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CANADIAN FORCES COLLEGE / COLLÈGE DES FORCES CANADIENNES

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*Warfare in the 21<sup>st</sup> Century*

**MYTH OR REALITY :**

**NETWORK-CENTRIC WARFARE AND INTEGRATED COMMAND AND CONTROL  
IN THE INFORMATION AGE?**

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## *ABSTRACT*

This paper examines the concepts of network centric operations and integrated command and control in the information age while highlighting the significant challenges faced in embarking on a transformation journey. It argues that it will be some time before military forces undergoing transformation, like the Singapore Armed Forces (SAF), can achieve integrated command and control capability because significant impediments relating to the culture, structures and processes, and products must be addressed.

This paper begins by exploring the notion of the Revolution in Military Affairs and the need to understand this in a wider context. It examines the current developments in network centric, and effects based, operations as part of the changing nature of military operations. The recent developments in command and control are highlighted and the challenges to achieve interoperability are briefly discussed. It examines the SAF's framework of Integrated Knowledge-based C2 (IKC2) and argues that its development must be based on a shared purpose approach, as realising it will require patience and time. It then proposes the way ahead by addressing the ingredients needed to achieve IKC2 capabilities. These include working on the culture and people aspect by having a different learning climate, tackling the issue of "jointness" and experimentation, and the need to have intermediate and visible deliverables to sustain the transformation journey.

# MYTH OR REAL : NETWORK –CENTRIC WARFARE AND INTEGRATED COMMAND AND CONTROL IN THE INFORMATION AGE?

## INTRODUCTION

*“By making possible a faster, clearer reading of the situation and a more effective distribution of resources, a superior command system may serve as a force multiplier and compensate for weaknesses in other fields... ”<sup>1</sup>*

- Martin van Creveld, 1985

In the near future, can a commander really command and control his forces and synchronise actions to disrupt adversaries from vast distances away by a mere click of the computer mouse button? Would an integrated command and control system present an Achilles’ heel to a potential adversary rather than enabling optimum resource utilization and responsive combat power? What about the issue on interoperability in the new security environment where multi-agency operations will become common? What are the implications to the Singapore Armed Forces (SAF) in its transformation journey? This paper will attempt to explore these queries and examine the developments in these areas.

The field of Command, Control, Communications and Computers (C4) is moving so quickly that the interaction between user pull and technology push is becoming extremely dynamic. Advancements in C4, sensors, information and precision-strike technologies, as well as the implementation of networks, are creating a significant change to the military information environment.

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<sup>1</sup> Van Creveld, Martin. *Command in War*, (Cambridge: Harvard University Press, 1985), 4.

New ways of thinking about command and control (C2) are at the heart of Information Age Warfare.<sup>2</sup> The increasing complexity of military weapons systems, military organizations and war-fighting itself, have created an ever-increasing demand for and reliance on information technology systems.<sup>3</sup> The emergence of what is termed as the Revolution in Military Affairs (RMA) is generally accepted by many military services, i.e. the advent of knowledge warfare or information age warfare. The information age technologies could potentially be the key to dissipate the old dictums about the fog and friction of war by fundamentally changing a military commander's ability to "see", to "tell", and to "act".<sup>4</sup>

Information technology advancements are enabling modern armed forces to undergo a fundamental shift from a platform-centric orientation to a network-centric one. Recently, the concept of Network-Centric Warfare (NCW) has been widely discussed. Network-centric operations are military operations that are enabled by the networking of the force.<sup>5</sup> As such, perspectives about the process of command and control can change fundamentally. A robustly networked force will be integrated vertically by the network, through all command echelons – strategic to tactical and down to the lowest tactical level.<sup>6</sup> While it is usual to

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<sup>2</sup> David S. Alberts, *et al*, *Understanding Information Age Warfare*, (CCRP Publication Series, Aug 2001), 131. [Journal-online]; available from <http://dodccrp.org/Publications/pdf/UIAW.pdf>; Internet; accessed 20 Sep 03.

<sup>3</sup> A.H.H. Manfred, "Information Age Command and Control – The Weakest Link?" (Toronto: Canadian Forces College Advanced Military Studies Course Paper, 2002), 3.

<sup>4</sup> B. Owens, *Lifting the Fog of War*, (New York: Farrar, Straus and Giroux, 2000).

<sup>5</sup> A.K. Cebrowski and J.J. Garstka, "Network Centric Warfare: Its Origin and Future", *U.S. Naval Institute Proceedings*, Vol. 124, No.1, (January 1998), 31.

<sup>6</sup> David Potts and Jake Thackray, "No Revolutions Please, We're British", in *The Big Issue: Command and Combat in the Information Age*, ed. David Potts (U.K. Strategic and Combat Studies Institute, March 2002), 23.

focus on the technology portion of the information age influencing the evolution of command, the effect should be viewed as more than just a more effective C2 system.

This paper examines the concept of network centric operations and integrated command and control in the information age. It highlights the significant challenges faced in embarking on this type form of a transformation journey. The thesis is that it will be some time before military forces undergoing transformation like the Singapore Armed Forces (SAF), can achieve integrated command and control capability because significant impediments relating to the **culture, structures and processes, and products** must be addressed.

## **RMA DEBATE**

The notion of military revolutions grew from Soviet writing of the 1970s and 1980s analysing the revolutionary potential of new military technologies.<sup>7</sup> As Marxists, the Soviets were comfortable with the idea that history is driven by revolutions. Western analysts, however, were more focused on technology. Today, the technical impetus to an RMA remains foremost in most related studies. By one definition, RMA is “a major change in the nature of warfare brought about by the innovative application of technologies which, combined with dramatic changes in military doctrine and operational and organizational concepts fundamentally alters the character and conduct of military operations”.<sup>8</sup> A common

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<sup>7</sup> J.R. Cooper, *Another View of the Revolution in Military Affairs*, U.S. Army War College publication, (SSI, Carlisle Barracks, 15 Jul 1994), 27.

<sup>8</sup> Frank Watanabe, “Understanding the RMA”, *Armed Forces Journal International*, (August 1995), 6.

view is the synergy that advances in communication and computers can bring to the information application and management arena.

The estimate of 18 months for the computing capacity and processing power to double appears to be roughly applicable, commonly known as Moore's Law.<sup>9</sup> This implies a continued and powerful growth in the ability to process a great amount of information with increasing responsiveness. The cost of computing has also fallen. Until recently, networking was too costly to realize the value proposition embodied in Metcalfe's Law.<sup>10</sup> While bandwidth has become cheaper and widely available,<sup>11</sup> for the "communication hungry" military, there is often still a bandwidth deficit.<sup>12</sup> This is true especially in the context of wireless C2 information systems if map overlays and video conferencing are demanded indiscriminately.

Many analysts of the RMA have argued that technological breakthroughs will have a major effect on how operations will be conducted in future. The Gulf War is often cited as an example of how these new technological advances can be employed on the battlefield, based on the success of the high tech weaponry and the command and control systems of the U.S.

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<sup>9</sup> First uttered in 1964 by semiconductor engineer Gordon Moore, this relation relates to the amount of information storable on a given amount of silicon.

<sup>10</sup> David S. Alberts and Richard E. Hayes, *Power to the Edge : Command and Control in the Information Age*, (CCRP Publication Series, June 2003), xvi. [Journal-online]; available from <http://dodccrp.org/Publications/pdf/poweredge.pdf>; Internet; accessed 23 Sep 03. Metcalfe's Law states that the value of a network is proportional to the square of the number of nodes in the network..

<sup>11</sup> As highlighted by the Gilder's Law proposed in 1997, which stated that the total bandwidth of communication system triples every 12 months.

<sup>12</sup> Brook Peter and Thorn Tim, "C3I in the New Defence and Commercial Environments", *Journal of Defence Science*, Vol. 3, No.1 (1998), 8.

forces.<sup>13</sup> Some also argued that the rapid conduct of Operation Allied Force<sup>14</sup> and the widespread use of precision-guided munitions provides further evidence that we are on the verge of a change in how war will be conducted in future.<sup>15</sup>

Although generally accepted, the RMA debate continues because there are several different views of an RMA. O'Hanlon,<sup>16</sup> for example, identifies four main RMA schools. These range from a cautious approach acknowledging the contemporary RMA hypothesis (i.e. system of systems approach), to a bold assessment of global revolution involving the whole spectrum of technology. Revolutions imply periods of rapid and fundamental changes and are hard to predict because of the expected disruptive effects. There can be little doubt that further scientific revolutions will occur and any defence planning that looks more than 15 to 20 years ahead must be flexible enough to take account of the potential offered by the radically new technologies that might emerge.<sup>17</sup> However, if indeed there is an information led RMA, technology alone cannot decide the outcome of war. It is necessary to combine hardware, quality training, sound doctrine and effective organization as an integrated whole.

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<sup>13</sup> Michael O'Hanlon, *Technological Change and the Future of Warfare*, (Brooking Institution Press, 2000), 7.

<sup>14</sup> This operation refers to the military objective by allied forces to degrade and damage the military and security structure that President Milosevic (Yugoslav President) has used to depopulate and destroy the Albanian majority in Kosovo. (From prepared statement of William S. Cohen, Secretary of Defence, to the Senate Armed Services Committee on 15 April 1999.)

<sup>15</sup> Thomas D Young, "The Revolution in Military Affairs and Coalition Operations: Potential Problem Areas and Solutions" (US Monterey: Naval Postgraduate School RMA Paper, 24 Jul 2003), 1.

<sup>16</sup> Michael O'Hanlon, *Technological Change and the Future of Warfare* , 11-16.

<sup>17</sup> Andrew May, "Science forecasting: predicting the unpredictable", *Journal of the Defence Science*, Vol. 6 No. 2, ((2001), 69.

For the SAF, new challenges are constantly emerging (e.g. rise of trans-national terrorist threats such as the Al Qaeda network). The SAF must be prepared to meet future challenges while meeting the demands of the present. As such, there is a need to have greater flexibility and robustness in the developmental approaches. In its recently published monograph, the need to begin the transformation journey and to meet the complex challenges of technological discontinuities, asymmetry and globalisation were emphasised.<sup>18</sup> The *capacity to change* is as much about looking at fundamentally different strategic “options” as changing the *mindsets* of people to “dare” to look at radical changes and to experiment. The **military culture** is an important consideration if revolutionary operational concepts were to be tested successfully.

## NCW AND EFFECTS BASED OPERATIONS DEVELOPMENT

It would be tempting to think that the exploitation of information age technologies in the military environment is essentially a communications, information system or staff process issue. Also, that this will result in a substantive outcome, which will be a more effective command and control system – and that it can be left primarily to those responsible for developing our command and control systems.<sup>19</sup> However, if a more effective C2 system is intended to fight in a very different way, it must be understood and applied by commanders and warfighters, not technical staff.

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<sup>18</sup> Journal of the Singapore Armed Forces, *Creating the Capacity to Change: Defence Entrepreneurship for the 21<sup>st</sup> Century*, Pointer Monograph No. 1, (2003), 2-3.

<sup>19</sup> David Potts, “Tomorrow’s War”, in *The Big Issue: Command and Combat in the Information Age*, ed. David Potts (U.K. Strategic and Combat Studies Institute, March 2002), 23.

Over time, information age technology can be exploited by emphasizing an integrated battlespace by exploiting networked capabilities. The shift will be towards a network centric environment with integration throughout a theatre of operations and between theatres of operations. The emphasis will be on exploiting networked capabilities to apply integrated joint effects to precise effect. “There will be greater emphasis on connectivity between sensors, weapon platforms and C2 nodes and less emphasis on numbers of weapon platforms.”<sup>20</sup> These are essence of what is commonly termed Network Centric Warfare (NCW).

In a way, NCW provides the theory of warfare in the Information Age. It is, as the NCW Report to the U.S. Congress stated, “no less than the embodiment of an Information Age transformation of the DoD.”<sup>21</sup> It was stated that the network centric warfare and all of its associated revolutions in military affairs “grow out of and draw their power from the fundamental changes in American society”.<sup>22</sup> Basically, the argument was that the underlying economics (IT is central to competition based on return on investment) and the underlying technologies (e.g. explosive growth of internet and use of network-centric

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<sup>20</sup> *Ibid*, 23.

<sup>21</sup> This is the first sentence of the Executive Summary of the Network Centric Warfare Department of Defence Report to Congress , July 2001, according to David S. Albers and Richard E. Hayes, *Power to the Edge : Command and Control in the Information Age*, (CCRP Publication Series, June 2003), 98.

<sup>22</sup> Arthur K. Cebrowski and John J. Garstka, “Network-Centric Warfare: Its origin and Future”, *Naval Institute Proceeding*, Vol 124/1/1, 139. (Jan 1998); [Journal-on-line]; available from <http://www.usni.org/Proceedings/Articles98/PROcebwski.htm>; Internet; accessed 26 Sep 03.

computing) had changed. With the changes happening in the way business was conducted,<sup>23</sup> the military must also adapt.

NCW is characterized by information sharing, shared situational awareness and the knowledge of commander's intent. A warfighting force that can conduct network centric operations can be described as having the following attributes and capabilities:<sup>24</sup>

- Physical Domain: all elements of the force are robustly networked achieving secure and seamless connectivity.
- Information Domain: The force has the capability to collect, share, access and protect information. The force can collaborate in the information domain.
- Cognitive Domain: The force has the capability to develop and share high quality situational awareness and have a shared knowledge of the commanders' intent.

One of the major insights that have emerged as a result of ongoing NCW initiatives is that the combat power associated with network-centric operations is non-intuitive.<sup>25</sup> Hence, the likelihood is that warfighters will develop new tactics, techniques and procedures only after

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<sup>23</sup> Ibid, 3. An example was illustrated on how Wal-Mart achieve the competitive advantage by having a sensory grid of point-of-sale scanners which collect information and share them with the suppliers in near real time.

<sup>24</sup> United States, Department of Defense, *Network Centric Warfare: Department of Defense Report to Congress*. (Washington, DC: Department of Defense, 2001), v.

<sup>25</sup> John J. Garstka, "Network-Centric Warfare: Increased Combat Power for Joint Military Operations", in *Realising Integrated Knowledge-based Command and Control*, Journal of the SAF, Pointer Monograph No. 2, (2003), 48.

they have the opportunity to operate and train with an information advantage and develop trust in the advantage of operating in a network environment.

In spite of a ponderous acquisition process, technology insertion is ahead of and disconnected from joint and service doctrine and organizational development.<sup>26</sup> This is perhaps one of the reasons why the impediments to progress have also been a subject of debate in the literature. In a recent article on learning lessons about NCW from Operation Iraqi Freedom, it was mentioned that a retired U.S. Marine Corps General had said that many personnel still “have no clue what it is” and that “there’s a significant communications problem at the tactical units who were out of contact except for satellites”.<sup>27</sup> According to retired Navy Vice Admiral Arthur Cebrowski, not enough technology that drives NCW is finding its way into the hands of the warfighters and that a *change of culture* is also needed to adopt the technology.<sup>28</sup>

The issue of **culture** is an important consideration and will be discussed later as a key factor to consider if the SAF were to succeed in its transformation journey. It has been argued that the Western armies have progressed significantly over the years because of “...a long-standing Western cultural stance towards rationalism, free inquiry and the dissemination of knowledge...”.<sup>29</sup> An overall cultural landscape can therefore afford inherent military advantages in terms of the way the thinking and innovative ideas can develop.

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<sup>26</sup> Arthur K. Cebrowski and John J. Garstka, “Network-Centric Warfare.....”, 9.

<sup>27</sup> Dan Caterinicchia and Mathew French, “Network-centric warfare: Not there yet”, *Federal Computer Week*, (June 9, 2003), 3; [Journal-on-line]; available from <http://www.fcw.com/fcw/articles/2003/0609/cov-netcentric-06-09-03.asp>; Internet; accessed 26 Sep 03.

<sup>28</sup> *Ibid*, 3.

<sup>29</sup> Victor Davis Hanson, *Carnage and Culture*, (Doubleday, New York, 2001), 19.

For NCW to be useful, it must be applied to military operations. This is important especially to the operational-level commanders who need to translate the concepts to application in the theatre of operations. Military operations, in the new security environment, will span across the spectrum of operations from peace, to crisis and to war. The common term that is increasingly being used to describe the process to shape the desired result is “*effects based operations*” or EBO.

EBO (military operations directed at shaping the behaviour of foes, friends and neutrals, in peace, crisis and war) constitute the conceptual framework for a two-step process of turning network-centric capability into a national advantage.<sup>30</sup> In a way, EBO is not an entirely new thinking since using military forces to shape the behaviour of opponents and allies have been practiced since a long time ago. EBO can transcend the levels of operations in order for strategic, operational and tactical objectives to be attained. David Deptula, an early proponent of the concept of EBO,<sup>31</sup> provided a catalyst for much of the conceptual development and debate. Initially, the proponents were mainly from the U.S. Air Force due to the emphasis on air power to achieve strategic effects.

Adaptation to the Information Age will mean an understanding of what NCW and EBO can bring to military operations while bearing in mind that these are still largely terms used by

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<sup>30</sup> Edward A. Smith, *Effects Based Operations: Applying Network Centric Warfare in Peace, Crisis, and War*, (CCRP Publication Series, Nov 2002), 1. [Journal-on-line]; available from <http://dodccrp.org/EffectsBased.PDF>; Internet; accessed 25 Sep 03.

<sup>31</sup> David A. Deptula, “Effects-Based Operations: A Change in the Nature of Warfare”, Defense and Airpower Series, Arlington VA, (Aerospace Education, 2001). This is an expanded version of what was first published in 1995,

the U.S. researchers and they do not imply a replacement of the forms of warfare. However, they do present a possible synergistic approach in looking at military transformation. EBO encompasses the mind with focus on the mission and the conditions of military operations, while NCW provides the framework and tools. They deal with the why, what, how and support of military operations,<sup>32</sup> which are crucial to looking at the military transformation journey.

## **TRANSFORMATION IN THE INFORMATION AGE**

While some may argue that the NCW is not optimised for asymmetric warfare<sup>33</sup> and low intensity conflict, NCW is a key component of what is the latest term used in the conceptualisation of RMA: *transformation*. It was reported that the information networks established for the United Kingdom's Iraq War forces paved the way for the country's force transformation.<sup>34</sup> Some of these efforts were driven by the need to interoperate with vital U.S. C4I systems that were rife with imagery.

Worldwide, many modern military forces have crafted their own individual responses to the challenges and opportunities of the information age. NCW is a common term used by the

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<sup>32</sup> *Ibid*, ix.

<sup>33</sup> Edmund C. Blash, "Network-Centric Warfare Requires a Closer Look", *SIGNAL*, (May 2003), 57. Blash contented that NCW is optimised for a lighter logistical "tail" component, hence it may not be suitable for all form of warfare..

<sup>34</sup> Robert K. Ackerman, "Operation Iraqi Freedom: British Warfighters Exploits Network Centricity", *SIGNAL*, (Sep 2003), 33.

armed forces of the United States, Denmark, Norway and the Netherlands. Other terms coined include Australia's network-enabled warfare<sup>35</sup>, the United Kingdom's network-enabled capability, the Swedish armed forces' network-based defence and the Singapore Armed Forces' knowledge-based command and control.<sup>36</sup>

What does the term transformation mean? Dr David Alberts described transformation as “a process of renewal, an adaptation to environment”.<sup>37</sup> Essentially, transformation would mean adapting to significant changes and failure to do so would imply risks as well. Alberts argued that potential adversaries can also take advantage of the low cost of obtaining “Information Age technologies” and inaction is not an option in a transformation strategy.<sup>38</sup> Pushed by the U.S. Secretary of Defence Donald Rumsfeld himself, the need to transform was seen as important due to the changing environment (spectrum of operations) and different threats, while the capabilities are evolving.

However, while there are indeed remarkable improvements in developing warfighting concepts in the U.S. armed forces, the same progression has not happened in creating truly

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<sup>35</sup> Australia wanted a pragmatic approach and sees this as being a mechanism for seeking a Joint capability focus. For more details, refer to: Ed Kruzins and Jason Scholz, “Australian Perspectives on Network Centric Warfare: Pragmatic Approaches with Limited Resources”, *Australian Defence Journal*, No 150, (Sep/Oct 2003), 19-33.

<sup>36</sup> John J. Garstka, “Network-Centric Warfare Offers Warfighting Advantage”, *SIGNAL*, (May 2003), 60.

<sup>37</sup> David S. Alberts, *Information Age Transformation: Getting to a 21<sup>st</sup> Century Military*, (Washington, DC, CCRP, June 2002), vii.

<sup>38</sup> Ibid, 28-29.

ready joint forces in peacetime and the related rationalization of capabilities in the services.<sup>39</sup> This may be offset by a recent development in the Pentagon where the Joint Staff would have greater control by being able to ensure that efforts by the services are not duplicated.<sup>40</sup> Five functional capabilities boards (areas of force application, force protection, battlespace awareness, focused logistics, command and control) would be created to spearhead the analysis, prioritise needs and advise the higher approval committee.

In Singapore's context, the IT landscape has changed significantly and the quest to achieve a high level of competencies in IT related skills among her population are clearly producing results. Today, the SAF has developed into a military that is technologically focussed and professionally respected. However, these have also impeded the inertia to change radically for fear for upsetting the efficient and well-established procedures. As such, the transformation journey must focus on the **people** aspects and involve the operational commanders and men by enabling them to be part of the capability concepts development. For example, they can help to review and validate some of these concepts during command post and field exercises. One of the key desired outcomes, to be discussed shortly, would be the ability to implement an integrated C2 system that can significantly increase the desired combat effects for a spectrum of operations.

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<sup>39</sup> Don M. Snider, "Jointness, Defense Transformation, and the Need for a New Joint Warfare Profession", *Parameters*, (Autumn 2003), 18.

<sup>40</sup> Jason Sherman, "Requirement Revolution", *Defense News*, (4 August 2003), 1.

## RE-CONCEPTUALIZING COMMAND AND CONTROL

The terms ‘command’, ‘control’, and ‘C2’ are terms that are often used in the military literature. They are supposed to be quite entrenched in the doctrinal and operational “dictionary”. However, their usage can be said to be “abused” and it is probably true to say that a number in the military may sometimes be confused by the context of their usage. After some research, Pigeau and McCann remarked “there was little consensus within either the military or the research communities on the actual definitions for Command, Control and C2”.<sup>41</sup>

Historically, the topic of command has been extensively discussed and much written regarding its methodologies and practices. The term command and control (C2) appears to be more recent and could be attributed to the advent of IT and its application to the military.<sup>42</sup> Command as defined by the U.S. military includes “responsibility for effectively using available resources, planning the employment of, organizing, directing, coordinating and controlling military forces for the accomplishment of assigned missions. It also includes the responsibility for health, welfare, morale, and discipline of assigned personnel.”<sup>43</sup> As such, control is subsumed as a part of command. This view was also echoed recently about how

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<sup>41</sup> Ross Pigeau & Carol McCann. “Re-conceptualizing Command and Control.” *Canadian Military Journal*, Vol. 3, No. 1, (Spring 2002), 62.

<sup>42</sup> *Ibid*, 53

<sup>43</sup> Alberts and Hayes, *Power to the Edge.....*, 14. They were referring to the definition by the U.S. Joint Chiefs of Staff Publication JSP Pubs. 1-02, Department of Defense Dictionary of Military and Associated Terms, available on-line at <http://www.dtic.mil/doctrine/jel/doddict/> ; Internet; accessed 28 Sep 2003.

control is more than a feedback mechanism since **structures and processes** must be put in place to facilitate accomplishment of mission.<sup>44</sup>

It may not be fruitful to force a distinction between command and control. Some of the common distinctions argued include between art (command) and science (control) and one between the commander (command) and staff (control).<sup>45</sup> The U.S. DoD's JSP definition of C2 refers to the facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to the missions assigned.<sup>46</sup> The U.S. Army has also published the new C2 doctrine (Field Manual FM 6-0) *Command and Control* to take into account the development and use of modern IT and "their powerful ability to influence the conduct of operations".<sup>47</sup>

It is better to refer to C2 in the context of processes to achieve the accomplishment of mission, from formulating courses of action to monitoring the execution and giving orders. However, a growing number of those who are looking at command and control in the Information Age have concluded that the terms need to be clarified and brought into the 21<sup>st</sup> century,<sup>48</sup> without being constrained too tightly by historical references.

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<sup>44</sup> Pigeau and McCann, "Re-conceptualizing Command and Control", 54.

<sup>45</sup> *Ibid*, 14.

<sup>46</sup> Extracted from U.S. Department of Defense, *Dictionary of Military and Associated Terms*, Joint Pubs. 1-02, available on-line at <http://www.dtic.mil/doctrine/jel/doddict/data/c/index.html>; Internet; accessed 28 Sep 2003.

<sup>47</sup> William M. Connor, "Emerging Army Doctrine: Command and Control", *Military Review*, (March-April 2002), 80.

<sup>48</sup> Alberts and Hayes, *Power to the Edge*.....,17

Pigeau and McCann took a new look and defined the two terms separately and in an interesting way:<sup>49</sup>

- “Command: the creative expression of human will necessary to accomplish the mission.”
- “Control: those structures and processes devised by command to enable it and to manage risk.”

They place an important emphasis on the human aspect of command that can achieve outcomes through motivation and having the means and opportunity. They include a model to distinguish command that incorporates three factors: Competency, Authority and Responsibility. Their definition of C2 is the establishment of common intent to achieve coordinated action.<sup>50</sup> Hence C2 structures must have the ability to stay *flexible* to meet evolving needs while continual learning and change should be encouraged and rewarded.

C2, in its historical context, refers to the structures (real and imagined), process, technology, and people that comprise the system.<sup>51</sup> For a commander to have effective C2, the system must enable him to make timely decisions and take appropriate action. The well known Observe, Orientate, Decide, Act cycle (OODA Loop)<sup>52</sup> allows new thinking in reducing the

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<sup>49</sup> Pigeau and McCann, “Re-conceptualizing Command and Control”, 56.

<sup>50</sup> Definition was shown in their presentation to the Canadian Forces College on 18 Sep 03 entitled: “A New Conceptual Framework for Command and Control”.

<sup>51</sup> G.E. Sharpe and Allan D. English. *Principles for Change in the Post-Cold War Command and Control of the Canadian Forces*, (Kingston ON., Canadian Forces Leadership Institute, 2002), 4.

<sup>52</sup> The OODA Loop was created by Lt-Col Boyd’s observations on his own decision/action cycle as a USAF jet pilot fighting MIG-15s in the Korean War.

decision-action cycle. It has an intuitive appeal, resulting in the common phrase used by many commanders: “operating inside the enemy’s OODA loop”.

The OODA loop, when applied in the information age context, may appear too simple. For example, it was highlighted that it cannot model correctly the differing C2 processes, both in terms of function and timescale, which are carried out by HQs at various levels of command.<sup>53</sup> One of the useful models to look at when considering the network-centric portion of looking at C2 processes is provided in Figure 1 (next page).

The model consists of three domains that define military activity, which were described earlier as the attributes of NCW (page 10). Here, the physical domain consists of the operating environment (entities outside the C4ISR<sup>54</sup> processes and systems) while the cognitive domain refers to the minds of the participants. Within these domains, the interacting elements include battlespace monitoring, awareness, understanding, sensemaking (how situation may develop), command intent, battlespace management (command intent translated into activity) and synchronization.<sup>55</sup>

This model allows one to look at the cognitive domain with the aim of ensuring a better understanding of the situation and the higher command’s intent. Battlespace monitoring and management are taken care by the NCW aspects (i.e. sensors’ system of systems and

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<sup>53</sup> Jake Thackray, “The Holy Grail”, in *The Big Issue: Command and Combat in the Information Age*, ed. David Potts (U.K. Strategic and Combat Studies Institute, March 2002), 26.

<sup>54</sup> C4ISR (C4, Intelligence, Surveillance and Recognition) encompasses the entire sensors spectrum and how they are linked to provide intelligence and awareness.

<sup>55</sup> Jake Thackray, “The Holy Grail”, 28.

seamless information grid). A **shared understanding** of the operational situation at all levels of command should provide the stage for mission command to flourish and enable an unprecedented tempo of operations and effectiveness of manoeuvre and engagement.<sup>56</sup> This,

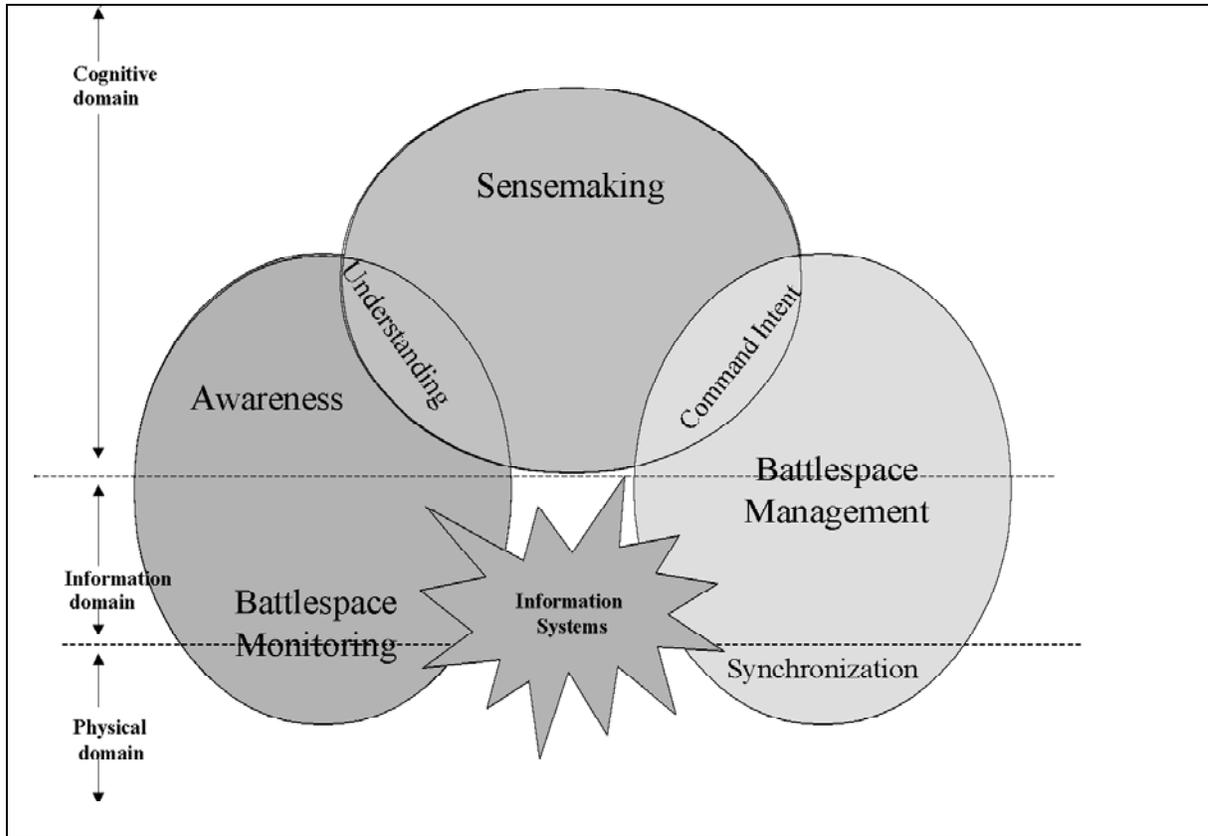


Figure1 – The Information Age C2 Process

(Adapted from David S Alberts, et al, *Understanding Information Age Warfare*, CCRP Publication Series, Aug 2001, 146).

Alberts proposes, can enable greater integration with a networked C4ISR and the information systems embedded in it.<sup>57</sup> Integration will also imply it will have great impact on the interoperability issue as well.

<sup>56</sup> *Ibid*, 31.

<sup>57</sup> David S Alberts, et al, *Understanding Information Age Warfare*, CCRP Publication Series, (Aug 2001,) 149.

## INTEROPERABILITY

To have an effective and robustly networked force, there is a need to have an integrated C2 system to be effective. Such a force can be achieved if there is a high interoperability among mission participants and the systems that support them.<sup>58</sup> Interoperability ensures the ability of systems and forces to interact effectively with other systems and forces. Forces that are interoperable are able to operate in a network-centric environment. Besides the domains of physical, information and cognitive, the domain of **social** is also needed. Interoperability in the social domain allows actions to be dynamically self-synchronized<sup>59</sup> (the ability for commanders to support one another without detailed prior coordination due to shared awareness). Again, the social domain implies the **cultural** impact that can create the kind of understanding that will promote interaction and actions congruent to the commander's intent.

The events of 11 September 2003 and the resulting coalition efforts amplified the need to address interoperability among forces from different nations. Technology has made it easier in the quest for interoperability but there are still many challenges to overcome. While global communication systems can enhance connectivity and emerging technology can create superb surveillance systems, the integration of coalition forces may not be easy.

Attaining technological interoperability will be difficult for coalitions in any case.<sup>60</sup> The Gulf War saw participants arriving with different levels of technical sophistication and hence

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<sup>58</sup> Alberts and Hayes, *Power to the Edge.....*,107.

<sup>59</sup> *Ibid*, 110.

<sup>60</sup> Robert H.Scales, "Trust, Not Technology, Sustains Coalitions", *Parameters*, (Winter 1998), 6.

there were systems that were just not compatible with others. Also, the tremendous rate of change in IT technology implies that obsolescence will be a constant worry for those attempting to maintain interoperability. To a theatre commander in coalition operations, the technological gap (e.g. with the less IT savvy nations) can be partly overcome by extending training means and methods. This will entail extra manpower and effort.

For the Asia Pacific nations, technology is not the only obstacle to coalition operations. In a recent presentation, a Malaysian general stated that the goals, culture, doctrine, logistics, status of coalition partners and the sense of trust are all important factors to consider.<sup>61</sup> For integrated C2 to be achieved in coalition operations, the command structure and relationships between commanders are important considerations. Command and control can be based on certain models from past operations, but it does require the appointment of a capable and credible coalition commander acceptable to all.<sup>62</sup> In the Asia Pacific region where the diversity of interest and motivation is significant, the use of operational control under the United Nations (UN) model is regarded as appropriate.<sup>63</sup>

The future operating environment is likely to see more coalition type operations. Even in limited wars, C2 technologies cannot be ignored as they can provide commanders with unprecedented levels of situational awareness. The U.S. has taken a leading role in the

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<sup>61</sup> Presented by Major General Dato' Abdul Aziz Zainal at the XXVI Pacific Armies Management Seminar 26-30 August 2003 At Calgary, Canada, entitled "Achieving Interoperability Across a Capability Gap between Partners". Presentation script available from [http://www2.apan-info.net/pams/pams\\_xxvi.htm](http://www2.apan-info.net/pams/pams_xxvi.htm); Internet; accessed 1 October 2003.

<sup>62</sup> Brigadier Steve Ayling and Sarah Guise, "UNTAC and INTERFET – A Comparative Analysis", *Australian Defence Force Journal*, No. 150, (Sep/Oct 2001), 53.

<sup>63</sup> *Ibid*, 53.

interoperability issue in the Asia Pacific region. One of the efforts related to C2 is the Joint Warfighter Interoperability Demonstration (JWID) which aims to provide commanders in a combined task force with improved C4ISR capabilities to meet the interoperability goal.

Many regional exercises are conducted to strengthen this aspect of development. For example, Exercise Cobra Gold in 2002 (participants from Thailand, Singapore and U.S.) saw eighteen other countries sending observers, a 100-percent increase since 2001.<sup>64</sup> However, the U.S. is likely to need to have “legacy” systems compatibility to operate with coalition partners since not many of the nations could keep pace with their superior technology used. This is made worse if proprietary systems are being fielded and when security considerations hamper sharing of systems seamlessly.

## **INTEGRATED KNOWLEDGE BASED C2 IN THE SAF**

The Singapore Armed Forces are in the eyes of many experts, the most competent and experienced in all-arms mobile warfare within ASEAN (Association of Southeast Asian Nations, comprising 10 countries).<sup>65</sup> They are recognized to be able to quickly adopt new technologies into their inventory.<sup>66</sup> In terms of defence expenditure, Singapore and Malaysia are among the highest spenders, as shown in Table 1. Singapore has recently purchased AH-

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<sup>64</sup> Adm. Thomas B. Fargo, “Strengthening Security in the Asia-Pacific Region”, *Asia-Pacific Defense Forum*, (Winter 2002-2003), 6

<sup>65</sup> J.N. Mak, *ASEAN Defense orientation 1975-1992: The Dynamics of Modernization and Structural Change* (Canberra: Strategic and Defense Studies Center, Australia National University, 1993), 162.

<sup>66</sup> Ghazemy M Mahmud, “Top Brass Interview: Maj Gen Ng Yat Chung, Chief of Defence Force, Singapore”, *Asian Defence Journal*, (7 & 8/2003), 14.

64 Apache Longbow helicopters, the indigenously produced Bionix infantry fighting vehicles and four ex-Swedish Navy submarines. On order are French La-Fayette class frigates and also the Next Fighter Replacement Program (the F-16E/F, F-15E Strike Eagle and Eurofighter Typhoon are some of the contenders). Malaysia has also initiated plans to purchase tanks (interest in PT-91Z Polish main battle tank), portable surface-to-air missiles systems, South African 155mm towed howitzers, two submarines from Spain and the Astros II multiple rocket systems from Brazil.<sup>67</sup>

Southeast Asian Countries	Defence Expenditure US\$m		No. in Armed Forces (Estimated 2001) 000's	
	2000	2001	Active	Reservists
Brunei	353	279	5.9	0.7
Indonesia	614	860	297	400
Malaysia	2579	3249	100.5	42.8
Myanmar	1020	1088	344	n.a.
Phillipines	1357	1065	107	131
Singapore	4316	4280	60.5	312.5
Thailand	2419	1831	306	200
Vietnam	2303	2351	484	3000

Table 1 Defence Expenditure for some of the Southeast Asia Countries (>US\$200m)  
(Extracted from *The Military Balance 2002-2003*, U.K. Oxford University Press, 2002, 334).

In terms of transformation and adoption of the NCW concept, both Singapore and Malaysia have recognized the need to change and to develop their force structure. The Malaysian Army is looking into upgrading its air defence C2 systems and acquiring battlefield

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<sup>67</sup> Extracted from *The Military Balance 2002-2003*, (U.K. Oxford University Press, 2002), 296, 305.

management system to be able to fight sophisticatedly, seeing NCW as one of the best options in information age wars.<sup>68</sup> The impact of the RMA within the SAF has been most prominent in the area of Integrated Knowledge-based Command and Control (IKC2).

The central idea of IKC2 is the superior collection and organization of knowledge to provide dominant situational awareness to all levels of command to achieve more effective command and control of forces and the precise application of effects.<sup>69</sup> IKC2 aims to maximize combat effectiveness and gives the SAF a quantum jump in capabilities within the constraints of its resources. Command and control is as much about the technology and **processes** that enable it as it is about the commanders and staff who are an integral part of it. *Integrated* refers to the need to fight as an integrated and multi-dimensional force. SAF is still largely organized along Service lines and hence there is a need to plan on the basis of the entire SAF's capabilities and one basic requirement is the integration of the command and control system.<sup>70</sup>

IKC2 enables the SAF to engage in NCW through the use of advanced C4 and IT technology. In a network environment, a knowledge-based approach that allows sharing of information and knowledge can be embedded in decision support systems, hence allowing commanders and staff to focus on core issues rather than technical analyses. IKC2 works on the OODA loop as a basis and consider the three domains mentioned earlier (pages 10 and

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<sup>68</sup> Extracted from Ghazemy M Mahmud, "Interview with Gen Dato' Wira Mohd Shahrom Bin Dato' HJ Nordin, Chief of Army, Malaysia", *Asian Defence Journal*, 3/2003), 16.

<sup>69</sup> Remarks by SAF's CDF in Ghazemy M Mahmud, "Interview with Maj Gen Ng...", 14.

<sup>70</sup> Highlighted by the ex-CDF of SAF, Lt-Gen Lim Chuan Poh, in *Realising Integrated Knowledge-based Command and Control*, Journal of the SAF, Pointer Monograph No. 2, (2003), 8.

19). Represented in Figure 2, IKC2 aims to “see first, see more” and therefore will result in better understanding and be able to “act decisively”. It is envisaged that IKC2 will enable knowledge-based warfighting concepts to be operationalised and to contribute to a more flexible and flatter C2 structure. If the speed of decision-making also increases, then this will enable a higher tempo of operations to be effected.

What does IKC2 imply to the commanders and men? While there is little doubt that IKC2 can change the way we think and the way we fight, much more needs to be done to the main components of force transformation: ***culture, process and product***. While IKC2 builds on the SAF’s comparative advantage of having a relatively large number of techno-savvy people, the development and subsequent changes must be based on a shared purpose approach with the commanders down to the battalion level. After all, integration in C2 implies working towards a common purpose by maximizing resources available.

While the “fruits” of IKC2 will not be so quick due to the existing gap, dialogue with all levels of commanders should always be maintained to highlight development and progress, e.g. testing of concepts and results of C2 related experiments. Intermediate products and knowledge gained (whether successful or not) should be shared widely. All these will efforts require patience and time. To achieve the next big leap in capability, *IKC2 cannot be the dream of just a few and remain distant and vague to the rest*. Transformation is indeed about moving forward and what it means to the soldiers should be a continuous effort so that the journey is made as a cohesive force. Intermediate products and results are part of getting the process going.

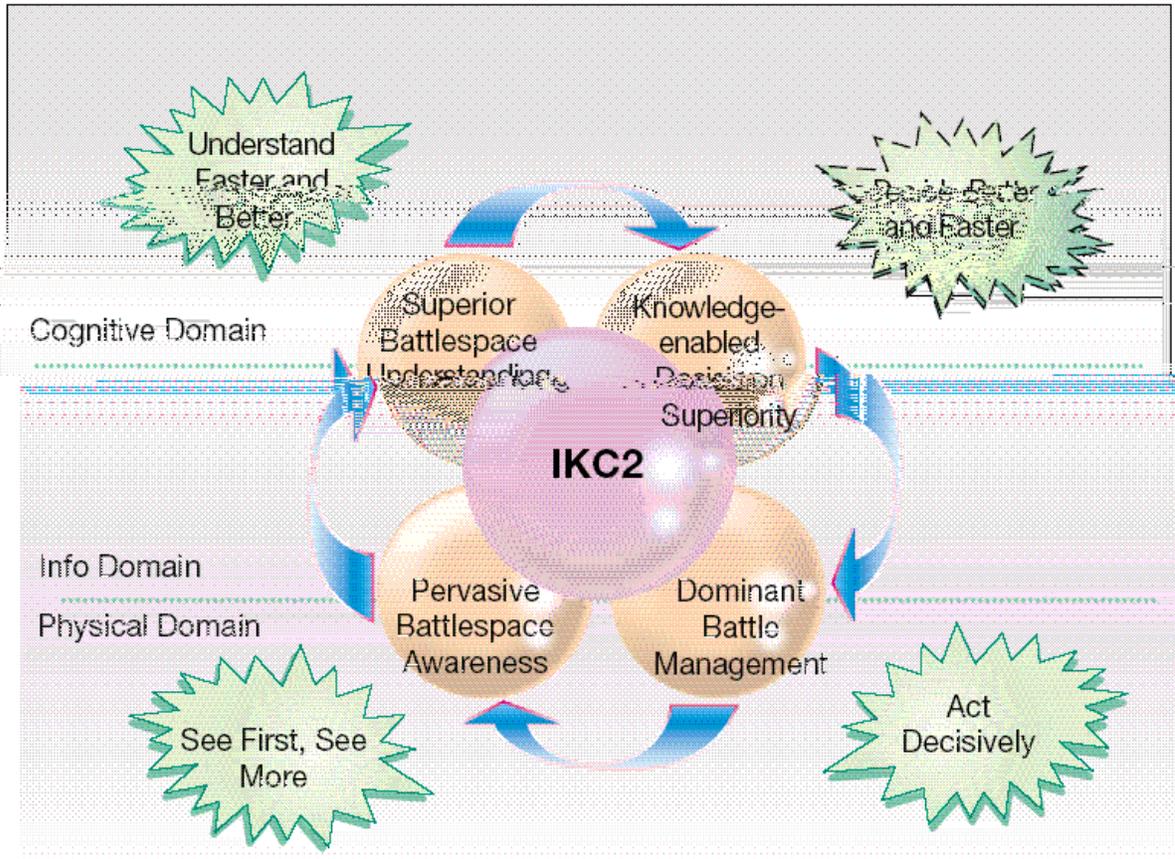


Figure 2 SAF's Integrated Knowledge-Based Command and Control Framework

(Extracted from Ravinder Singh, et al, "IKC2 for the SAF – Organising around Knowledge", in *Realising Integrated Knowledge-based Command and Control*, Journal of the SAF, Pointer Monograph No. 2, 2003, 14).

## **WAY AHEAD**

It is not an easy task to embark on the transformation journey and ensure the success of the IKC2. Indeed, short-term pain versus the long-term gain is recognized, since initially, adherence to standards and requirements under the IKC2 framework will possibly slow down

the current pace with which individual systems and capabilities are fielded.<sup>71</sup> What then are the main considerations and ingredients needed in this “salad bowl”, in order to create and achieve NCW and IKC2 Capabilities?

As mentioned earlier, one of the key ingredients in achieving IKC2 is about *culture and people*. This is often cited in many reports of change but to really be able to transform and harness the power of IKC2, the need for the shared purpose cannot be ignored. The development process, as argued previously and well accepted by planners, will take a long time. Few, if any, could afford the kind of resources and capital devoted to the transformation and NCW developments that the U.S. DoD has done. The SAF, with limited resources, would need to work out an overarching set of capabilities that our forces would need to possess.

The time factor highlights further the need to have the shared ownership of this journey. The hype of a technologically enabled transformation could quickly fade if the momentum cannot be sustained. The operations tempo will not be reducing due to the wider spectrum of operations that the SAF has to handle. Hence, commanders must set priorities so that work objectives are narrowed down to a manageable level. With the commitment of the leadership across the services, officers and men alike will feel that they are part of this transformation process, rather than being casual observers.

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<sup>71</sup> Journal of the Singapore Armed Forces, *Realising Integrated Knowledge-based Command and Control*, Pointer Monograph No. 2, (2003), 10.

Hence, it must be clear to the commanders and warfighters why and what are we changing to induce understanding and develop commitment. With this, there is a need for a credible communication plan. The military people have shown tremendous capacity to adapt and are very good at a task-oriented kind of environment. The switch to having rigorous debate, discovery and experimentation among warfighters, defence academic and defence scientists will entail a different learning climate. The SAF Army's effort towards grasping the fundamentals of organisational learning at various command levels and training schools will support this effort. The Navy and the Air Force have also embarked on similar initiatives. Hence, the culture of a learning organisation becomes apparent. A spirit of learning and sharing that transcends the services and right to the smaller units and teams will create the capacity to change. The challenge is how to make this become an integrated effort since IKC2 is very much about integration.

The second ingredient involves the difficult aspect of *structures and processes*. To be able to fight in an integrated manner and across a spectrum of operations, the issue of "jointness" need to be carefully addressed. The need to be modularised and be task force oriented for better responsiveness and agility are already quite well accepted. However, what this entails in terms of being able to fight in an integrated manner and for commanders to have superior C2 in operations may not be that simple. Sun Tzu observed that "just as water retains no constant shape, so in warfare there are no constant conditions"<sup>72</sup>, emphasizing the need to have continuous adaptation and superior battlespace awareness and understanding.

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<sup>72</sup> Sun Tzu, *The Art of War*, trans. by Lionel Giles, (London: Stackpole Brooks, 1985), 36.

The faster and more complicated war becomes, the more the need for tighter and continuous cooperation among the services.<sup>73</sup> With a tight defence pie, the synergy can be obtained by having the joint staff channel the competitive environment among the services towards a productive purpose. Hence the sense of purpose remains important. The Air Force and Navy are still very much platform dependent while the Army operates very much on a combined arms division set-up. There is a need to have flexibility and versatility to achieve operational success. Decision-making needs to be decentralized through understanding of the superior commanders' intention. IKC2's network structures contrast with the hierarchical nature of the SAF structure and a major revamp may be needed.

“Jointness” is intimately related to the information revolution since seamless information and knowledge interaction will not be bounded by divisions among the services. Our network centric forces must be able to “plug” quickly into an integrated battlefield operating system and this will require interoperable communications, standards, doctrine, tactics and procedures. However, joint interoperability is quite different from coalition interoperability. creaiongm(e)Tj

Activities that are important to adopting process changes include clarifying the new operating concept, developing new training methodologies and system and taking on an experimental approach. The setting up of the SAF's Future Systems Directorate is a commitment towards transformation by focusing on exploring new operational concepts and experimentation. However, such exploration would still require the active participation of commanders and men so that they can feel the tempo of change. It should not be taken as a validation exercise by troops and the emphasis must be that it is "*safe to fail*", a significant change in the mindset of military personnel. Experiments and lessons learnt from operations or exercises can be the source of emerging doctrine, or else there will be significant lags in doctrine development.

In fact, in order to have some creativity necessary to embrace NCW, IKC2 and effect-based planning, a "*dare to experiment*" attitude would enhance the process of adapting and learning. Likewise, while training evaluation and validating doctrines are necessary activities, a fresh look at the training process will be fruitful. This would include new learning methodologies (e.g. knowledge-based approach, experiential and team learning, adaptive thinking) and new doctrines (e.g. fighting integrated and joint). With such an approach, some of the major obstacles related to C2 development like information overload (especially in HQs) and the lack of bandwidth to mobile troops, can have more emphasis. The danger of relying on higher HQs having the best situational awareness could result in high-level commanders trying to be involved in minor tactical manoeuvre and operations. Situational awareness should also filter to the lower levels of command.

The third ingredient is related to *products*. Here, **visible deliverables** become important to sustain the transformation journey towards IKC2. Products that are based on integrated C2 architecture will give the SAF a quantum leap in capabilities when combined with battlespace awareness and precision strike. Products for the tactical levels cannot be ignored and while operating in wireless mode for mobile forces still present significant technical challenges (e.g. bandwidth and reliability), intermediate products have to be tested so as to enhance the learning curve. Service commanders need to grasp the implications of being able to operate in an integrated manner and operating with new technologies will enhance the understanding of C2 requirements in the information age.

Products, while needing to leverage on technology, can also be in the form of learning from the experimentation process. This would also help develop the key competencies required to be familiar about operating in a network environment. An overarching architecture needs to be developed and communicated quickly so that integration can at least begin to take shape, even though changes and fine-tuning to the architecture will be expected. However, experimentation and products inevitable imply the commitment to put in capital investments. Also, the more we rely on information resources and systems, the greater must be our efforts to protect them.<sup>74</sup>

Ultimately, investing in IKC2 as part of force transformation will have an impact on resources and on efforts tied to force readiness and near-term force development. The children of today are acquainted with playing computer games and are hence good at

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<sup>74</sup> Aaron E.S. Chia, “Countering the Friction and Fog of War in the Information Age”, *Pointer*, (Singapore Armed Forces: April-June 2003),117.

“button-pressing” to shoot at “enemies” while playing a combat game. The “transformer” toy that allows them to change the form and shape of a robot to another more powerful version by just a few twists and add-ons is also very popular. However, military operations have become more complex and transformation will require more than just a few quick twists. Indeed, arguments have been raised regarding the possible vulnerabilities (e.g. easier to attack and exploit an integrated network, new innovations by adversary, inherent chaotic nature of operations) of having IKC2. There are also implications to soldiers relying too much on technology since machines as yet cannot match the judgment capability of human minds. The “champions” of the IKC2 journey need to be aware of such possible pitfalls.

## **CONCLUSION**

In the past decade alone, we have seen tremendous development in the use of information technology for military peacetime information systems and wartime command and control systems. The security environment today has a reduced distinction between war and peace since peacekeeping, homeland security and war against terrorists have shown that the military need to adapt to performing in a spectrum of operations. While the development and acquisition of hardware will continue, the opportunity is there to move ahead by a fundamental shift towards networking of forces and capabilities.

The networking paradigm is inevitable in the future. Network centric warfare and network centric operations are not ends in themselves. Effects-based operations encompass the mind with focus on the mission and the conditions of military operations while NCW provides the

framework and tools. They deal with the why, what, how and support of military operations, which are crucial in looking at the military transformation journey.

There is little doubt that the concept of integrated command and control under the context of the SAF's IKC2 framework can change fundamentally the way we train and fight. It is *real* in that it necessitates the commitment and capacity to change, as transformation is inevitable.

This will enable commanders to operate in an ever-changing environment and where the spectrum of operations will require new command and control tools and processes.

However, there are major impediments that must be tackled before IKC2 can succeed, or else the journey would remain a *myth* to many. These include the need to transform the **culture**, the **structure and processes**, and the ability to sustain support by having **visible deliverables**.

The need to have a shared purpose cannot be ignored since the process towards achieving IKC2 will be a long one. It must be clear to our operational commanders and warfighters why and what are we changing to induce understanding and develop commitment. The switch to having rigorous debate, discovery and experimentation among warfighters, defence academic and defence scientists will entail a different learning climate.

To be able to fight in an integrated manner and across a spectrum of operations, the network centric forces must be able to plug quickly into the CCIS networks. This will entail interoperable communications, standards, doctrine, tactics and procedures. Joint operating concepts and interoperability must be addressed. The quicker and more complex nature of future operations will require tighter and continuous cooperation among the services. With

the new security environment, the need to focus on applicability to other operations like low intensity conflict will need to be examined. A common operating picture will not guarantee that the commander or staff viewing it will interpret it the same way.

While the “fruits” of IKC2 will not be so realised so quickly, dialogue with all levels of commanders should always be maintained to highlight the development and progress e.g. testing of concepts and results of C2 related experiments. To achieve the next big leap in capability, IKC2 cannot be the dream of just a few and remain distant and vague to the rest. Intermediate products and knowledge gained (whether successful or not) should be shared widely. This will enable commanders and soldiers to be trained and developed to operate in an information rich environment.

Amidst the excitement of exploring new ways to be able to fight in an integrated environment, core military imperatives will still be needed where the commander will discern the salient points pertinent to his mission and lead his men towards planning and operating successfully in combat. The possibilities with embracing NCW and integrated command and control are indeed tremendous. IKC2 provides the framework to re-define organizational structures and provide clarity to the orientation of C2 in the information age. If this can lead towards a SAF that can deal effectively with threats across the entire spectrum of conflict, then the way ahead would need deliberate and continuous effort.

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