations.

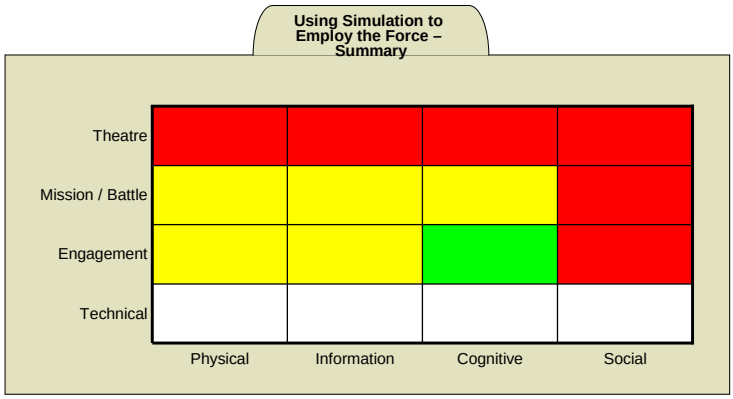

Figure 15 – Summary of 'As Is' Simulation Support to Employ the Force

7 PERCIEVED GAPS BETWEEN THE 'AS-IS' AND THE 'TO-BE' 2017-VISION FOR SIMULATION SUPPORT TO NCW

7.1 Perceived Gaps in Simulation Support to Develop the Netcentric Force

There is no doubt that Defence's current simulations have yielded good results against their stated requirements. But, there is as yet no overarching view on how these investments should combine or interact in support of future NCW outcomes. This introduces risk that, in a resource-constrained environment, there may be over-investment in some areas of simulation (perhaps an overemphasis on individual training), and under-investment in others. Also, simulation technology is not yet sufficiently mature to address a number of the problem areas facing NCW. Thus changes are required to Defence's current simulations to effectively support the future NCW goals.

To fully achieve the 2017 vision for simulation support to NCW requires better coordination with respect to:

- Testing fundamental NCW concepts;
- Testing netcentric warfighting business processes;
- Assisting performance and compliance assessments of different force-level and system-level netcentric designs; and
- Developing and assessing interfaces and the level of interoperability that can be achieved at a force level, with whole-of-government and coalition partners.

In summary, the gaps in simulation support to developing the netcentric force is shown below in Figure 16.

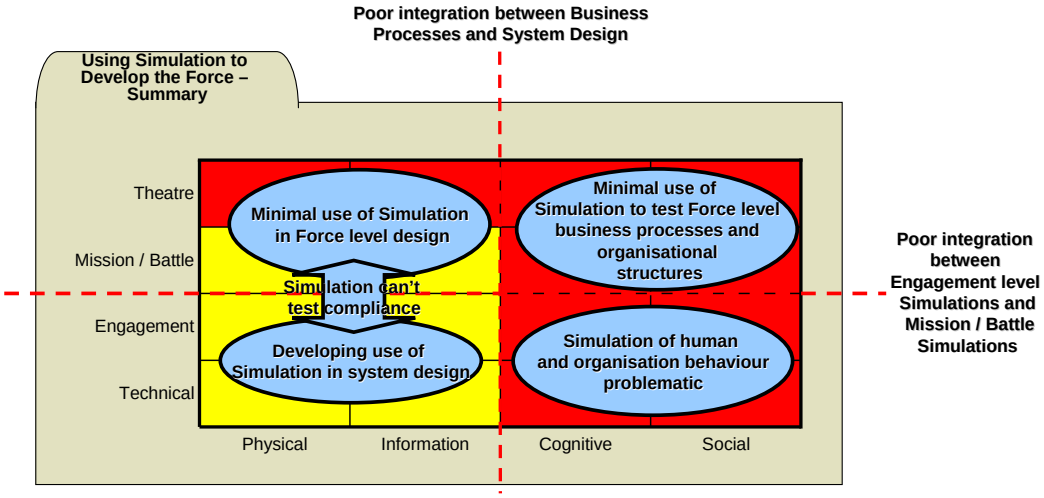

Figure 16 – Gaps in Simulation Support to Netcentric Force-Level Design and Compliance Testing

7.2 Perceived Gaps in Simulation Support to Netcentric Force Employment

While simulation is used widely across Defence to support Defence's "Professional Mastery", achieving the 2017 vision for simulation support to employing the netcentric force needs additional focus upon:

- Coordination of team and individual training in the concepts and practices of self synchronisation, mission command and professional mastery across the force;
- Support to mission planning, rehearsal and execution at the force level, by rapidly testing command and control arrangements, required information and connectivity requirements, and how this allows the ultimate generation and coordination of effects; and
- Extracting lessons and insights through the training and planning activities for improvements to doctrine and concepts of operation at a whole-of-force level.

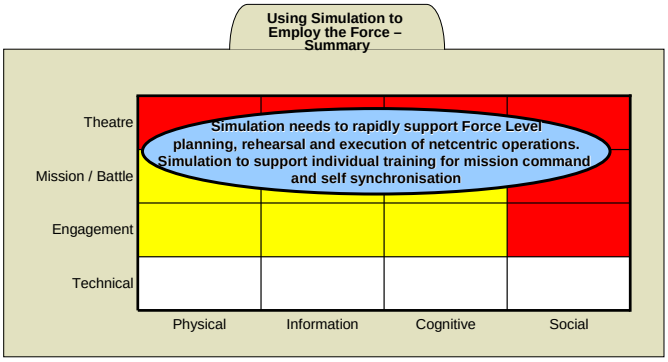

Figure 17 – Gaps in Simulation Support to Netcentric Force Employment

7.3 Summary of Perceived Gaps in Simulation Support to NCW

The perceived gaps in simulation support to NCW may be summarised as:

- Limited use of simulation to understand and test fundamental NCW concepts and hypotheses, and how these are translated into the netcentric business processes, including WoG and coalition aspects;
- An inability to ***rapidly*** test netcentric related business processes, and how these affect force-level designs, including WoG and coalition aspects;
- An inability to ***rapidly*** test system-level compliance to force-level designs. This needs to be markedly improved through better integration of simulations that test force effectiveness and simulations that test system effectiveness;
- Difficulty matching simulation sophistication to the user. Simulation interfaces are too complex and require extensive support. Simulation users need to be more simulation savvy, and understand the specific limitations of each simulation capability;
- While recognising the need for diversity and flexibility for innovative NCW related simulation R&D, Defence must standardise and consolidate the number of development environments, simulation tools and infrastructure. Less is more. There needs to be developed and endorsed, standardised but flexible NCW and simulation:

language	lexicon	approaches	processes
architectures	designs	models	tools
interfaces	components	data	

- Simulations must be more robust and timely enough to support decision making as the decisions are being made. This will require a better understanding of individual simulation and integration limitations, and more responsive and timely generation of simulation outputs.

8 CONCLUSIONS

A useful framework was developed to support analysis of where simulation can/should support the achievement of a Netcentric Australian Defence Force.

The perceived focus areas to achieve the 2017 vision for simulation support to NCW related to:

- NCW Enablers. A number of NCW enablers were identified, that did not relate specifically to simulation, but would enhance the effectiveness of future simulation support once they were developed.
- Simulation Support to Netcentric Force Development. Opportunities for simulation to test fundamental NCW hypotheses and related future business processes against potential Force level designs, and the ability of simulation to assist in testing future system level NCW compliance.

- Simulation Support to Netcentric Force Employment. These related to the usability and use of simulation for netcentric mission training, planning, rehearsal and execution.

- Governance for Simulation support to NCW. These related to recommended governance improvements to focus all relevant simulation activities towards a common end-point

Successful implementation of the NCW program is a formidable challenge. If appropriately applied and used, simulation is a useful methodology that can greatly assist Defence achieve its NCW aspirations, in the medium to long term. This analysis, and review of the NCW Integration Plan when released, will assist in the development of an Australian NCW Simulation Support Plan.

9 REFERENCES

[1] Alberts, D.S., and Hayes R.E. (2003), Power to the Edge, Command and Control in the Information Age, DoD Command and Control Research Program, Washington D.C., United States. www.dodccrp.ors/files/Alberts_Power.pdf.

[2] Australian Government – Department of Defence (2007), NCW Roadmap 2007, Defence Publishing Service, Canberra, Australia. http://www.defence.gov.au/capability/ncwi/docs/2007NCW_Roadmap.pdf.

[3] Australian Government – Department of Defence (2006), Defence Simulation Roadmap 2006, Defence Publishing Service, Canberra, Australia. http://www.defence.gov.au/capability/ADSO/.

[4] Australian Government – Department of Defence (2007), Defence Simulation Manual Part 5 – Defence Simulation Proposal Guide, Australian Defence Simulation Office, Canberra, Australia. http://www.defence.gov.au/capability/ADSO/.

[5] Australian Government – Department of Defence (2005), Explaining Network Centric Warfare, Defence Publishing Service, Canberra, Australia.

[6] Committee on Network Science for Future Army Applications, National Research Council (2005), Network Science, 1st edition, National Academy Press, Washington D.C., United States.

ANNEX A – NCW TARGET STATES

NCW 2007 Roadmap Target State area	Key characteristics of the 2007 NCW Roadmap Target State
Force Application in 2020: *The ADF can generate a range of lethal and non-lethal effects that are both timely and appropriate and are synchronised with other partners to achieve the desired effect*	▸ NCW allows the ADF to accurately apply an appropriate level of force in close combat and from standoff ranges in complex environments ▸ Forces are able to identify friendly, hostile and neutral forces in the battlespace with enhanced accuracy ▸ This information is distributed through a Common Operating Picture (COP) ▸ The COP greatly reduced fratricide and the number of platform on standby and deployed, while significantly increasing the lethality of friendly forces ▸ The ADF has a robust ability – in demanding environments – to gain and share data on the effects of its application of force ▸ ADF commanders possess a greatly enhanced decision making environment
Information Superiority and Support in 2020 *Defence has continuous information connectivity to link fighting units, sensors and decision-makers in a way that increases situational awareness and the capacity to act decisively*	▸ Seamless interfaces exist between fixed and deployed domains within the Defence Information Environment (DIE) and between Australian and allied intelligence domains ▸ All source coordination of collection and tasking exists across both national/allied and ADF controlled capabilities ▸ Information is processed and analysed to provide integrated intelligence products to the right people at the right time, providing friendly forces with an awareness of the situation that is superior to that of an adversary ▸ The information architecture is robust enough to ensure continuous availability under demanding conditions, including frequent denial of service attacks by an adversary
Command and Control in 2020 *The ADF's command and control system promotes collaboration*	▸ Commanders achieve a virtual presence with senior decision-makers ▸ Decision-support tools are an integral and trusted element of the decision-making ability of commanders and their staff allowing rapid and effective decision-making in all situations ▸ Commanders are trusted and capable of adaptation and employing highly flexible command arrangements in the accomplishment of assigned missions ▸ The ADF is capable of filtering information in order to speed the decision-making process in ambiguous circumstances
Force Deployment in 2020 *The ADF is capable of rapid and accurate identification, and the protected deployment, of an optimised force*	▸ Deployment assets have access to appropriate areas of the COP and the tactical information environment ▸ The deployment of forces is conducted with maximum efficiency and in-transit visibility and with minimum risk of interdiction en route ▸ Deployment agility is achieved through self-synchronising networks at the service level and a significant part of the joint force
Force Protection in 2020 *Forces deployed, and in home locations, have a pervasive network of active and passive sensors, which are automatically fused into a COP in order to achieve an enhanced level of shared situational awareness about their surroundings*	▸ The ADF is able to predict a wide range of environmental threats and protect deployed forces against them ▸ The underlying information infrastructure (the network) employed by the networked force has continuous protection in the most demanding of circumstances to ensure continuous availability in the face of determined attacks on the network by an adversary ▸ The fusion of information and intelligence provides automatic early warning, through secure protected networks ▸ The ability to counter an adversary's Information Operations has been enhanced to such a level that they have a minimal capacity to deny the achievement of the desired effect
Force Generation and Sustainment in 2020 *Key logistical function networks within the National Support Area (NSA) are linked with those in theatre, and provide connectivity and a collaborative ability with industry and coalition partners*	▸ Commanders have an end-to-end visibility of the logistic system providing the ability to rapidly and effectively prioritise scarce resources required to generate and sustain deployed force elements ▸ Automated ordering and replenishment takes place as supplies and ordnance are consumed by platforms and field units ▸ The deployed force has minimised its vulnerabilities and greatly enhanced its mobility through more effective reach back, optimum force presence and the precision sustainment for the majority of logistic requirements

ANNEX B - SIMULATION SUPPORT TO NCW TARGET STATES

Taking into account that the "Learning by Doing" construct as described in the NCW Roadmap 2007 means that these NCW Target States are based upon current knowledge, and may change, simulation may possibly support these target states as follows:

Simulation Support to NCW Target State 1 – Force Application 2020

NCW 2007 Roadmap Target State area	How Simulation could help
Force Application 2020	▸ Simulation could help understand and address how information flows across communications networks, and how they may influence the generation of lethal and non lethal effects. ▸ Simulation could help understand, develop and enable the synchronisation of different lethal and non-lethal effects may be synchronised with other partners to achieve desired effects. – Help understand what level of force is appropriate in different environments – Help to understand how to identify and track friendly, neutral and hostile forces, in order to reduce fratricide and greatly enhance the lethality of friendly forces. – Understand how information is distributed across Common Operating Pictures

This may be further categorised into evolutionary and revolutionary improvements to the Netcentric Force, as shown below.

NCW Roadmap 2007 Target State area	Sim support for *evolutionary* improvements to current NCW force	Sim support for *revolutionary* improvements to future NCW force
Force Application 2020	▸ Simulation can help understand how information may flow across legacy communication and information systems in order to better generate lethal and non lethal effects with existing assets. ▸ Simulation can help understand and assist with deconfliction and distribution of information across the various COPs.	▸ Simulation may assist in the development of entirely novel lethal and non lethal effects, including effects based operations, which target the non physical aspects of adversary forces such as their reason and beliefs. Simulation can help develop various automatic and/or robotic systems ▸ Simulation can help better understand, develop and implement more effective and efficient ways of sharing information in order to generate future effects ▸ Simulation can help design, test and implement the future NCW force with a focus on information sharing and use, in order to maximise the effects that may be brought to bear.

Simulation Support to NCW Target State 2 – Information Superiority and Support 2020

NCW 2007 Roadmap Target State area	How Simulation could help
Information Superiority and Support 2020	▸ Simulation could help understand how to best design, implement and improve continuous information connectivity: –In order to link fighting units, sensors and decision makers –In order to increase situational awareness and the capacity to act decisively ▸ Simulation could help understand how best to design, develop and implement "Seamless interfaces" between fixed and deployed domains, within Australian and Coalition environments. ▸ Simulation could help understand, develop and test various ways to coordinate information collection and tasking across national / allied and ADF controlled capabilities. ▸ Simulation could help test whether the right people are getting the right information at the right time, and how this provides an advantage over an adversary. ▸ Simulation could help develop, implement and test information architectures that are robust enough to ensure continuous availability under demanding conditions, including attack.

This may be further categorised into evolutionary and revolutionary improvements to the Netcentric Force, as shown below.

NCW Roadmap 2007 Target State area	Sim support for *evolutionary* improvements to current NCW force	Sim support for *revolutionary* improvements to future NCW force
Information Superiority and Support 2020	▸ Simulation can help improve and test the connectivity of the current Force, by: – Develop and test information architectures for legacy and newly fielded systems. – Testing interfaces between legacy and newly fielded systems. – Testing and improving information collection and tasking across National and International capabilities. – Testing and improving information advantages over adversaries.	▸ Simulation can help improve and test the connectivity of the future Force, by – Developing a much better understanding of future information requirements, and designing the force and systems to incorporate these. –Developing and testing much more robust information architectures. – Developing, testing and implementing improved information collection and tasking across National and International capabilities. – Developing a much better understanding of how information superiority provides advantage over adversaries, and how best to realise this advantage.

Simulation Support to NCW Target State 3 – Command and Control 2020

NCW 2007 Roadmap Target State area	How Simulation could help
Command and Control 2020	▸ Simulation could help achieve command and control systems achieve collaboration –Simulation can help define and test how Commanders may best achieve a "virtual presence" with their senior Decision Makers. –Simulation will be integral to the decision support tools that allow rapid decision making in all situations. –Simulation can assist Commanders employment of highly flexible Command arrangements in the accomplishment of assigned missions. –Simulation can test how best to filter information in order to speed the decision making process under conditions of uncertainly.

This may be further categorised into evolutionary and revolutionary improvements to the Netcentric Force, as shown below.

NCW Roadmap 2007 Target State area	Sim support for *evolutionary* improvements to current NCW force	Sim support for *revolutionary* improvements to future NCW force
Command and Control 2020	▸ Simulation can help Commanders develop and communicate shared understanding of complex goals, in order to build a "virtual presence" with their senior Decision Makers. ▸ Simulation can help determine how best to filter information, under various scenarios, in order to speed the decision making process under conditions of uncertainty and stress, in order to make better decisions faster. ▸ Simulation can help determine how best to invest in, and integrate rapidly developing decision support technologies into the current force. ▸ Simulation may test existing Command arrangements, in terms of decision rights, organisational structure and information flows, in order to accomplish assigned missions.	▸ Simulation can help understand, develop, test and implement entirely new and unfamiliar command arrangements, involving novel ways of collaborating during operations, in order to make better decisions faster. ▸ Simulation can help future Commanders develop and communicate shared understanding of complex future goals, in order to build a "virtual presence" with their senior Decision Makers. Simulation can help determine how best to filter information, under various scenarios, in order to speed the decision making process under conditions of uncertainty and stress. ▸ Simulation can help determine how best to invest in, and integrate rapidly developing decision support technologies into the future force. ▸ Simulation may test future Command arrangements, in terms of decision rights, organisational structure and information flows, in order to accomplish possible future missions.

Simulation Support to NCW Target State 4 – Force Deployment 2020

NCW 2007 Roadmap Target State area	How Simulation could help
Force Deployment 2020	▸ Simulation could help the ADF achieve a rapid and accurate identification, and the protected deployment of an optimised force by: –Simulating how best to enable deployment asset access to the TIE and COP –Simulating force deployment in order to optimise efficiency and in transit visibility, with minimum risk of interdiction on route. –Simulating how best to self-synchronise networks at service and joint level.

This may be further categorised into evolutionary and revolutionary improvements to the Netcentric Force, as shown below.

NCW Roadmap 2007 Target State area	Sim support for *evolutionary* improvements to current NCW force	Sim support for *revolutionary* improvements to future NCW force
Force Protection 2020	▸ Simulation could help implement better fusion of the current Force's network of active and passive sensors, and their integration with various COPs. ▸ Simulation could help understand, and test how information fusion relates to improving shared situational awareness within the current Force. –Simulation can help define and predict a wide range of environmental threats, and how to best protect existing deployed forces against them. –Simulation could help design, test and implement the existing network and legacy systems so that is continually protected against determined attacks by an adversary	▸ By enhancing innovation and cost effectiveness, simulation could be used to test and improve novel and innovative ways of protecting future forces. ▸ Simulation could help understand, design and implement the future Force's pervasive network of active and passive sensors, and their integration with various COPs. ▸ Simulation could help understand, and test how this future network of integrated sensors could improve shared situational awareness. ▸ Simulation could help predict a wide range of future threats, and how to best protect future deployed forces against them. –Simulation could help design, test and implement the future network so that is continually protected against determined attacks by an adversary –Simulation could help best determine how to provide early warning, by providing fused information and intelligence, through secure protected networks –Simulation could help understand how best to counter future Information Operations.

Simulation Support to NCW Target State 5 – Force Protection 2020

NCW 2007 Roadmap Target State area	How Simulation could help
Force Protection 2020	▸ Simulation could help understand, design and implement the Force's pervasive network of active and passive sensors, and their integration with various COPs. Simulation could help understand, and test how this improves shared situational awareness. –Simulation could help predict a wide range of environmental threats, and how to best protect deployed forces against them. –Simulation could help design, test and implement the network so that is continually protected against determined attacks by an adversary –Simulation could help to provide early warning, by providing fused information and intelligence, through secure protected networks –Simulation could help understand how best to counter Information Operations.

This may be further categorised into evolutionary and revolutionary improvements to the Netcentric Force, as shown below.

NCW Roadmap 2007 Target State area	Sim support for *evolutionary* improvements to current NCW force	Sim support for *revolutionary* improvements to future NCW force
Force Protection 2020	▸ Simulation could help implement better fusion of the current Force's network of active and passive sensors, and their integration with various COPs. ▸ Simulation could help understand, and test how information fusion relates to improving shared situational awareness within the current Force. –Simulation can help define and predict a wide range of environmental threats, and how to best protect existing deployed forces against them. –Simulation could help design, test and implement the existing network and legacy systems so that is continually protected against determined attacks by an adversary	▸ By enhancing innovation and cost effectiveness, simulation could be used to test and improve novel and innovative ways of protecting future forces. ▸ Simulation could help understand, design and implement the future Force's pervasive network of active and passive sensors, and their integration with various COPs. ▸ Simulation could help understand, and test how this future network of integrated sensors could improve shared situational awareness. ▸ Simulation could help predict a wide range of future threats, and how to best protect future deployed forces against them. –Simulation could help design, test and implement the future network so that is continually protected against determined attacks by an adversary –Simulation could help best determine how to provide early warning, by providing fused information and intelligence, through secure protected networks –Simulation could help understand how best to counter future Information Operations.

Simulation Support to NCW Target State 6 - Force Generation and Sustainment 2020

This may be further categorised into evolutionary and revolutionary improvements to the Netcentric Force, as shown below.

NCW Roadmap 2007 Target State area	Sim support for *evolutionary* improvements to current NCW force	Sim support for *revolutionary* improvements to future NCW force
Force Generation and Sustainment 2020	▸ Simulation could help understand how to best link the key current logistic function networks within the National Support Area to those currently in theatre. –Simulation could help test how best to achieve connectivity and collaborative ability with current industry and coalition partners, using legacy and soon to be fielded systems. –Simulation could help test the end-to-end visibility of the existing logistics system. Simulation could also provide the means to prioritise the allocation of scarce resources to currently deployed force elements. –Simulation could help test and stress test the current resupply and replenishment systems, as supplies and ordnance are consumed by existing platforms and field units. –Simulation could help test the existing Force's vulnerabilities, in order to take steps to minimise them.	▸ Simulation could develop and test entirely novel new ways of generating and sustaining forces. ▸ Simulation could help understand how to best design, implement and test how to link future key logistic function networks within the National Support Area to those in that may be in theatre. –Simulation could help understand, develop and implement optimum connectivity and collaborative ability with future industry and coalition partners. –Simulation could help develop, implement and test the end-to-end visibility of future logistics systems. Simulation could also provide the means to prioritise the allocation of scarce resources to deployed force elements. –Simulation could help test and stress test future automatic resupply and replenishment systems, as supplies and ordnance are consumed by platforms and field units. –Simulation could help test the future Force's vulnerabilities, in order to take steps to minimise them. i.e. Simulation can design, test and implement various methods to enable Reachback, optimum force presence and precision sustainment for the majority of logistic requirements.