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WEB-ENHANCED NETWORKING:
A FUTURE ALTERNATIVE FOR COMMAND AND CONTROL 2025

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Executive Summary

When envisioning Marine Corps command and control innovation in the next 15 years, it is plausible to conceptualize a secure multi-function handheld command and control device (C2) that encompasses a global positioning system (GPS) and laser range finder with full stream web-based capability in voice, data, picture, and full motion video. With the current rate of advance in internet technology, a squad leader in the year 2025 could conduct a real time video teleconference, control supporting arms, manage logistical issues, communicate with joint and international partners in his battlespace, share intelligence, and have full reach-back connectivity for intelligence applications all from a handheld C2 device. With the breakthroughs in technologies with physical networks, and the advancement of networking systems, exploring web-based alternatives to command and control can provide a consolidated C2 medium for tactical units, build internet architecture to support joint and interagency operations, and leverage emerging technology to enrich combined operations. This paper will examine these problems, along with the theory of networks, and offer ways to maximize the potential of emerging technologies over the next 15 years. This analysis will offer direction to Marine Corps command and control to meet the threats for the most likely security environment for year 2025.

INTRODUCTION

When envisioning Marine Corps command and control innovation in the next 15 years, it is plausible to conceptualize a secure handheld command and control (C2) device at the squad level. With the rate of technological advance, this unit could be global positioning system (GPS) capable with a laser range finder, and incorporate full stream web-based capability in voice, data, picture, and full motion video. With this handheld C2 device, a squad leader in the year 2025 could conduct a real time video teleconference, control supporting arms, manage logistical issues, communicate with joint and international partners in his battlespace, share intelligence, and have full reach-back connectivity for intelligence applications. This device would be useful for distributed operations in the potential security environment of hybrid warfare. As the *Marine Corps Vision and Strategy 2025* states, “A significant trend is the blurring of what was previously thought to be distinct forms of war or conflict – conventional war, irregular challenges, terrorism, and criminality – into what can be described as hybrid challenges.”¹ Such an environment will require a Marine infantry unit with the flexibility to mass for full scale conventional warfare, while also being able to conduct dispersed low-intensity conflict operations against an elusive cellular network of non-state adversaries – often simultaneously.

In order for the Marines Corps to operate effectively in this new environment, it must be at the forefront of technological innovation with both C2 equipment and internet programming. With the breakthroughs in technologies associated with physical networks, and the advancement of networking systems, exploring web-based alternatives to command and control can provide a consolidated C2 medium for tactical units, build internet

architecture to support joint and interagency operations, and leverage emerging technology to enrich combined operations.

However, there are significant challenges that may inhibit the Marine Corps from realizing the full potential of the C2 in the future. Issues such as network security, information control, and equipment modernization procedures can slow or de-rail this type of innovation. This paper will examine these problems, along with the theory of networks, and offer ways to maximize the potential of emerging technologies over the next 15 years. This analysis intends to offer direction to Marine Corps command and control to meet the threats affecting the most probable security environment for year 2025. Ultimately, the Marine Corps must not only dominate communication with regard to capability, reliability, speed, and security relative to its adversaries, it must also compete with its rival services for institutional relevancy. It is a matter of organizational survival to remain on the cutting edge of technology to ensure a healthy allocation of missions and resources

PROBABLE C2 SCENARIO FOR 2025

Marine Corps Vision and Strategy 2025 clearly states that there will be a versatile command and control networking system for this future security environment that will complement joint, interagency, and coalition operations. It further explains how the full spectrum of command and control capabilities must be pushed down to the squad level.

Over the past decade, we have made great strides in enhancing our C2 and intelligence, surveillance, and reconnaissance capabilities (ISR) at the battalion/squadron level and above. We need now to make similar strides from the battalion down to squad, while recognizing that “the last hundred yards” of this challenge is exponentially harder. To this end, we must aggressively pursue integrated microtechnologies, such as a secure communication personal data apparatus that communicates via the spoken word, data, and imagery without adding to the already heavy combat load.²

The Marine rifle squad needs the ability to independently execute all the warfighting functions – command and control, maneuver, fires, intelligence, logistics, and force protection to effectively operate in the future security environment. It needs to be able to link into intelligence networks, call for supporting arms, manage logistical sustainment, and communicate across the joint, interagency, and coalition domains.

This technology is actually on the verge of availability today. Small phones such as the iPhone and the Droid offer wide-band internet, e-mail, text, voice, picture, video and GPS capabilities. A competing device, the ATT Blackberry, has been approved for government unclassified use.³ To hypothesize this physical network will be available to support the Marine Corps vision of a small secret sensor C2 device at the squad level in 2025 is not only possible, but probable in the future.

The retired CEO of Intel, Gordon Moore, stated that “the number of components the industry would be able to place on a computer chip would double every two years.”⁴ This theory has become known as Moore’s Law and serves to explain how the computer technology industry maintains its rate of progress by consistently offering products smaller, less expensive, and more powerful.⁵ This technological progression can be seen in the internet networking industry as well. With the explosion of Web 2.0 technology, web design has facilitated information sharing, collaboration, and the “development and evolution of web-based communities and hosted services, such as social-networking sites, *wikis*, blogs, and *folksonomies*.”⁶ Since the launch of Facebook in 2004, the utility of virtual networking and live stream applications has been brought to the main stage in both government and private business. To plan for this phenomenon to continue to dominate in the information age is a sound long-range assumption.

THE PRACTICAL UTILITY OF NETWORK ANALYSIS

The study of networks has erupted in the past decade with online social networking sites such as Myspace and LinkedIn.⁷ Network analysis is the study of *nodes*, *links*, and *hubs*. The *nodes* are the components, the *links* are how they are connected, and the *hubs* are the center points in which multiple *nodes* are connected. For example, a *node* can be a laptop computer, the *link* can be the 3G wireless network, and the *hub* can be an internet website. There are several different terms and definitions used to explain these concepts in the world of academia. However, network analysis is a combination of different sciences (computer science, social science, and network science) used to explain relationships and interactivity within a system.

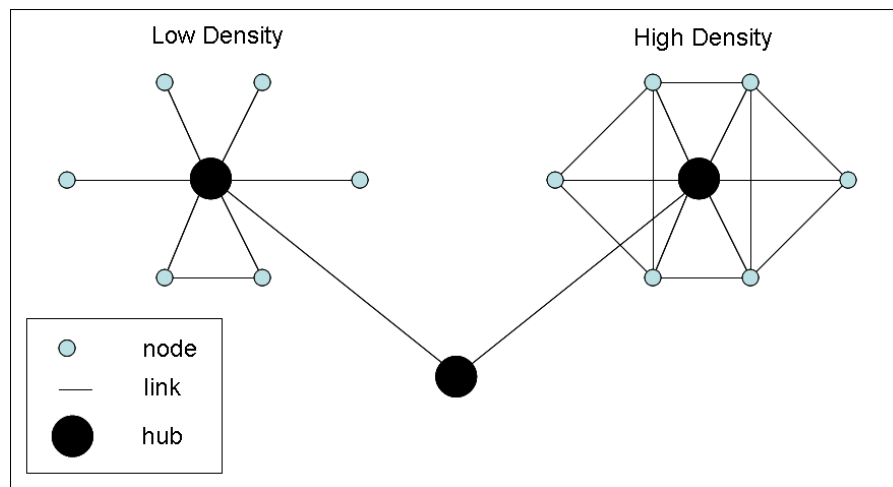


Figure 1. Example of Network Analysis

This theory gained momentum when the premise of Six Degrees of Separation was introduced. The author, John Guare, proclaims that “everybody on this planet is separated by only six other people.”⁸ This sparked another book by Duncan Watts that is dedicated to the study of social network analysis and the interconnectedness of modern society. Further popularity was generated in pop culture when a computer scientist, Brett Tjaden proclaimed

that the movie star Kevin Bacon was the nexus of Hollywood. This proposition went on to say that every actor had either been in a movie with Kevin Bacon or had been in a movie with someone who had. It later made it to late night television only to bring further recognition to the “small world” phenomenon.⁹ The underlying theme is that as modern *links* and *hubs* enter a system (e. g., movies, computers, railroads), interconnectedness increases. When Moore’s Law collides with the “small world phenomenon”, the implications to the Marine rifle squad will be a handheld C2 device with the software/programming to interact with an entire network. The squad will be exponentially more capable and have a much greater degree of autonomy.

The application of the network theory has relevance to the future of Marine Corps command and control as a whole. Indeed one can see the C2 of military operations a series of *nodes*, *links*, and *hubs*. There are two specific laws that dictate the value of a network. First is Metcalfe’s Law which states that “the useful power of a network multiplies rapidly as the number of nodes in the network increases.”¹⁰ This is particularly applicable to the desire to push sophisticated and affordable C2 equipment down to the squad level. As we integrate squads (*nodes*) to C2 networks, the value of the network will increase. The second law is Reed’s Law. This states that “the power of a network, especially one that enhances social networks, multiplies even more rapidly as the number of different human groups that can use the network increases.”¹¹ This implies that if networks can connect over a common medium, they will merge into a greater power than that of sum of its parts. This lends particular importance to joint, interagency, and international networks that can be technologically fused by enhanced interoperability internet-based programs. The challenge remains building the

most capable hardware to establish the physical networks and then creating the optimal *links* and *hubs* through web-based protocol that can connect to these nodes.

PRESENT AND EMERGING INTERNET TECHNOLOGIES

Given the pace at which communications technology is advancing, Moore's Law may be operating closer to a 12 to 18 month cycle. Technology that is emerging in one year may be considered outdated in the next. When analyzing the quantum leaps that have been made in the past decade with wireless communications, it is clear that if these present and emerging technologies are introduced to Marine Corps command and control, it will have positive implications to warfare in 2025. These technologies can be separated into two categories: physical networks and web-based networking technology.

Physical Networks. The first aspect of the physical network is the advancement of cellular phones. Even the term "cell phone" has become a phenomenon known as a *genericized trademark* in the marketing industry.¹² As the brand Kleenex became the standard word for any type tissue paper, the term cell phone is widely accepted for devices like Blackberrys and iPhones; although these products no longer operate on an analog network and have exponentially greater capabilities than just mobile phones. The most significant innovation of cell phones was the ability to connect to the internet. This has spurred a cascade of applications including browsing, search functions, and e-mail. The most competitive phone on the market is the iPhone. This device is equipped with a 32 gigabyte (GB) capacity, a 3 megapixel digital camera that is full motion video capable, and is text messaging capable.¹³ It also possesses a GPS that works off satellite triangulation versus cell tower triangulation; which gives it greater coverage and accuracy. These types of devices have revolutionized the way people communicate. In terms of Medcalfe's Law, it has

drastically increased the number of nodes on a network because most individuals are now able to stay perpetually connected to the internet. “The mobile internet may be the first major new communication medium where social impacts have been systematically observed from its earliest stages.”¹⁴ It is this type of device that could be easily adapted to a squad C2 node.

The physical network has also made radical advances in wireless technology. The 1G (1st generation) networks worked off an analog cellular network. The 2G network moved to a digital network that allowed broader applications like push-to-talk and simple web browsing/e-mail. 2G networks are still in use today for voice services only. The 3G network was the progressive breakthrough that allowed broadband internet access similar to DSL speeds. “As a result, 3G can provide support for more demanding multimedia applications, such as video conferencing, voice-over-internet protocol (VoIP), full motion video and streaming music (for example, to support television programming and satellite radio), while also offering faster web browsing and faster file downloads.”¹⁵ A look into the 4G network is a continuation of broader bandwidth, faster speeds, and extended international coverage. This technology will truly make cell phones a *genericized trademark* because the voice service will no longer be over a digital network, but over an internet connection using VoIP.¹⁶ This type of speed will also allow progressive programs such as Skype to provide real-time video teleconferencing.¹⁷ It is these types of networks that will allow the squad to be linked to necessary *nodes* and *hubs*.

Web-Based Networking Technology. There are many advancements beyond the scope of this paper that make web-based networking possible, but in the simplest terms it is Web 2.0 technology. Although the term has been used as early as 1999, it was energized in a

conference between O'Reilly Media and MediaLive International in 2004.¹⁸ Figure 1 depicts how that conference tried to define Web 2.0.

Web 1.0		Web 2.0
DoubleClick	-->	Google AdSense
Ofoto	-->	Flickr
Akamai	-->	BitTorrent
mp3.com	-->	Napster
Britannica Online	-->	Wikipedia
personal websites	-->	blogging
Evite	-->	upcoming.org and EVDB
domain name speculation	-->	search engine optimization
page views	-->	cost per click
screen scraping	-->	web services
Publishing	-->	participation
content management systems	-->	wikis
directories (taxonomy)	-->	tagging ("folksonomy")
stickiness	-->	syndication

Figure 2. Web 1.0 vs. Web 2.0

The foundation of Web 2.0 is information sharing and collaboration software that enables virtual networks based on a common interest or goal. Information sharing started with blogs like Live Journal used to share ideas.¹⁹ The information sharing then migrated to pictures and video with the introduction of sites like Flickr.com and Youtube.com. This concept has even created a micro-blog trend that enables people to share short burst transmissions of updates or thoughts to a large number of people over multiple forms of media on Twitter.com.²⁰ This has all led to the latest trend of social networking sites.²¹ This Web 2.0 byproduct allows users to establish personalized networks, share real time updates using stream technology, share photos/videos, e-mail, chat, and establish groups. The most important feature is the information filtration programming. This allows the user to receive live feed information based off *links* and settings in the network. In the book *Here Comes Everybody*, Clay Shirky describes how this modern technology can become a genesis for action through a series of short stories. The *strength of the interpersonal tie*²² (the

relationship) is enhanced by the increase in the *degree of connectedness*²³ (how well people communicate). People can share thoughts and ideas in multiple forms to become virtual online activists. This concept is developed further with how internet-based social networks, and the ability to access them through mobile devices, can organize groups for a common purpose as described in the book *Smart Mobs* by Howard Rheingold. “The “killer apps” of tomorrow’s mobile infocom industry won’t be the hardware devices or software programs, but [sic] the social practices. The most far-reaching changes will come, as they often do, from the kinds of relationships, enterprises, communities, and markets that the infrastructure make possible.”²⁴ The social practices of sharing thought, ideas, intelligence, pictures, and videos will also be a huge factor for the Marine rifle squad as the same technology is introduced to tactical C2 in the era of hybrid warfare.

The social networking site dominating the market place is Facebook.com. It has gained legitimacy from main stream media, the entertainment industry, government, and large businesses. While the military and other agencies have addressed security concerns with it, the Marine Corps has made similar shifts in computer technology toward collaborative web-sites called *portals*. Websites like MarineOnline, the Marine Corps Center for Lessons Learned, and MarineNet are several avenues the Marine Corps is capitalizing upon using this type of information sharing technology. However, they are compartmentalized endeavors that lack stream technology and the establishment of comprehensive networks. Social networking sites like Facebook are pursuing streaming voice/video and real time language translation.²⁵ This same technology will dramatically help the flow and value of information a user could leverage for command and control of military operations. As stated in MCDP 6 *Command and Control*, “there are two basic uses for

information. The first is to create situational awareness as the basis for a decision. The second is to direct and coordinate actions in the execution of a decision.”²⁶ The social networking stream and filtration technology will enable a user to process much greater amounts of information at a much faster speed. The increase in the quantity of information that can be transmitted, and the speed at which it will flow, will drastically change the way squads operate.

INTERNET TECHNOLOGY C2 IMPLICATIONS FOR 2025

FMFM 1 *Warfighting* states, “Whoever can make and implement his decisions consistently faster gains a tremendous, often decisive advantage. Decision making thus becomes a time-competitive process, and timeliness of decisions becomes essential to generating tempo.”²⁷ If implemented properly, this internet technology could provide a decisive advantage with regard to a C2 generating tempo. In terms of just the physical network, the use of an iPhone-like device can be the solution to providing a “secure communication personal data apparatus”²⁸ that gives the squad leader the capability to operate in a distributed manner. With the current capabilities of an iPhone, this small device could manage all the warfighting functions²⁹ for a small unit leader. The only requirement that needs to be developed is creating this type of device at the secret gensur level. As per Medcalfe’s Law, not only will the amount of nodes grow, but the *density* will increase to exponentially strengthen the network.

Another factor of the physical network that will enable web-based technology for C2 is the continued development and expansion of the 3G and 4G networks. If one uses history as a yard stick to measure the progress of the future, roughly a new generation of cellular network is created every ten years.³⁰ This, coupled with satellite technology, suggests that

broad-band wireless internet access will be available through multiple means over the entire earth's surface in 2025.

When considering both the physical network and web-based networking technology, they are not mutually exclusive. Handheld C2 devices at the squad, platoon and company level will provide the *nodes* in the C2 architecture. The *links* will be provided by wireless networks and satellite connections. The *hubs* provide that enhanced web-based networking capability on a common site or different organizations merging to join common network. By using basic Web 2.0 networking technology, it is possible to create a controlled virtual network as a one-stop shop for C2.

As one article predicted, a cell phone number will become the new social security number in the future; meaning an individual receives one and it will never change.³¹ To add another dimension to this concept, the Marine Corps could give each member of a squad an internet protocol (IP) address as a primary means in which that Marine would communicate. Even by developing the social networking technology from sites like Facebook, a member of a squad could use his profile for posting a biography, pertinent qualifications, picture, and use the site for chat/e-mail/voice. From this, a network and its hierarchy could be created or dismantled by factors like billet, command relationships, informal relationships, and mission requirements. The virtual command will enable the creation of a task force, and give command authorities, like tactical control (TACON) and direct liaison authority (DIRLAUTH), all by just modifying the network. This will add structure and control to network of the squad.

The site would also be the reach-back link to intelligence, orders, reports, standard operating procedures, and live-feed updates. Taking into account emerging technology of

VoIP and streaming video, it is completely plausible to foresee a squad leader conducting video teleconferencing, calling for fire support, and instantly posting pictures for intelligence purposes all from a handheld device. Even just developing the present technology to operate at the secret gensor level will revolutionize C2. Figure 3 shows how a basic social networking profile would look if converted for the use of Marine Corps C2.

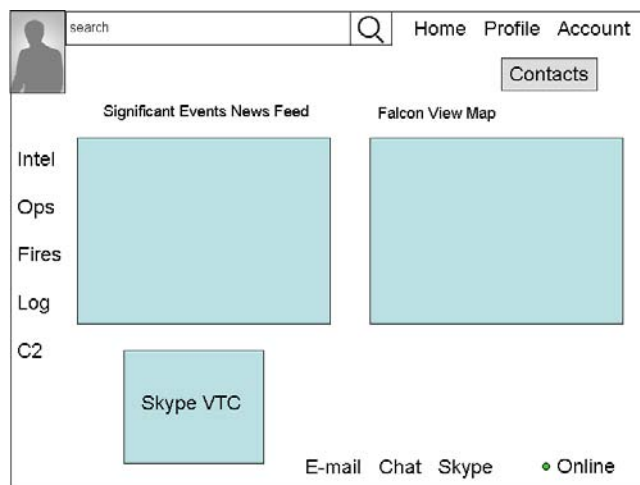


Figure 3. Sample Social Networking Site for C2

This medium could also serve in bridging the gap between different organizations during joint and interagency operations. Considering this web-enhanced networking as an alternative form of C2 to the department of defense (DOD) and the national command authority (NCA) would simplify C2 by primarily using internet protocol. As joint and interagency operations permeate down to the tactical level, this technology will enable the rifle squad to integrate into a multiagency approach of the future. Consistent with Reed's Law, the merging of several groups into one virtual network will bring unity of effort that is needed for joint and interagency operations.

Computer based translation is another emerging technology that could be leveraged with this type of C2 system. With the advancements of language translation technology, it is

possible that computer-based translation will replace human translators.³² This technology would mean that multinational partners could enter a coalition network and receive information posted real-time in their host nation language.³³ It would transform the manner in which a coalition would communicate with its international partners. The U. S. military could leverage the use of a multi-language web-based network as the primary means to chat, e-mail, issue orders, and disseminate intelligence. It would enhance the combined operations at the tactical level as well. The squad would have a universal way to communicate with international partners while conducting partnered training and operations.

FUTURE CHALLENGES TO ENHANCED WEB-BASED NETWORKING C2

While directing Marine Corps C2 efforts toward enhanced web-based networking would greatly enhance command and control in the future, there are challenges that would need to be overcome for this type of innovation. First, the most significant potential complication is the institutional resistance to becoming over-reliant on a particular form of communication. Much like the electrical power grid has become the life-blood of civilized life,³⁴ an all encompassing network may be vulnerable and would produce cascading catastrophic effects if it failed. To centralize information through a central hub makes it susceptible to computer network attack or a breach of network security. The Defense Department already is targeted by tens of thousands of cyber attacks every year. As General James Cartwright stated in congressional testimony, “we lack dominance in cyberspace and could grow increasingly vulnerable if we do not fundamentally change how we view this battlespace.”³⁵

The second likely challenge will be the loss of information control. The Marine Corps may be reluctant to create a network that allows nodes to publish real time information

before it has been verified, validated, and approved. While an enhanced web-based network would increase the amount of information transmitted between nodes at a much faster pace, the information may not be productive. There is a risk that the end-user may get saturated with too much information. There is also the possibility that the information published may be false. The information published may also be transmitted to nodes that were not intended to receive it. There is a chance that information may not be properly vetted to ensure brevity, clarity, and relevancy as well.

Finally, there is the bureaucratic manner with which the Marine Corps conducts equipment acquisition. Often C2 equipment that has already been implemented is difficult to replace with updated technology. Below is an illustration from Marine Corps Tactics and Operations Group (MCTOG) of over twenty C2 systems on which battalion and regimental staff are trained prior to deployment.

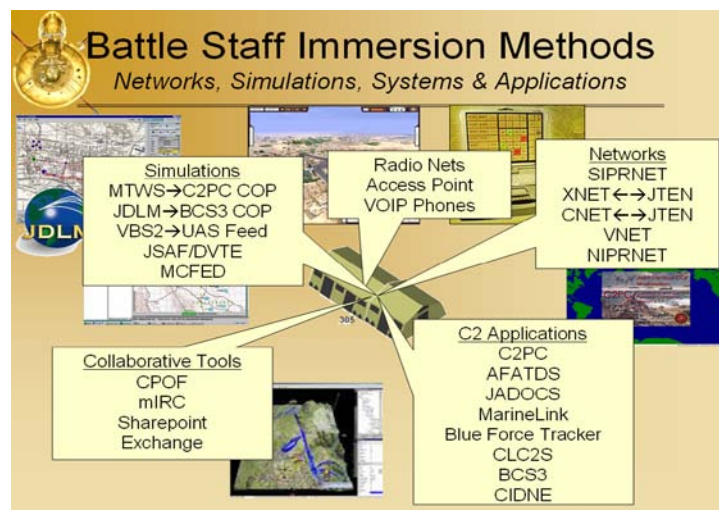


Figure 4. MCTOG Networks, Simulations, Systems, and Applications³⁶

Many of these systems are incompatible with each other and there is wasteful spending on “bridging programs” that attempt to build a common operational picture. C2 innovation has become compartmentalized and this has caused serious interoperability challenges among the services and with other government agencies. This continues in part because killing a piece of outdated or incompatible equipment means killing jobs. That action has a ripple effect into the high echelons of the military and the government which makes it hard to impose change.

AN AZIMUTH FOR C2 PROGRESSION TOWARD 2025

The future progression toward web-based networking can give the United States Marine Corps an advantage in the full range of future conflicts and a competitive edge in the future joint/interagency environment. This is an approach to overcome these challenges and continue to push the enhanced web-based networking to its maximum potential. These recommendations can establish a path for the Marine Corps to achieve more efficient and effective command and control in 2025.

Simplify. In an effort to modernize C2 in the Marine Corps, there has been a large infusion of different systems to aid the battle staff in directing operations. There are redundant methods for chat, multiple means to send text data/images, and even more ways to transmit voice data. This not only adds complexity to C2, but severely taxes manpower to operate these additional systems. The Marine Corps needs to simplify C2 by cutting redundant and/or outdated systems. This process needs to be in close coordination with joint and interagency partners.

IP Address to IP Address Communication. The Marine Corps must focus on the C2 systems that communicate from internet protocol (IP) address to IP address. This is defined

by Buddenberg's Interoperability Reference Model as Layer 3 Technology. "Data element interoperability is a clear requisite to information system interoperability."³⁷ Equipment that cannot connect to internet protocol should be only considered as a secondary or tertiary means to communicate. This reasoning should be applied to procurement of man-portable nodes, mobile nodes, and large C2 systems.

Exploit Commercial Trends. Commercial computer technology is a lucrative field that drives Moore's Law. There is value in analyzing the different media and networks dominating the market place. Internet devices and websites continue to surpass all other means by which people interact in both capability and cost. The Marine Corps should leverage such technological trends in the commercial market in order to provide a future path for C2 innovation. It may find that with a progressive Web 2.0 network, it will be easier to control information while increasing the speed transfer.

Prepare Junior Leadership. With the increased autonomy of the Marine rifle squad, comes increased risk. As the Concept for Distributed Operations states, the United States Marine Corps needs to provide the "infantry squad leaders a broad understanding of C2 systems, the intelligence cycle, fire support coordination, logistics, and other disciplines, in which extensive knowledge has heretofore been principally the domain of Marines far more senior."³⁸ Enhanced web-networking technology is going to impact tactical C2. Anticipating the implications for doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) would better prepare the Marine Corps for the advanced training required for the future squad leader. To mitigate the impact, the Marine Corps should start to field the technology to more specialized small units like Marine Special

Operations Command, which already possess the small unit leaders with many of these skill sets.

CONCLUSION

As the spectrum of warfare gets blurred in a hybrid type of conflict, ambiguity will increase. As Carl von Clausewitz explains in his book *On War*, “War is the realm of uncertainty; three quarters of the factors on which action is based are wrapped in the fog of greater or lesser uncertainty. A sensitive and discriminating judgment is called for; a skilled intelligence to scent out the truth.”³⁹ Information flow and management becomes essential to what MCDP 6 *Command and Control* calls basic uses of information; the situational awareness to make a decision and the execution of the decision.⁴⁰ This is essential for formulating operational tempo against the enemy.

Web-enhanced networking technology will reduce uncertainty. Concentrating on Layer 3 Technology and trends in commercial technology will lead to handheld devices that can be fielded at the squad level with full C2 capability. This will strengthen the network by adding the amount of nodes in the network, and by increasing *density*. Then, using web-enhanced networking, users will be able to absorb and understand a much larger amount of information in less time and for less cost. With Web 2.0 technology, the Marine Corps could merge to consolidated networks at the secret level and below. This, coupled with the development of real-time computer based translation technology, will transform the ways in which joint, interagency and coalition warfare are conducted.

When developing a reliance on computer networks for C2 there is significant risk to cyber warfare and cyber espionage, however, the benefits far outweigh the threat. The Marine Corps has an opportunity to pioneer a more efficient way to command and control.

In order to do so, it must simplify C2 to reduce redundancy and out-dated technology. Systems should be scrutinized to determine which methods of communication must be maintained for secondary/tertiary communication. A significant investment into Layer 3 technology must be made. The Marine Corps must also prepare to enhance the skill sets of the infantry squad leader of the future. Finally, the Marine Corps must also look into trends in the commercial market to capitalize on the efficiencies that have been developed with Web 2.0 technology. “There is no single activity in war more important than command and control”⁴¹ When looking at the nature of technological advancements in enhanced web-based networking, it is easy to envision how the Marine Corps can shape the future of C2 by conceptually and functionally preparing for 2025.

Appendix A – Selected Glossary of Terms

<i>degree of connectedness</i>	The extent to which refers to the extent to which the actors are able to connect to each other through a network. (Kilduff & Tsai, p38)
<i>density</i>	A measure of how many connections [links] there are between actors [nodes] compared to the maximum possible number of connections that could exist between actors. (Kilduff & Tsai, p30)
<i>folksonomy</i>	A type of classification system for online content, created by an individual user who tags information with freely chosen keywords; also, the cooperation of a group of people to create such a classification system. (Dictionary.com)
<i>genericized trademark</i>	A brand name or trademark of a successful product that has come into general use to refer to the generic class of objects rather than the specific brand type. (allwords.com)
<i>hub</i>	A center around which other things revolve or from which they radiate. (Dictionary.com)
<i>link</i>	Anything serving to connect one part or thing with another. (Dictionary.com)
<i>node</i>	A centering point of component parts. (Dictionary.com)
<i>portal</i>	A Web site that functions as an entry point to the Internet, as by providing useful content and linking to various sites and features on the World Wide Web. (Dictionary.com)
<i>stream</i>	To transmit (data) in real time, especially over the Internet. (Dictionary.com)
<i>strength of interpersonal tie</i>	Combination of amount of time, the emotional intensity, the intimacy, and the reciprocal services which characterize the tie. (Kilduff & Tsai, p32)
<i>wiki</i>	A collaborative website whose content can be edited by anyone who has access to it. (Dictionary.com)

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