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Improved distance learning environment for Marine Forces Reserve

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THESIS

IMPROVED DISTANCE LEARNING ENVIRONMENT FOR MARINE FORCES RESERVE

by

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September 2016

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IMPROVED DISTANCE LEARNING ENVIRONMENT FOR MARINE FORCES RESERVE

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MarineNet offers distance learning (DL) training and education (T&E) opportunities to all Marines. For active duty Marines, government-provided desktops and laptops (GPDLs) typically support DL T&E or learning resource centers (LRCs) located inside many military installations. In contrast, Marine Forces Reserve (MFR) personnel have a unique challenge: most MFR units are located in home training centers (HTCs) away from military installations. Consequently, reserve Marines do not have GPDLs or LRCs to access DL T&E. The current alternative is for MFR personnel to use personal devices outside of the Nonsecure Internet Protocol Router Network (NIPRNET). This alternative assumes MFR personnel will purchase or already have their own devices. In addition, devices outside of the NIPRNET tend to experience compatibility issues when accessing some MarineNet courseware. This research tested equipment, software, and virtual machine (VM) architectures to find a technologically efficient alternative to GPDLs and LRCs that can support the unique needs of MFR. The emphasis is on researching mature technologies and leveraging free Internet options currently available in the United States. An efficient alternative is proposed to provide reserve personnel with a device to access the Internet, offering free Wi-Fi at the HTCs, and deploying VMs based on the VMware architecture.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADL	advanced distributed learning
CAC	common access card
CB	community broadband
CDE	content delivery engine
CDET	College of Distance Education and Training
CPU	central processing unit
DL	distance learning
DLC	distance learning center
DLNOC	distance learning network operations center
DOD	Department of Defense
DON	Department of the Navy
EDCOM	Education Command
FLC	functional learning center
FOUO	for official use only
GAO	Government Accountability Office
GCSS	Global Combat Support System
GPDLs	government-provided desktops and laptops
HD	hard drive
HTC	home training center
MIE	Microsoft Internet Explorer
IoTs	Internet of things
IT	information technology
JIE	Joint Information Environment
LMS	learning management system
LOC	lines of code
LOE	lines of effort
MCBul	Marine Corps Bulletin
MCI	Marine Corps Institute

MFR	Marine Forces Reserve
MOs	major objectives
MOS	military occupational specialty
MWN	municipal wireless network
NIPRNET	Nonsecure Internet Protocol Router Network
NMCI	Navy and Marine Corps Intranet
NPS	Naval Postgraduate School
OS	operating system
PC	personal computer
PME	professional military education
RAM	random access memory
RDC	remote desktop connection
RSSI	received signal strength indicator
T&E	training and education
T&R	training and readiness
TECOM	Training and Education Command
USMC	United States Marine Corps
VM	virtual machine
VoIP	voice over Internet protocol
WWW	World Wide Web

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I. INTRODUCTION

A. BACKGROUND

Marine Forces Reserve (MFR) units are vital to the mission of the United States Marine Corps (USMC) because they offer the flexibility to increase the number of battle-ready troops at any point in time. Marine reservists normally hold primary occupations outside of the USMC and are part of Home Training Centers (HTCs) throughout the United States. The geographical distribution, diverse professional backgrounds, and unique capabilities of MFR personnel make them a force multiplier for the USMC and the Department of Defense (DOD). A major disadvantage for reserve Marines as compared to their active-duty counterparts is less access to support infrastructure. One primary example of this is that most major military installations house a Learning Resource Center (LRC), where users can access free training courses and other technical services. LRCs also provide access to digital pre-deployment training programs, military occupational specialty (MOS) courses, unit & annual required training as well as access to Marine-On-Line, MyPay, and other job-related websites. This research explores the reserve Marines' lack of access to College of Distance Education & Training (CDET) courseware and develops options to overcome the lack of LRC support infrastructure at HTCs.

B. PROBLEM STATEMENT

Reserve Marines have minimal access to distance learning (DL) opportunities from CDET courseware. A substantial number of MFR personnel lack the necessary online access to successfully complete required professional military education (PME), annual required training, and to take advantage of other CDET eLearning opportunities. Reserve Marines may be unable to access CDET courseware due to web browser incompatibility with existing and new courseware as well as a lack of minimum hardware requirements by end users. LRCs or other government-provided desktops and laptops (GPDLs) are not readily available to most MFR personnel because their units are widely dispersed across the United States. As shown in Appendix C, MFR units are located

throughout the United States, primarily in company and platoon-size units, and typically away from major military installations. CDET courseware available through a DL platform is critical to the overall capability of MFR manpower and its mission performance. The DL model used by LRCs for the active duty component is not technologically efficient for the unique needs of the MFR community. A more versatile and flexible DL alternative is needed to support the training and education (T&E) requirements of MFR Marines.

C. PURPOSE

The purpose of this research is to provide MFR personnel with a technologically efficient DL alternative to access CDET courseware. This research will evaluate current education delivery systems as well as DL technologies that would allow MFR personnel to access T&E modules provided by CDET. This research will include provisions to maintain efficient accessibility to courseware and DOD cyber security standards. For instance, the use of For Official Use Only (FOUO) and limited distribution course materials require strict accountability and authentication for access and course completion.

Finding an optimal conduit for CDET's DL courseware will allow MFR personnel to access a wealth of DL and eLearning opportunities from CDET. Completing mandatory PME as well as courseware that will enhance their professional and personal careers is essential for unit readiness. In addition, finding a more technologically efficient DL alternative can negate the need for the inefficient option of outsourcing LRCs to MFR locations throughout the United States.

D. RESEARCH QUESTION

The primary research question is as follows:

- What is a technologically efficient alternative for MFR personnel to access MarineNet DL courseware throughout the United States?

E. POTENTIAL BENEFITS

The benefit of this research will be the increased accessibility of CDET's courseware to MFR personnel throughout the United States. As depicted in Figure 1, accessibility is one of the current issues affecting MFR DL opportunities for several reasons later discussed in this thesis. Ultimately, giving reserve personnel additional accessibility increases the effectiveness of USMC DL education goals.

In addition, efficiencies are possible from current methods of DL delivery when considering LRCs that require real estate, equipment, and personnel. Decreasing the footprint required to set up LRCs inside military installations eases the burden of competing for limited facilities. Identifying a more versatile and flexible DL alternative to support the T&E requirements of MFR Marines will therefore increase MFR's combat readiness.

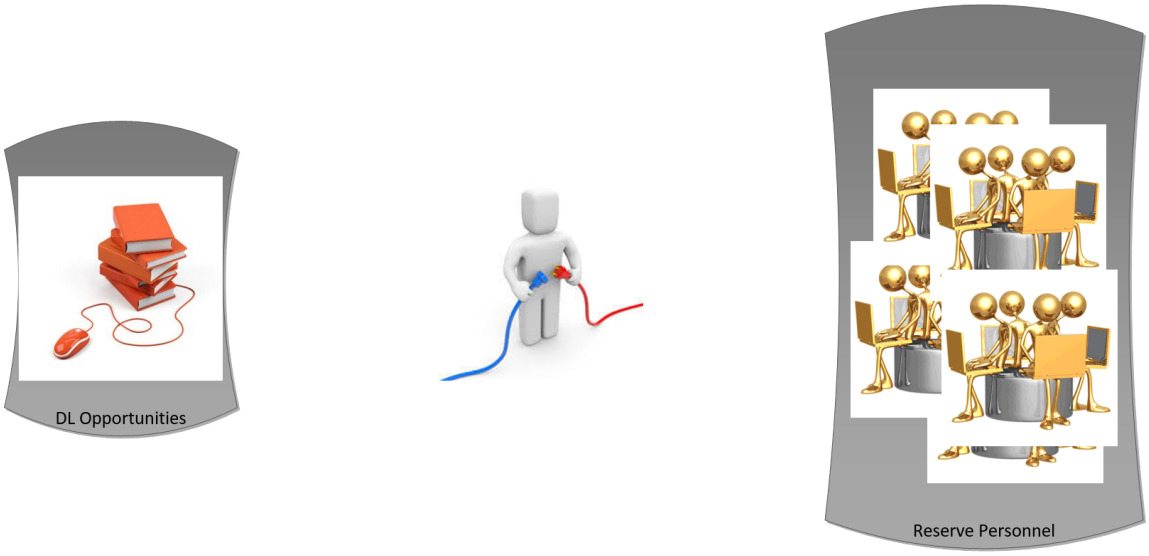


Figure 1. Connecting Distance Education Opportunities to Reservists.

F. SCOPE

The scope of this research involves exploring technologies in DL to present a possible solution for MFR DL accessibility difficulties. Several DL information technologies currently available in the market can facilitate the communications link

between MFR personnel around the world and DOD T&E opportunities. Research areas include DL methodology, online delivery approaches, courseware development, and virtual machines, as the means of linking courseware and end users.

G. THESIS OVERVIEW

Chapter II explores current issues with MFR personnel accessing Marine Corps DL opportunities. This chapter will also cover general information and key technologies about the DOD and industry approaches to DL. Chapter II also describes those key technologies that become the building blocks for an alternative system to the current MFR approach to DL.

Chapter III covers a technical analysis of the USMC approach to DL. This analysis includes an overview of the USMC DL organizational structure and information technology (IT) architecture. In addition, this chapter explains the current DL model as suitable more for the active duty component than the reserves at MFR.

Chapter IV describes the variables used to select software and hardware for testing. These variables guided the type of equipment tested. This chapter explains equipment testing and the results of those tests. Graphs and tables describe test results.

Chapter V describes the best alternative based on test results from Chapter IV. This chapter contains a summary of the tests conducted and the lessons learned from this research. This chapter also contains topics for future exploration that emanated from this research.

II. LITERATURE REVIEW

A. OVERVIEW

At major Marine Corps military installations, LRCs provide the conduit for DL education and CDET courseware to active duty Marines (MarineNet, 2016a). In contrast, due to MFR units' geographical locations, Marine reservists do not have viable access to LRCs. MFR personnel also face other unique challenges. They must balance their investment of time and effort between their civilian responsibilities and those of a reserve Marine. It is essential for reserve Marines to have a flexible DL model that provides them T&E opportunities similar to their active duty counterparts. According to the Naval Postgraduate School (NPS) Naval Research Program website (2015):

> Standard practice for courseware development in the CDET is to design courses to the Navy and Marine Corps Intranet (NMCI) baseline; currently Internet Explorer 10. The practice of designing electronic courseware to a specific browser baseline implies certain limitations and creates conditions where the courseware will become unsupportable as technology advances. An identified problem within the MarineNet Learning Management System (LMS) is the incompatibility of several courseware products with the top three most popular web browsers (Chrome, Firefox, and Safari) as well as with the current versions of Internet Explorer. A recognized goal of electronic courseware development is to design courses that are fully functional on any and all available operating systems and commercial browsers. As a way to mitigate CDET's courseware accessibility issues, virtualization is seen as a method. (p. 1)

Virtualization is one approach this research will explore from among emerging technologies. Virtualization can include categories such as one-alone, one-to-one, one-to-many, or many-to-many, depending on the complexity of the information transmitted and the interaction of the students with the system (Palloff & Pratt, 2003). According to Veletsianos (2010), emerging technologies are "tools, concepts, innovations, and advancements utilized in diverse educational settings (including distant, face-to-face, and hybrid forms of education) to serve a varied education-related purpose" (p. 12). Other emerging technologies such as smart TVs, digital media gadgets, Android & Apple smartphones and tablets, and other high-tech devices, have increased the possibilities for

better synchronous and asynchronous mobile learning systems (Lee, Park, Jeong, & Park, 2015). Emerging technologies and their applications require a balance between synchronous or asynchronous designs according to established organizational DL goals (Moore & Anderson, 2003). Because of these emerging technologies, the development and improvement of better DL solutions must be dynamic and constantly improving to keep up with the increasing need of education demands (Duggal, Ali, & Sharma, 2015).

The search for better DL solutions has become a global phenomenon where new LMS platforms are evolving at a high pace throughout the education environment (Humanante-Ramos, Garcia-Penalvo, & Conde-Gonzalez, 2015). E-learning modules supported by a cloud platform offer some benefits and some challenges according to students' educational needs and accessibility requirements (Duggal, Ali, & Sharma, 2015). Advantages of cloud computing as a platform for DL provides efficient, anywhere access to information, improved educational capability, and better educational collaboration throughout the world (Shakil, Sethi, & Alam, 2015). However, regardless of the DL model, a high probability exists for technical issues that can frustrate students to the point of exhaustion (Palloff & Pratt, 2003).

Centralized or decentralized distribution is another factor involving the effective employment of DL programs (Veletsianos, 2010). The best approach between centralized and decentralized distribution depends on factors such as costs and management control of the organization's data. Both costs and control of an organization's data have direct implications for the IT infrastructure. Even with a decentralized distribution of the IT architecture, the system as a whole will end up highly coupled and interconnected (Dodero et al., 2015).

B. ORGANIZATION GUIDANCE ON TRAINING AND EDUCATION

In the DOD, more than in other large organizations, the concept of "mission first, troops always" prioritizes personnel as the most important asset for mission success. Aside from inherent traits and skills DOD personnel bring to the organization, knowledge acquired through T&E adds another dimension of contribution that makes them a force multiplier. Regardless of how sophisticated the equipment, systems, and processes are,

men and women in the DOD are the facilitators who ensure either success or failure in the organization's mission. Due to the size and complexity of the organization, the DOD needs individuals with the correct skills to operate, manage, and process everything from humanitarian missions to kinetic actions. Referring to cyber education, Commander Michael Bilzor (2015) pointed out that "few questions are more critical to the future of the DOD and the nation than how we can most effectively prepare these men and women for their mission" (p. 14).

The highest levels of the DOD leadership understand that T&E is essential to current and future conflicts. The DOD has mandates and guidelines that provide DOD personnel with opportunities to train and educate. These mandates and guidelines apply regardless of where the member is located around the world. In a report published in 2009, *Strategic Plan for Transforming DOD Training*, the Undersecretary of Defense instructed the DOD to "place a priority on training, education and experimentation capabilities that are forward looking and address integrated operations and irregular warfare" (p. 15). The United States Army, for instance, leverages joint and multinational exercises as well as home station live and virtual training opportunities to cut costs in a fiscally constrained environment (DOD, 2015a).

At the service level, the Marine Corps Reference Publication 3–0B (2015a), *How to Conduct Training*, encourages DL, stating that "based on command guidance and a leader's experience, the leader selects key tasks for Marines to learn and then arranges for enrollment in the appropriate DL courses" (p. 16). The Marine Corps provides T&E guidance via official publications. One of these publications, the *Marine Corps Bulletin (MCBul) 1500*, lists requirements that apply to uniformed members in the USMC to include the reserve component, MFR (USMC, 2015b). Appendix A is the complete list of T&E requirements.

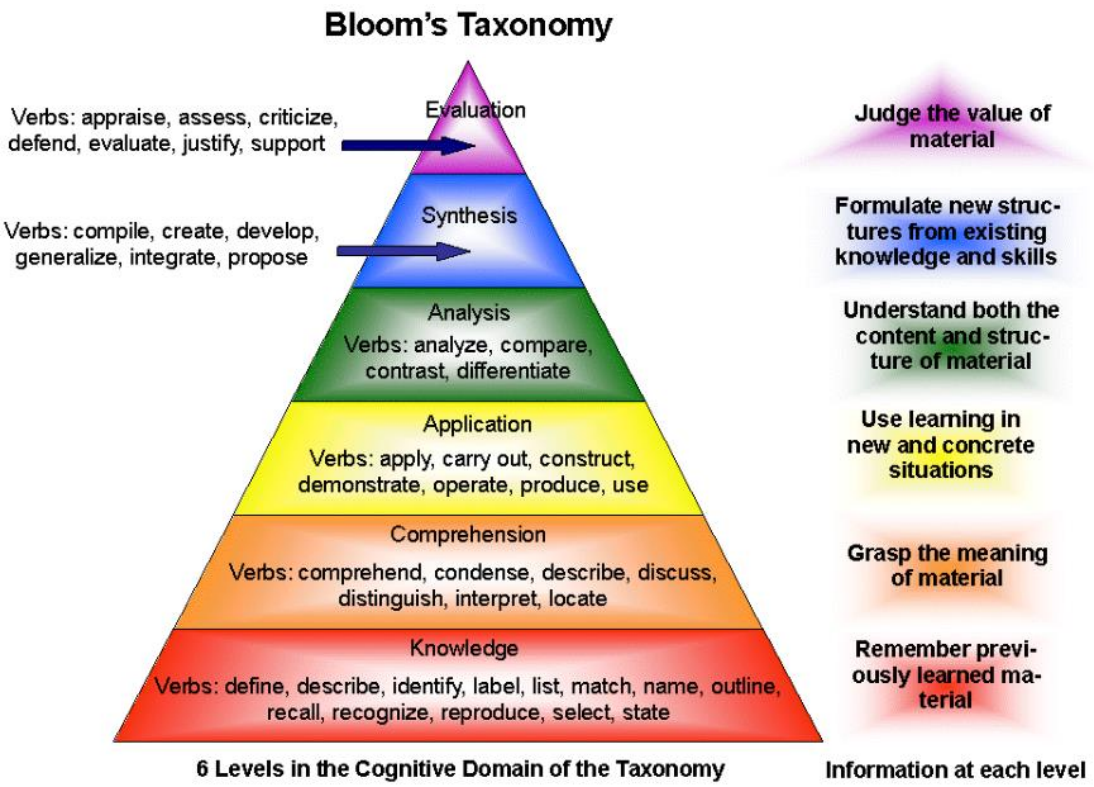
Most of the requirements listed in Appendix A have to be completed annually, based on calendar year or fiscal year timeframes. The USMC waives very few training requirements according to the unit's type, organization, and location. All but one, Annual Cyber Awareness, can be delivered via standard unit training. Several DOD policies

provide additional guidance on unit training such as the Marine Corps Order 1553.3B (USMC, 2011).

The delivery of unit training varies widely in methodology and presentation throughout the USMC. Factors for the variation in methodology or non-standardization of unit training include allocating training time, training location, equipment used, attendees' preexisting knowledge about the topic, and most importantly, the instructor's knowledge about the topic and motivation to teach. The result of non-standardized delivery of T&E is a wide range in the percentage of effectiveness of such T&E. In the best-case scenario, experienced instructors consider factors that affect the transmission, reception, and assimilation of information. Some of these factors include the number of personnel receiving the instruction, the location where instruction occurs, the manner of information delivery, practical applications of the information delivered, and the instructor's attitude towards the course. However, in some cases, large groups of individuals cram into an auditorium to hear a PowerPoint presentation about a topic. This scenario becomes worse when that particular period of instruction extends for a time much longer than the average attention span of regular individuals. In extreme cases, instructors cram slides with as many words as they can fit on them and read them verbatim from slide to slide.

C. BLOOM'S TAXONOMY OF LEARNING

Ensuring personnel is matched with the correct DL course complexity is essential to produce positive results. The mismatch of course complexity and personnel level of understanding of a particular course wastes time and resources for an outcome that is unpredictable at best. Benjamin Bloom's original taxonomy model shown in Figure 2 helps explain this concept by breaking down how well a person knows a subject into six different levels of knowing (Mastascusa, Snyder, & Hoyt, 2011):



Bloom's Taxonomy of learning captures the logical flow of a person's assimilation of information. The Bloom's Taxonomy pyramid describes the process from the time an individual learns a particular subject (bottom) to the time that individual can "judge the value of material" (Mastascusa, Snyder, & Hoyt, 2011).

Figure 2. Bloom's Taxonomy Model. Source: Stowe (2015).

Beginning with "knowledge" as the starting point of human cognition, the pyramid increases in complexity and understanding until a person reaches the point where he or she has "the ability to make judgment" (Mastascusa et al., 2011). Individuals have to start at knowledge, bottom of the pyramid, and move up to the evaluation level, on top of the pyramid (Mastascusa et al., 2011). Skipping levels does not allow individuals to build enough cognition to move to the next level (Mastascusa et al., 2011). The ability to evaluate and judge the value of material learned is not possible by skipping levels. It comes after knowledge is comprehended, applied, analyzed, synthesized, and evaluated (Mastascusa et al., 2011). Applying Bloom's Taxonomy Model, in USMC DL opportunities can explain possible misalignments in matching personnel with correct training and readiness (T&R) courses (Thomas, Agila, & Cini, 2015).

Table 1 compares and matches the USMC T&R levels with the learning taxonomy levels of Figure 2 (Thomas et al., 2015). The scope of the courses, from 1000 to 9000 levels, follow a similar sequence to that in the learning taxonomy. On a typical learning path, an individual would start at the 1000 T&R level, or knowledge level, and finish at the 9000 T&R level, or the evaluation level of the pyramid (Thomas et al., 2015). Issues arise when an individual assigned to a USMC T&R level course that does not match his or her level of cognition according to the learning taxonomy (Thomas et al., 2015). The result is an ineffective use of funds and time for the organization. In DL, matching T&R course levels with an individual's level of cognition is essential for an effective use of time and resources (Thomas et al., 2015).

Table 1. Taxonomy Learning Objectives. Source: Thomas et al. (2015).

Bloom's Taxonomy	Description	USMC T&R Level	Description
Knowledge	Information retrieval	**1000 Individual**	Formal School training, core skills
Comprehension	Grasp of meaning and intent of material	**2000 Individual**	OJT, core+ skills
Application	Given a goal and conditions, remembering and applying appropriate concept.	**3000 Team**	Core crew skills
Application	See above.	**4000 Section**	Collective crews
Application	See above.	**5000 Platoon**	Collective sections
Analysis	Detecting and evaluating relationships and their organization in an application.	**6000 Company**	Collective platoons
Analysis	See above.	**7000 Battalion**	Collective companies
Synthesis	Generation of new knowledge structures.	**8000 Regt/BDE/MEU**	Collective battalions
Evaluation	Making judgments about the value of knowledge.	**9000 Joint Task Force**	Collective task forces

D. KEY TECHNOLOGIES

Technology is advancing at a rapid pace and touching every area of human society. Any model that aims to find a technologically efficient alternative for MFR personnel access to DL opportunities needs to include mature technologies rather than emerging technologies. The earlier include technologies that have been on the market for

some time, which already have a market share. The latter include technologies that are in their infancy, which require more testing before they become mature technologies. Additionally, emerging technologies tend to have more risk associated with their research and implementation.

1. Digital Processing Power

Central processing units (CPUs) are an essential part of the "brains" in almost all-modern electronic equipment. From its invention and development, CPUs have increased in capacity and decreased in size. Increased CPU capacity meant increased computer power to process more complex tasks. Original CPUs required considerable amounts of hardware and were very costly to build and maintain. For instance, the first computer mainframes, with CPUs as their main component, occupied entire floors to operate. These mainframes had much slower digital processing power than many cell phones in the market today.

In addition to the high costs of putting the first computer mainframes together, the initial attempts to create hardware that could run simple programs resulted in the creation of massive IT infrastructure, which occupied substantial amounts of physical space and was complicated to maintain. The original mainframe computers could process one batch of instructions at a time. Mainframe operators needed high levels of computer programming knowledge to "instruct" mainframes to perform simple tasks, one at time. Programmers would submit their instruction cards with programming code to the system administrator and wait their turn until the mainframe had processed other programmer's cards. The original mainframes were slow and could only process few instructions at a time.

The aforementioned process meant that using earlier mainframes had the following limitations:

- Cost: Costs to build, operate, and maintain the first mainframes were high.
- Mobility: Computer processing happened only in the mainframe location.
- Operation: Only individuals with high levels of IT education could use the mainframes.

With new technologies, computer mainframes decreased in size, cost, and complexity. With technological advancements in faster, cheaper, and smaller CPUs, personal computers (PCs) became popular. Shown in Figure 3, the IBM 610 Auto-Point Computer built in 1954 was one of the original PCs. Labeled a PC because it served one person or one office. These earlier PCs retained many of the limitations of the original mainframes; in particular, they were stationary systems with limited capabilities.

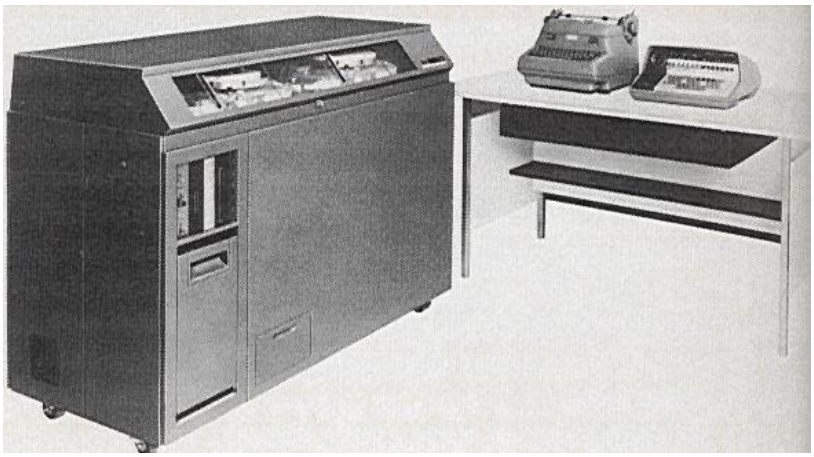


Figure 3. IBM 610 Auto-Point Computer. Source: Cruz (2013).

Fast-forwarding to the year 2016, IT has improved substantially. PCs have become ubiquitous devices in most of the U. S. homes as well as private and public organizations. In addition, newer technologies have concentrated processing power into smaller devices with lower costs. For instance, an individual who does not have access to a PC can utilize cheaper, smaller and more powerful portable devices with similar processing capabilities.

2. Mobile Devices

Because of advancements in technology, devices that can access the Internet are becoming cheaper, smaller and more mobile. The decreased cost of IT has made mobile devices a ubiquitous technology. As digital processing power becomes less expensive, faster, smaller, and portable, its advantages will influence emerging technologies in all areas including DL capabilities. Figure 4 shows the time spent on digital media by adult

users in the United States from 2008 to 2015. These statistics demonstrate the increase in use of mobile devices in relation to the use of desktop PCs and laptops (Dogtiev, 2015). In 2008, adults spent an average of 0.3 hours during the day on mobile devices (Dogtiev, 2015). In 2015, the number of hours adults spent on mobile devices had increased to 2.8 hours or 51 percent of the total time in a day (Dogtiev, 2015). Using these statistics, we can assume that adults in the United States are (1) acquiring mobile devices at an increasing rate, (2) becoming familiar with their usage and capabilities, and (3) connecting more to the Internet. The three aforementioned actions become the driving force to develop new DL models that include mobile devices.

DOD DL programs can take advantage of the proliferation of mobile devices for two reasons. First, the DOD will save time and funding in the development, set up, and maintenance of new DL programs by utilizing devices that are commonplace in the general population. Second, by leveraging a technology commonly used by the public, the DOD will save time and resources on training personnel on how to use them. The Advance Distributed Learning (ADL) is a DOD initiative that conducts research on learning with technology. ADL has done extensive research in the area of mobile device learning. The two predominant factors that are most desirable in mobile device learning, according to ADL, are screen size and touchscreen features (Berking, Birtwhistle, Gallagher, Haag, 2013). Figure 5 shows survey results that corroborate these preferences. Modern tablets and smartphones have both better screen clarity and touchscreens (Berking et al., 2013).

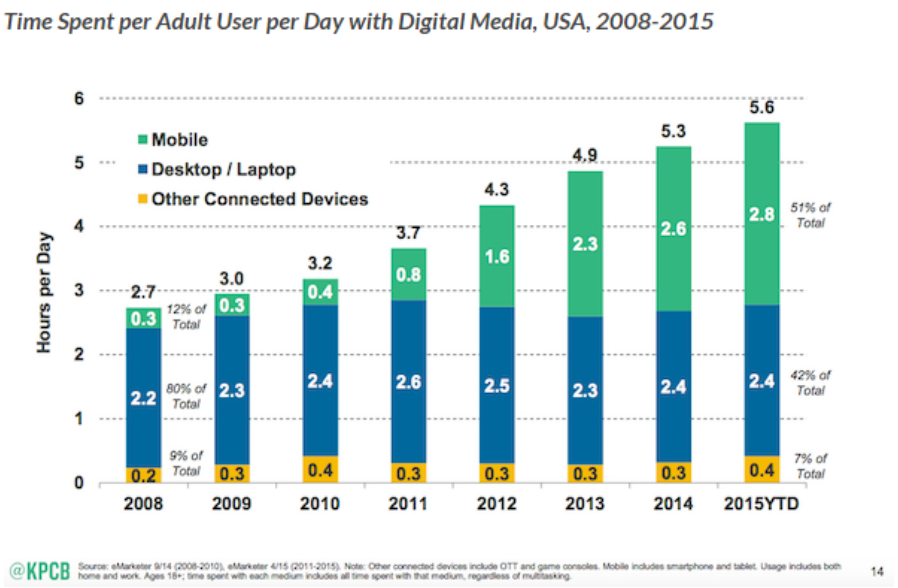


Figure 4. Number of Hours Spent by Adults with Digital Media. Source: Dogtiev (2015).

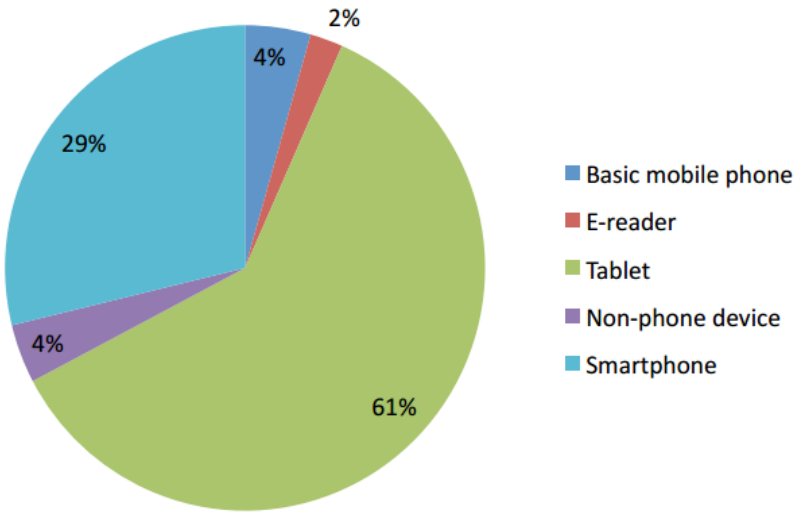


Figure 5. Mobile Devices Most Often Used for Learning. Source: Berking et al. (2013).

3. Internet

Internet access is essential to any DL model. Internet is the backbone that links end users with servers that hold courseware. This is particularly important when

considering MFR personnel and their geo-location around the United States. Today, the Internet is a mature technology that continues to link more people and devices.

a. Origins

Communication has been essential to human development since the beginning of human civilization. In modern times, digital communications have contributed exponentially to the development of new technologies that touch every aspect of human interaction. The creation of the Internet is a major contributing factor to the way individuals and organizations communicate today. The Internet begun with a limited scope: to provide military research communications. Since its creation, the number of nodes, distance between nodes, and communication capabilities of what we now consider the Internet has grown exponentially. The Internet has grown from being the communications bridge of a few nodes to being the link that connects billions of nodes. Today, the Internet is the foundation that links individuals, processes, organizations, services, and communities around the world. In the future, the Internet of Things (IoTs) promises to link billions of devices. The IoTs will link devices such as planes, cars, and blenders, as well as information systems such as industrial processes and military organizations.

b. Ubiquitous Internet

Considering how ubiquitous the Internet currently is today, it is important to reflect on its capabilities when developing DL solutions. In particular, DL solutions need to consider the advantages that the Internet has contributed to mobile device utilization around the world need. Mobile devices have benefited from the Internet in that they provide common users the ability to stay connected at any time and at any place. Mobile devices' portability, connectivity, and ease of use have contributed to the increased number of hours adults spend using them, as previously shown in Figure 4 (Dogtiev, 2015). In addition, as shown in Figure 6, mobile devices were used 75.1 percent of the time to access the Internet and 4 out of 5 consumers use them to shop (Stevens, 2016). These statistics demonstrate how common the Internet has become today.

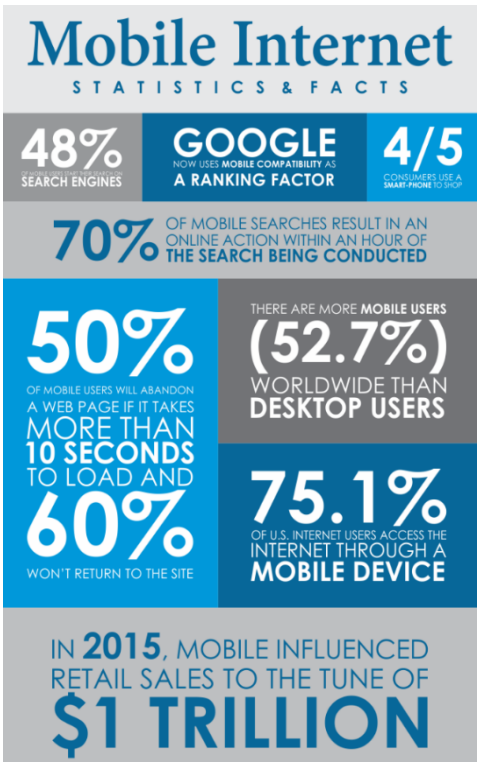


Figure 6. Internet Statistics and Facts for 2016. Source: (Stevens, 2016).

c. From Government to Municipalities

The U. S. Department of Education is also pursuing ways to leverage the Internet and make it ubiquitous in the United States. With ConnectED, a strategic initiative to connect 99 percent of American students, President Obama is seeking to increase digital learning around the country (Keengwe, 2015). Obama's plan is to bring next generation broadband as well as high-speed wireless to all students in America within the next five years (Keengwe, 2015). The U.S. Government, through ConnectED, has an ambitious goal, but it is not the only public or private organization with plans for large-scale Internet connectivity. Municipal Wireless Network (MWN) and Community Broadband (CB) are two emerging concepts that are being considered, tested, and in some cases fully implemented within the United States. These two concepts are similar to ConnectED in that they aim to provide free Internet access to a large number of individuals. In addition, both MWN and CB aim to provide Internet access to the public, not only students, in public buildings, local parks, and in some cases, entire cities.

MWN is still in its infancy, but the concept of free Internet access to the public is gaining traction around the United States for two reasons. First, offering free wireless Internet access is beneficial for the local economy. It directly helps the poor by giving them access to the World Wide Web (WWW) and all the benefits that come with it. Benefits of having access to the WWW include online banking, free voice over Internet protocol (VoIP) communications, social networking, email, online shopping, and access to vast amounts of information. Many of these benefits translate directly into cost savings for end users. For instance, VoIP would allow a family to have telephone access for around $1.66 a month (http://www.magicjack.com/) compared to $42 with regular land line access (Schwandt & Kroger, 2016a). Second, when MWN offers free wireless access, it opens up educational opportunities that would otherwise be unavailable for the individuals that do not currently have Internet access. MWN would supplement an existing infrastructure that already provides Internet access to about 85 percent of Americans older than 18 (Springer, 2013). An example of a MWN that is currently operational is the LinkNYC free wireless program. LinkNYC is available in Manhattan, New York, NY, as shown in Figure 7 (CityBridge, 2016). In addition to offering free gigabyte Wi-Fi, the kiosks offer a touchscreen tablet for Internet access, the capability to make free phone calls anywhere in the United States, and USB ports for charging electronic devices, as shown in Figure 8 (CityBridge, 2016). In the United States, more than 57 cities offer free wireless access similar to LinkNYC (Springer, 2013). Free wireless access will be the norm and not the exception as technology keeps improving. More and more local governments will recognize the benefits of free wireless access for the public. Leveraging these services as part of a DOD DL architecture is technologically efficient and adds mobility to end user access.

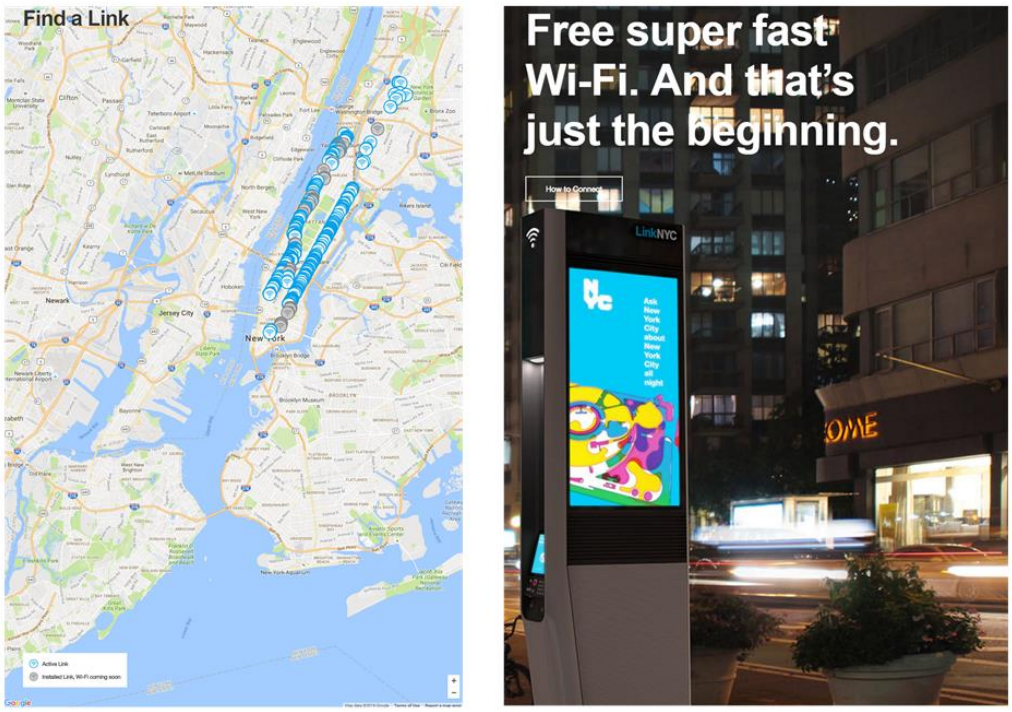


Figure 7. Finding LinkNYC Free Wireless Internet. Source: CityBridge (2016).

Figure 8. LinkNYC Free Wireless Internet Kiosks Features. Source: CityBridge (2016).

4. Virtualization

The concept of virtualization has been around for decades. As the world continues to be interconnected and cloud services become more prevalent, the concept of virtualization keeps expanding to fulfill more needs. In education, for instance, virtualization keeps expanding to every aspect of teaching and learning, inside and outside of the classroom. In DL, virtualization offers many ways in which classroom education can reach individuals regardless of their geo-location.

a. Desktops and Laptops

With the increase in processing power, the explosion of mobile device use, and the extensive availability of the Internet, virtualization is gaining acceptance as a means to deliver DL opportunities. Many institutions see virtualization as a way to reduce server and computer farms that are inefficient and difficult to maintain. Virtualization takes advantage of emerging information technologies such as cloud computing. Cloud Computing is an appealing model for organizations that need to manage large amounts of processes and distributed applications; with a scalable approach that can adjust to changes dynamically (Mahmood, 2016). Benefits of cloud computing for the DOD include decreased capital investments, lessening management requirements, improve scalability and availability of resources anywhere, and the ability to share resources (Mahmood, 2016).

Providing DL to hundreds of thousands of personnel around the world, as in the case of MFR, fit the cloud-computing domain. Server virtualization is the foundation required to provide the considerable scale of virtual machines (VMs) needed by large organizations. Server virtualization is an influential ecological solution to massive deployment of VMs utilizing cloud computing (Moritoh & Imai, 2015). Server virtualization can be better understood by first understanding the basic components of a typical PC. Figure 9 shows the basic components of a basic PC including the CPU, random access memory (RAM), hard drive (HD), and network card. On a normal setup, the aforementioned components, along with others, are put together on a computer motherboard and connected to input/output devices such as a monitor and keyboard, to

form a desktop computer. Laptop computers share similar components but add mobility to the user. If additional desktop computers are necessary, the process repeats for the number of assets required. In this scenario, the cost of buying the parts, assembling, shipping, setting them up, maintaining, upgrading, and recycling them is multiplied by as many times as desktop computers are needed. If we needed 100,000 computers for instance, we would multiply that number by the average price of a desktop computer, $379 (Schwandt & Kroger, 2016b). The cost would add up to about 37.9 million dollars. This does not consider other ancillary costs such as shipping, setup, maintenance, power consumption and replacement cost. The average number of years before desktop PCs need replacement is 4.45 years (Schwandt & Kroger, 2016c). Lastly, these desktop computers would need to occupy physical space to operate as intended, which substantially adds to the overall costs.

Figure 9. Basic Components of a PC.

On the other hand, virtualized environments have several advantages over desktop PCs and laptops. Server virtualization share all components listed in Figure 10 with the VMs located within the server. This model creates efficiencies in numerous areas. First, it saves funding by creating a virtual environment that costs a fraction of what a physical machine would cost. Second, IT system administrators have more control over every aspect of the virtual environment, to include the operating system (OS), amount of RAM, HD space, and software within the OS. Third, VMs scaled up or down depending on the needs of the organization. These adjustments can be done in a fraction of the time and without the cost it would take to procure, ship, and install a physical machine, making the use of VMs an efficient alternative to physical machines. As described by VMware (2006),

Virtualization is an abstraction layer that decouples the physical hardware from the operating system to deliver greater IT resource utilization and flexibility. Virtualization allows multiple virtual machines, with heterogeneous operating systems (e.g., Windows 2003 Server and Linux) and applications to run in isolation, side-by-side on the same physical machine. (p. 3)

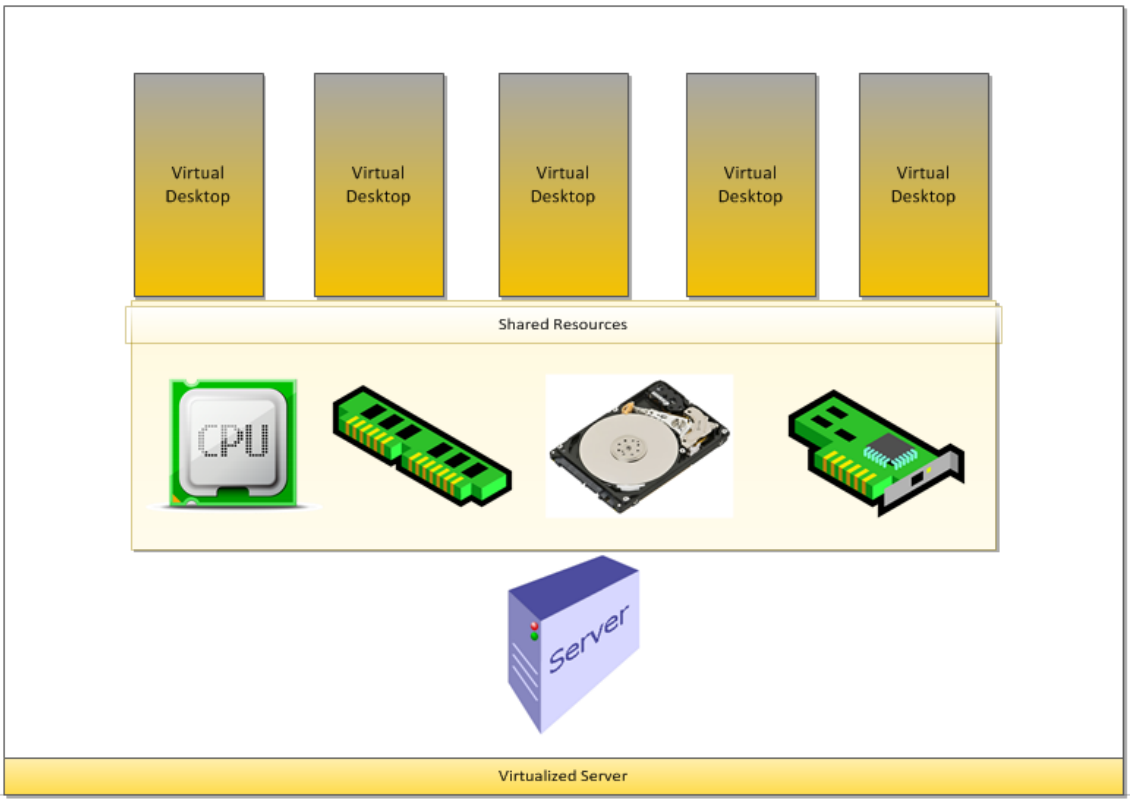


Figure 10. Virtualized Environment Model.

b. Simple Virtualization Model

Figure 11 shows an example of how virtualized environments apply to DL. Taking advantage of virtualized environments that simulate typical desktop or laptop computers has several advantages. First, it expands the platforms from which users can access DL opportunities. This is essential to in the MFR environment where DL users employ a wide range of devices. These devices include iPads, Microsoft Windows computers, Mac computers, iPhones, Android tablets and Android mobile phones. The types of devices and OS platforms used will only increase as technology creates new

capabilities. Second, the VM can be set up to run a wide range of OSs depending on the server with which the system will communicate. This capability offers more opportunities and flexibility to access servers hosting DL courseware that require other OS platforms. Third, the VM server can create and replicate VMs that have the needed software and hardware requirements to run DL courseware. Furthermore, when requirements change at the LMS servers, updating and disseminating changes throughout the VMs is substantially less complex than doing the same updates on physical machines. Lastly, updates or changes to the VMs or the servers running DL courseware are transparent to the end user. System administrators can update software or modify the virtual environment from their consoles. By managing the VMs remotely, network administrators no longer require physical or network access to end user devices. The transparency of updates for the end user adds more flexibility to the types of devices that can be used to access DL courseware. Figure 11 shows that in theory, users can employ a variety of devices with different hardware and software configurations, sizes, manufacturers, and OSs to access DL courseware. In this model, the crucial component between the end user and MarineNet courseware is the VM. The VM provides the communications link and necessary software that allows all MarineNet courseware to work on most desktop, laptops, and mobile devices. The requirements for this model to work are as follows:

1. Virtual environment. The VM environment needs to have all software and hardware required by the LMS.

2. VM access. The VM needs to have a client, remote desktop connection (RDC), or web browser accessibility options for devices to connect.

3. Access device. The device accessing the VM needs to have the VM client installed, RDC capabilities, or a web browser compatible with the VM requirements.

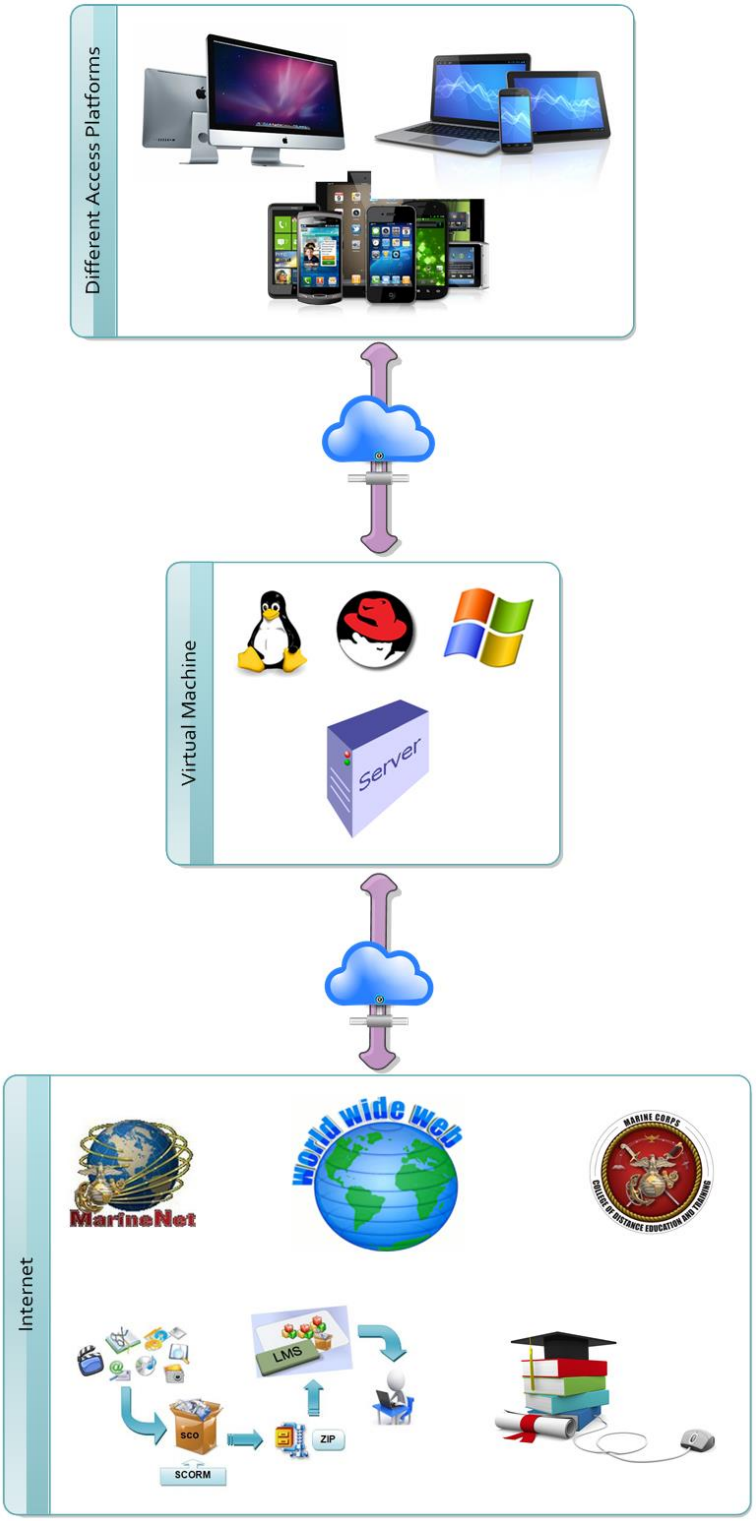


Figure 11. Simple Virtualization Model.

c. Accessing VMs

In a virtualized environment, devices accessing the VM need only a compatible client software, a RDC, or a typical Internet web browser, depending on the VM infrastructure. In addition to proprietary VM client software, regular web browsers such as Internet Explorer, Mozilla, and Google Chrome can access the VM. In this case, a user only needs a device that can run a compatible web browser to access the VM. By increasing accessibility options, VMs work with several platforms to include desktops, laptops, mobile phones, and tablets.

For instance, VMware offers proprietary software to access VMware VMs from Mac, Linux, iOS, Windows, and Android platforms. Figure 12 is an example of how VMware VMs work via either their proprietary software or a typical Internet web browser. Having the flexibility to access VMs via Internet web browsers implies compatibility with almost any device, stationary or mobile, that can run an Internet web browser. When considering the vast use of the Internet illustrated in Figures 4 and 5, VMs open a window of opportunity to reach a large portion of the population who already has access to mobile devices.

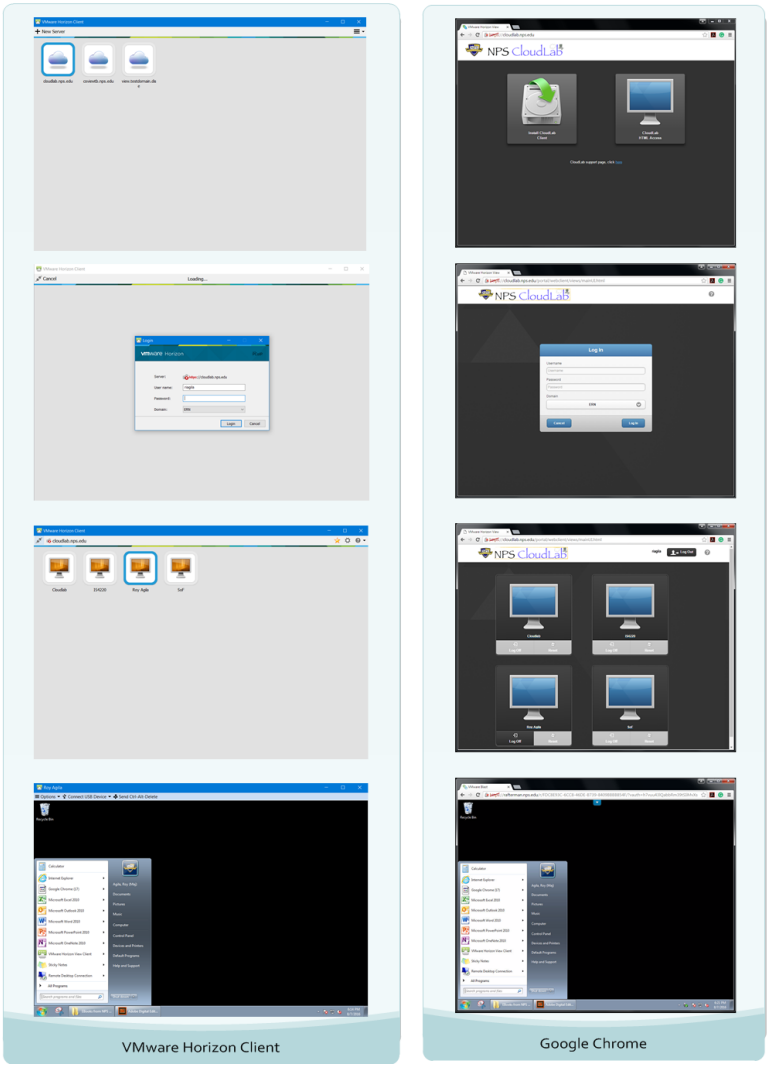


Figure 12. VMware Access through Client Software and Typical Internet Web Browser.

5. Common Access Card (CAC) Readers

Members of the DOD use CACs to authenticate them when accessing many FOUO DOD sites. CACs are part of a digital system to encrypt communications and authenticate that the user of the system is who he or she claims to be. This system is based on a two-factor authentication security process that includes something-you-have (CAC) and something-you-know (the CAC pin number) to grant individuals access to FOUO sites. These two components provide added security because CACs and their pin numbers are verified and issued during face-to-face visits to the local Real-Time

Automated Personnel Identification System. CAC readers are the bridge between CACs and the device accessing the Internet. CAC readers come in many forms and from different manufacturers, and each model has different characteristics and uses. All Nonsecure Internet Protocol Router Network (NIPRNET) stationary terminals have a CAC reader as part of the system.

GPDLs either have CAC readers mounted on the device or have external USB CAC readers. For non-DOD devices, such as the ones used outside of DOD networks, external USB CAC readers are the most common. Complications in using CAC readers are more prevalent in devices that do not have standard USB ports. This is the case for many mobile devices such as iPads and Android tablets. Many companies have developed CAC readers to fit the most common mobile devices' connectors. The most common mobile devices' connectors include micro-USB (for Android devices) and lighting connectors (modern iPads). The use of CAC readers in mobile devices is not as straightforward as the use of CAC readers in desktops or laptops. The main reason for this disparity is that mobile devices' hardware limits OS and software capabilities.

III. TECHNICAL ANALYSIS

A. MARINE CORPS DISTANCE LEARNING PROGRAM

In a document titled, *Training and Education Command (TECOM) Strategic Plan*, dated 1 July 2016, the USMC lays out its lines of efforts (LOE) and major objectives (MOs) for training and educating its force. LOE #2 points toward developing Marines' ability to become better leaders and work at a global level. One of the two MOs of LOE #2 is to "provide the benefit of a distance education that is on par with the quality of resident courses" (USMC, 2016, p. 11). The intent is to offer DL T&E opportunities comparable to the learning achieved in resident courses. To that end, Critical Task 2.1.4 of the same document specifies that TECOM seeks to "make training and education accessible to all Marines" (USMC, 2016, p. D-25). The lead organization for this effort in the USMC is Education Command (EDCOM) (USMC, 2016). Figure 13 shows TCOM's organizational chart.

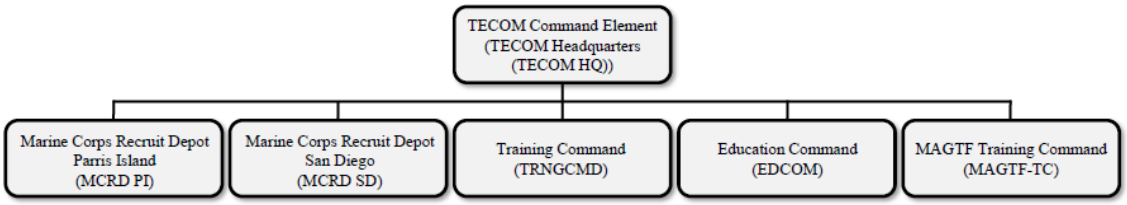


Figure 13. TECOM Organization. Source: USMC (2016).

Within EDCOM, the CDET oversees MarineNet, which provides DL capabilities to the USMC. MarineNet provides end users the ability to access DL at a global scale, and its goals encompass three main areas that include "(1) content development, (2) distribution infrastructure, and (3) management infrastructure" (MITRE Corporation, 2000, p. 1). To accomplish its goals, MarineNet uses a LMS with similar capabilities to typical LMSs found in industry. As shown in Figure 14, in an earlier MarineNet architecture model, the LMS was present at the three major functional areas: Distance Learning Center (DLC), Functional Learning Center (FLC), and area learning center (MITRE Corporation, 2000). The NIPRNET provides access to the Internet and links

these three functional areas. In this architecture, users outside of NIPRNET had additional access restrictions that prevented them from fully accessing the FLC or DLC. In addition, duplication of efforts existed between the DLC and the FLC, as both built, deployed, and maintained courseware for the USMC. This architecture has changed since 2000, improving MarineNet's efficiency and reducing duplication of efforts. Before 2015, the Marine Corps Institute (MCI) managed the DLC. The DLC was similar in scope to CDET. According to MARADMIN 209/15, "This [architecture] caused inefficiencies, redundancy, and a disjointed training and education continuum for the Marine Corps" (USMC, 2014, para. 1). MCI eventually consolidated under CDET (USMC, 2014).

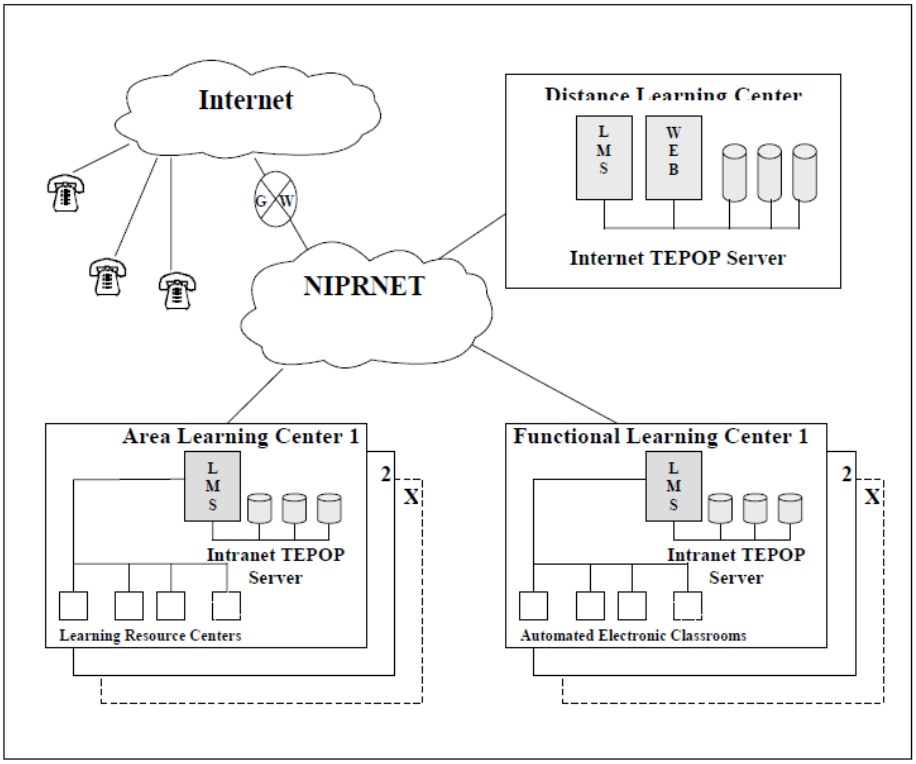


Figure 14. Earlier MarineNet Architecture. Source: MITRE Corporation (2000).

Figure 15 shows a more updated MarineNet architecture. This model has fewer redundancies and provides a more direct access between end users accessing the network and courseware resident in MarineNet. The DL Network Operations Center (DLNOC) is

the current organization that manages the MarineNet courseware, LMS, and SCORM systems. The Content Delivery Engines (CDEs) provide MarineNet courseware to authenticated users and are located at the DLNOC. To improve latency, CDEs are set up in other locations inside major USMC installations around the United States (CDET, 2012).

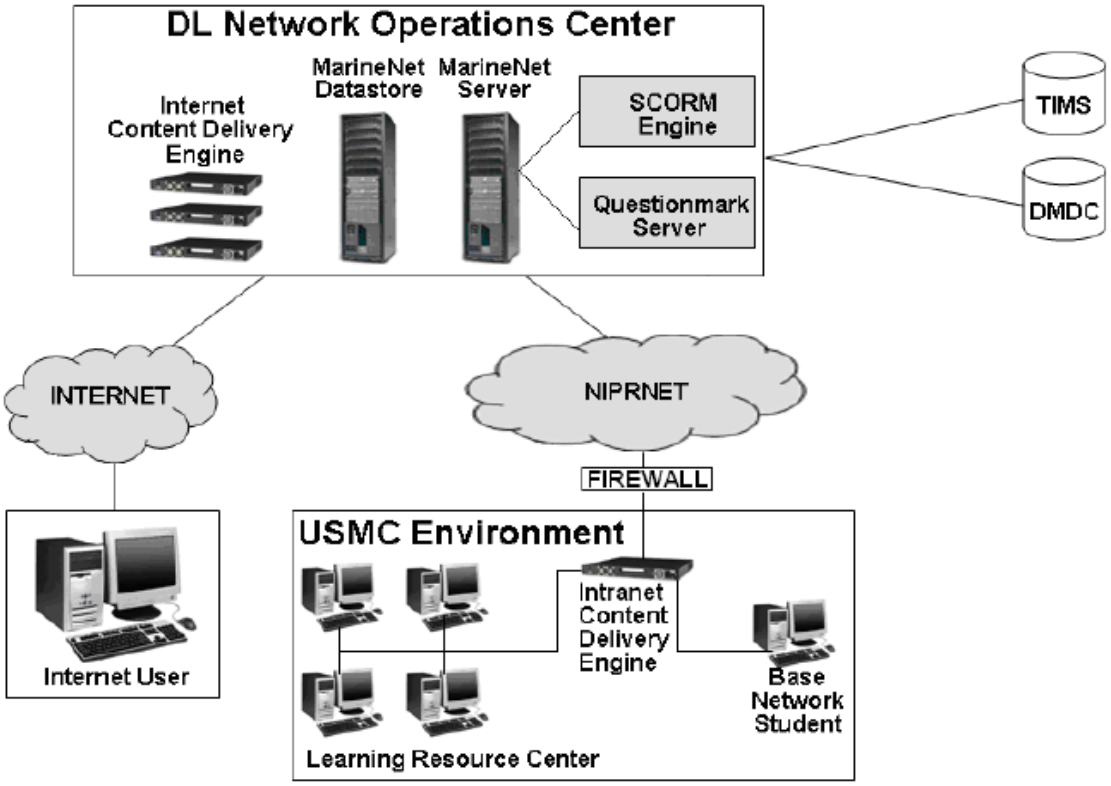


Figure 15. MarineNet Architecture. Source: CDET (2012).

MarineNet's planned logical network and physical infrastructure are shown in Figure 16 and Figure 17, respectively. From the end users' perspective, access to MarineNet occurs via GPDLs on the .mil domain or through non-DOD devices connected to the Internet (Naval Air Systems Command, 2013). From those access points, data filters through different firewalls before it reaches the intended destination inside the MarineNet network (Naval Air Systems Command, 2013). Both of these models incorporate emerging technologies in virtualization, firewalls, encryption, storage area

networks, domain controllers, and backup (Naval Air Systems Command, 2013). Examining the logical architecture, this network provides the correct balance between security and accessibility, filtering most of the network traffic coming from non-NIPRNET devices through the DMZ (Naval Air Systems Command, 2013).

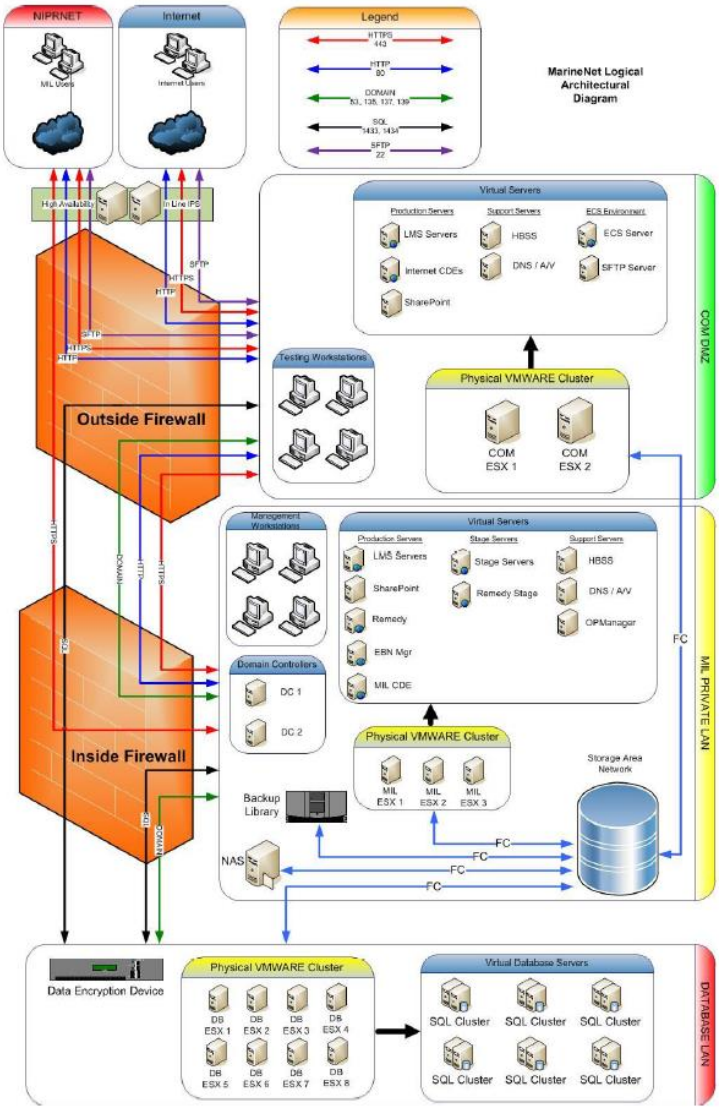


Figure 16. MarineNet Logical Network. Source: Naval Air Systems Command (2013).

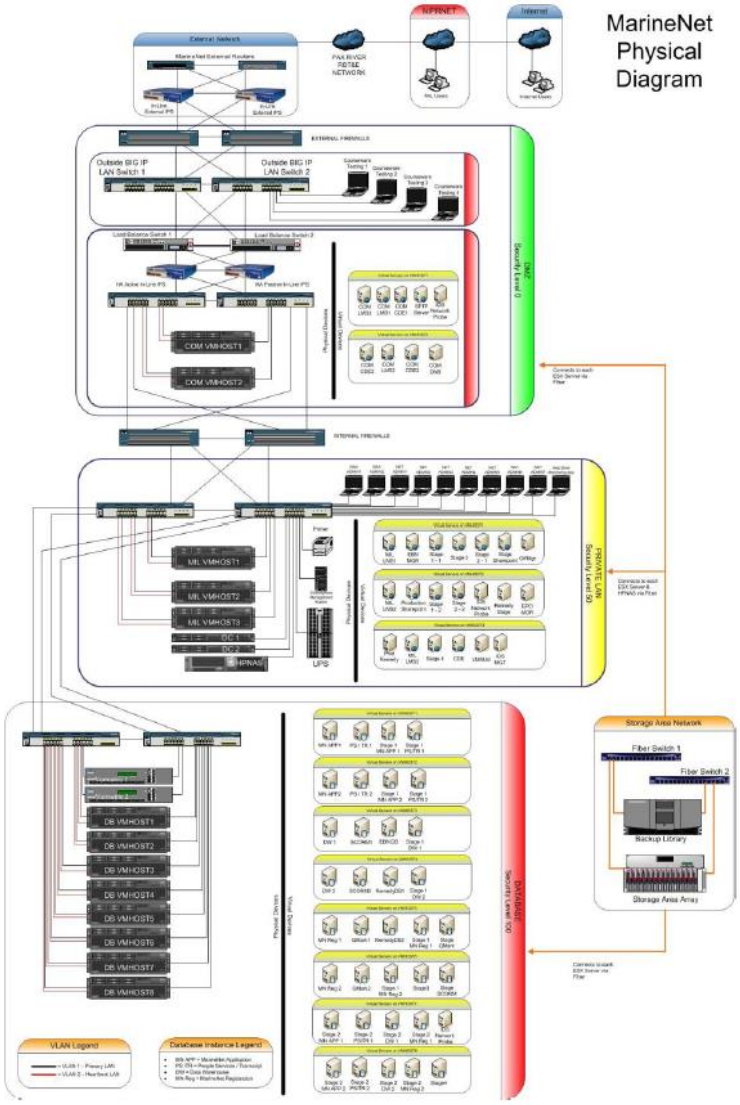


Figure 17. MarineNet Physical Network. Source: Naval Air Systems Command (2013).

B. MARINENET COURSEWARE

MarineNet servers are accessible through a regular Internet connection. Once a user authenticates and logs in, a page with access to all MarineNet resources is available. Resources available include CDET courseware as well as links to courseware from other organizations. Courseware accessible through the MarineNet webpage varies in scope from mandatory training courseware to optional courses that USMC personnel can register for to enhance their knowledge in areas other than their MOSs. Some examples

of MarineNet courses are Operating the MK-Series Vehicle Off-Road, Amphibious Operations, Dari Language, and Microsoft Office 2010: Beginning Word (MarineNet, 2016c).

The wide variety of course topics offered and the different periods when they deployed has increased standardization complexity. For instance, courses about repairing engines may require additional visual aids, such as how-to videos, as opposed to the theory and nature of war courses. In addition, many courses developed and deployed several years ago have compatibility issues with modern hardware and software. New features and capabilities are added to courses commensurate with the technology available at the time of their development and deployment. For example, software used in the creation of a particular course is updated, upgraded, or completely replaced as time progresses. Another problem involves the type of web browser employed by the end user to access a particular course. For instance, when an older course developed several years ago, it was compatible with existing web browsers at the time of deployment. Several years later, that same course may no longer be viewable when newer web browser versions developed to accommodate newer technologies in hardware and software. As a result, MarineNet has many courses that no longer work with current web browsers and/or hardware. This condition will continue as technology advances and newer hardware, software, and communication systems come online.

The lack of standardization has increased the software and hardware requirements expected from devices accessing MarineNet courses. To accommodate compatibility with existing courses, MarineNet has a long list of minimum software requirements it expects the device accessing MarineNet to have, as shown in Appendix B. The software requirements found in Appendix B are easier to implement in GPDLs because they are part of the USMC NIPRNET.

Because successful MarineNet courseware access is subject to having the correct hardware and software requirements, accessing CDET's courseware is more complex for users not in close proximity to typical military installations. Appendix C, MFR unit locations, and Appendix D, LRC locations, demonstrates a disadvantage for MFR personnel compared to active duty personnel with ready access to GPDLs and LRCs.

Because of the lack of GPDLs and LRCs, MFR personnel access MarineNet courseware from a wide range of platforms that include personal desktops, laptops, tablets and cellphones. Reserve Marines are responsible for having the correct combination of hardware and software. This is problematic for many reasons. First, there is the possibility that a reserve Marine may not have an acceptable device to access the Internet. This situation does not exempt MFR personnel from completing required annual training, shown in appendix A, or making an effort to improve their MOS through additional MarineNet training. Second, if a reserve Marine has an acceptable device to access MarineNet, incompatibility issues may prevent him or her from successfully accessing some courses. Incompatibility issues can include having the incorrect web browser version a particular course can to work on. Third, the OS may play a part in preventing users from successfully accessing MarineNet courseware. The two most popular OSs currently available are the Mac and Microsoft OSs. The Mac OS has an additional disadvantage over some incompatible Windows platforms: most of the existing MarineNet courseware work in Microsoft Internet Explorer (MIE). The last MIE version supported in the Mac OS was MIE version 5.2 (Microsoft, 2015). As of December 31, 2005, Microsoft no longer supports MIE for Mac OSs (Microsoft, 2015). In many cases, the approach to fill these gaps at the small unit level is to conduct mass training sessions. Conducting training sessions with maximum output in terms of personnel trained rather than emphasizing actual learning is a waste of time and resources. At a minimum, mass training sessions have unpredictable results in terms of actual knowledge assimilated by students.

C. CURRENT MODEL

To provide DL capabilities, MarineNet assumes that the end user has (1) access to an Internet connection (2) access to a device capable of using an Internet connection, (3) the correct combination of hardware and software needed to run courseware at the end user device, (4) a requirement to enroll in MarineNet courses, and (5) permission to access its courseware. A successful enrollment and completion of courseware available in MarineNet needs all five assumptions. Issues arise when end users lack any or all of the

aforementioned assumptions. For many reserve Marines, these assumptions fall short of reality. This research focuses on gaps and solutions for assumptions 1–3. The current MarineNet DL system is more effective for the USMC active component but ineffective for the reserve component.

1. End User

Because of the nature of the MFR mission, end users are located throughout the United States. The majority of MFR personnel muster for training at locations that are away from major military installations. As such, they lack the access to infrastructure similar to NIPRNET terminals and LRCs found at typical military installations. Appendix C shows the location of MFR units in the United States. On average, MFR personnel get together to drill (train) one weekend a month and two weeks a year at their HTCs. Regardless of the lack of resources available for reservists at HTCs, MFR personnel are still required to complete training requirements listed in Appendix A. As shown in Appendix A, very few waivers or exceptions to the annual training requirements exist. This dilemma puts reservists at a disadvantage compared with their active duty counterparts because MFR personnel have training requirements equal to active duty Marine but fewer GPDLs to complete them.

2. Devices

As an organization, the vast majority of MFR personnel has limited access to GPDLs. The Inspector Instructor staff uses the few GPDLs available at HTCs. At the Orlando MFR HTC, for instance, there are around twelve GPDLs for permanent personnel compared to over 250 reservists that train there. This discrepancy in the number of computer terminals and personnel that needs Internet access makes it more problematic for MFR personnel to access DL opportunities. Marines with a desire or requirement to access MarineNet can currently do it in one of three ways: LRCs, GPDLs, or personal devices.

a. LRCs

LRCs are facilities located at major military installations that have an average of thirty computers with ready access to .mil websites including www.MarineNet.usmc.mil. They normally carry other IT equipment as well such as printers and scanners. Appendix D shows LRC locations in the USMC. When comparing the location of LRCs with the location of MFR units of Appendix C, it is evident that LRCs do not offer a GPDLs alternative for MFR personnel. LRCs are not the solution with the current setup and would not be efficient to increase their numbers for several reasons. First, LRCs require physical space that many HTCs do not have. Many HTCs are collocated with other organizations or units that are already competing for physical space at their training centers. Second, LRCs are not a flexible platform that can accommodate MFR dynamics. Physical space and other resources would go unused because reserve personnel mainly train one weekend a month and two weeks a year. Lastly, LRCs are costly to retain when considering the costs associated with setting them up, maintaining them, and covering utility costs. Consequently, LRCs are technologically inefficient to provide MFR personnel access to DL opportunities.

b. GPDLs

HTC's normally have just enough GPDLs to support a small number of permanent personnel assigned as the Inspector Instructor staff. The number of GPDLs is a small fraction of the number of MFR personnel assigned to the HTC. Increasing the number of GPDLs is ineffective because of the lack of physical space and costs associated with buying new NIPRNET seats. In addition, it taxes the NIPRNET network infrastructure without making a substantial dent in the asset shortfall.

D. IT INFRASTRUCTURE CHALLENGES

A successful DL program requires a solid IT infrastructure as well as knowledgeable personnel who can troubleshoot any technical issues that are bound to occur. Hardware and software update constantly, making their upkeep and integration crucial for a good user experience. Figure 18 illustrates driving forces in a DL IT infrastructure. The emphasis of an effective DL program should be the end user. When

end users drive IT requirements, the organization can effectively invest time and resources to develop an effective DL program. A successful DL program is one that does not just expose students to information but requires students to learn the material covered.

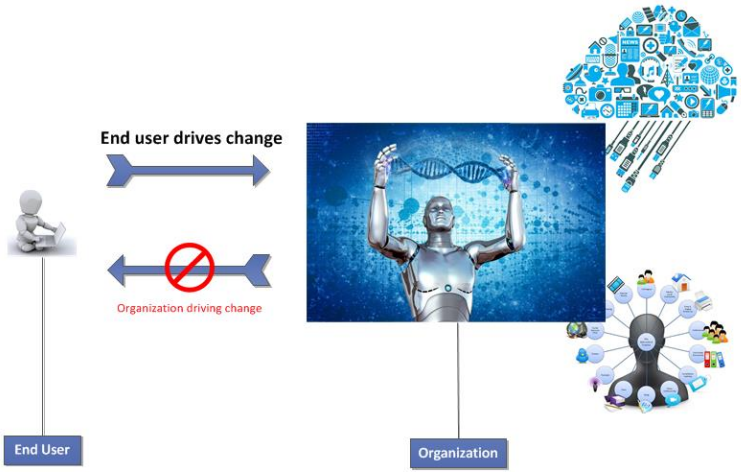


Figure 18. End User Drives Change.

Figure 19 shows statistics on the reasons for the failure to graduate of some Army DL students. Courseware complexity, the information presented during the course, accounts for a small fraction of the reasons for failure to graduate (Straus et al., 2011). Most of the contributors for students failing DL courses included technical issues and a weak DL support (Straus et al., 2011). In an ideal DL program, technical issues and DL support should account for a small percentage of failures, while courseware and its complexity should account for a high percentage of non-graduation. Technical issues and DL support are issues that are more tangible. Courseware and its simplicity or complexity would be harder to manage because it deals with the intangible—the student's ability to comprehend and learn the material.

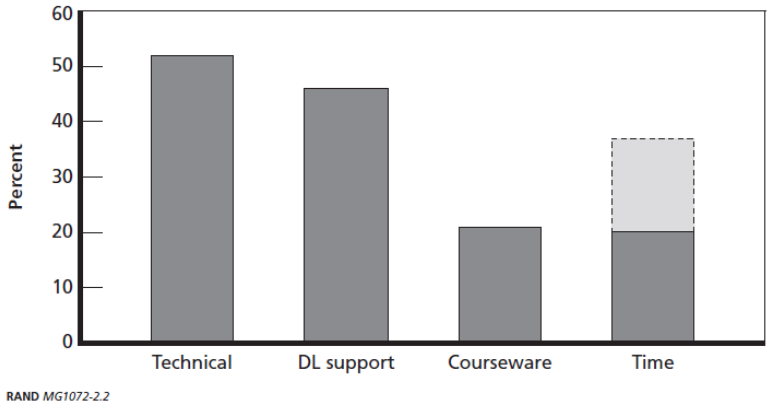


Figure 19. Reasons for Failure to Graduate in Army's DL Courses.
Source: Straus et al. (2011).

DL recipients who experienced technical issues have a tendency to fail courses. In many cases, it is not the information's complexity that pushes students to fail a course but technical issues that the student could not overcome. The Army created a report that, among other research, evaluated the reasons why DL students failed courses (Straus et al., 2011). An Army report called *New Tools and Metrics for Evaluating Army Distributed Learning* by Stratus et al., (2011) states that

> But we do know that about one third of non-graduates with technical issues had trouble getting access to a reliable computer, regardless of whether they started the course or not. Moreover, 22 percent of respondents with technical issues also cited mobilization or deployment as a reason for non-completion. Among students who did not start the courses, 30 percent had problems getting access to an Internet connection. High-speed Internet access was not a problem for students who started but did not complete courses. (p. 26)

Both issues brought up in this Army report—troubles accessing a reliable computer and the user's physical location—are comparable to issues experienced by MFR personnel. A high percentage of MFR personnel do not have access to GPDLs as discussed in the previous chapter. Deployed or mobilized personnel in the Army with limited access to DL courses are comparable to MFR personnel located away from typical military installations.

E. POSSIBLE SOLUTION

The literature review in Chapter II reveals three main building blocks that fill gaps in DL access for MFR personnel. As shown in Figure 20, the building blocks are mobile devices, Internet access, and virtualization. Each of the three has the potential to circumvent existing problems for MFR personnel to access MarineNet.

Figure 20. Building Blocks for DL Access.

1. Mobile Devices

As discussed in the literature review, mobile device usage has grown exponentially in the past decade, and it appears that trend will continue in the future. Any DL solution needs to capitalize on this fact quickly and effectively to reach the existing and growing mobile device audience. MarineNet can take advantage of existing experience of mobile device users to save time and resources.

2. Internet

The Internet has become ubiquitous as advancements in technology make it less costly. Free Wi-Fi is already a reality in many places, providing access to anybody within reach of the signal. Many places where free Wi-Fi is offered include local business such as Starbucks coffee shops and public areas such as public libraries. In addition, other social and political interests are pushing societies and their lawmakers to invest in

providing Internet access to the masses. In the United States, many local municipalities are providing free Wi-Fi. Ultimately, the USMC can take advantage of free Wi-Fi for reserve Marines' Internet access.

3. Virtualization

Based on the literature review and analysis of the As-Is DL model for MFR, the use of VMs and their related infrastructure seems to be the best option. VMs allow end users to access a standardized virtual environment from which to access MarineNet resources. The simple virtualization model shown in Figure 11—from mobile device to VM to MarineNet servers—allows a more efficient way to manage thousands of virtual machines. This model can become particularly efficient when MarineNet or any other DL system offered to MFR personnel upgrades or substantially changes. The upgrade can be instantly disseminated to every VM in the network and still be a transparent process for all users. VMs and their inherent infrastructure fit the need of MFR to reach out to an unlimited number of users. These users can potentially be located anywhere around the world and still have the access and capabilities of personnel using GPDLs.

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IV. EXPERIMENTATION

This research was aimed at finding a technologically efficient alternative for reserve Marines to access MarineNet DL courseware regardless of their geo-location. The purpose of this experimentation phase was to test devices, Wi-Fi signals, and VMs that can efficiently provide access to all MarineNet courseware. The final recommendation considered the level of maturity in the technology being tested and its current market availability. Data presented in this chapter proved that technologically efficiency can occur with existing technology and not necessarily with the newest DL technology available today.

A. CONSIDERATIONS

Cost and availability were two of the factors considered when selecting hardware for testing. The primary determinant, due to current and projected funding constraints in the DOD, remains cost. In many cases, the lack of funding to initiate or to maintain a new system increases the possibility that the system will fail before it is fully implemented (DOD, 2015b). Also, funding resources become more scarce and difficult to obtain as capabilities are better understood and implemented (DON, n.d.). The *DOD Agency Strategic Plan* directs organizations within the DOD to budget programs efficiently (DOD, 2015c). In addition, it aims to minimize existing conflicting interests in funding utilization to achieve DOD goals (DOD, 2015c). The objective of this research falls within "Goal 4: Achieve Dominant Capabilities through Innovation and Technical Excellence" as shown in Figure 21 (DOD, 2015c, p. 22). Organizations in DOD, such as the ones depicted in Figure 21, compete for funding, and in many cases, other DOD strategic goals and objectives overshadow education and training needs. Finding the most cost-efficient use of funds to achieve DOD goals is essential for a budget-constrained environment.

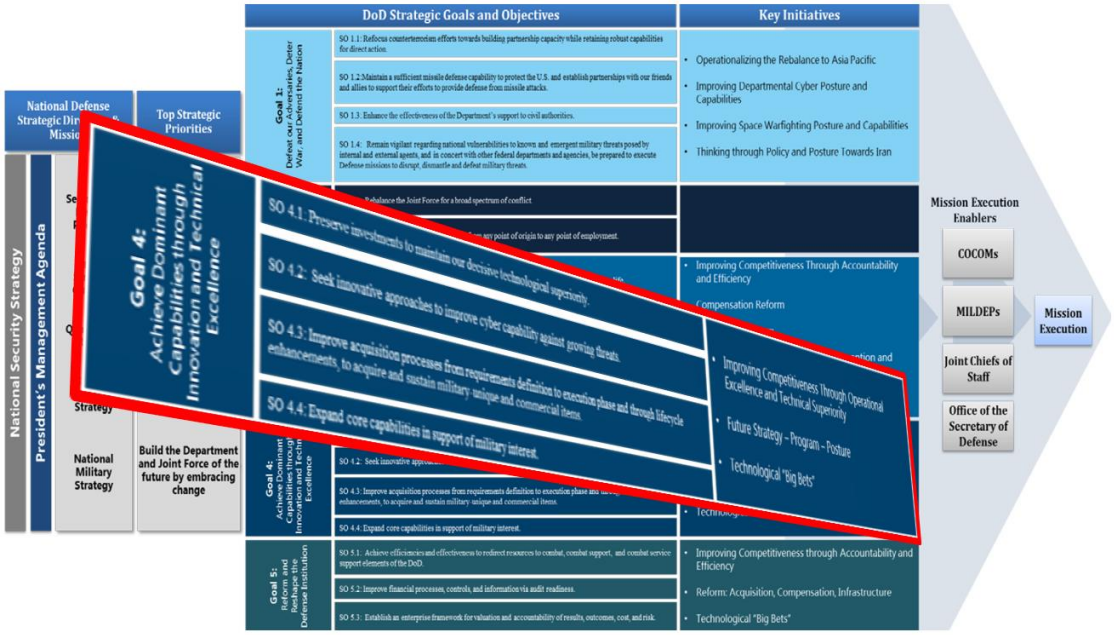


Figure 21. DOD Agency Strategic Plan Alignment. Source: DOD (2015c).

Another important factor in deciding which hardware to test during this research is its availability in the private sector. Hardware that is readily available reduces procurement expenses for the DOD. This model makes a more efficient use of current technology advancements, investments in the private sector, and research and development. Table 2 depicts mobile devices and their availability and utilization percentages by the public. These statistics reveal the type of devices used to access the Internet. In 2010, close to 75 percent of the respondents used a desktop PC to access the Internet (Schwandt & Kroger, 2016d). This percentage has been decreasing to only 56 percent in 2015 (Schwandt & Kroger, 2016d). The use of mobile devices that allow individuals to access the Internet more freely has been steadily increasing (Schwandt & Kroger, 2016d). Compared to desktop PC, the use of mobile devices is more evident among individuals using tablets to access the Internet (Schwandt & Kroger, 2016d). In 2010, only about 3 percent of respondents used tablets to access the Internet compared to 31 percent in 2015 (Schwandt & Kroger, 2016d). Based on these statistics, in five years, the use of tablets has increased by a factor of ten (Schwandt & Kroger, 2016d).

Table 2. Devices Used to Access the Internet at Home in the U.S. Source: Schwandt & Kroger (2016d).

	Desktop PC	Laptop	Mobile Phone/Smartphone	Games console	Portable media player	Tablet	Connected or Smart TV	e-Reader	A TV connected to the Internet either directly (Smart TV) or via another device such as a set-top box or a game console
2010	74%	59%	27%	14%	7%	3%	0%	-	-
2011	63%	68%	32%	14%	6%	6%	4%	-	-
2012	59%	58%	31%	9%	4%	15%	3%	7%	-
2013	63%	60%	45%	15%	6%	24%	6%	6%	-
2014	54%	60%	50%	15%	5%	31%	7%	7%	-
2015	56%	61%	53%	-	7%	31%	-	10%	

B. SOFTWARE

Software is the most dynamic of the DL building blocks for many reasons. First, software needs constant updates. Depending on the level at which the software operates, OS or application, compatibility issues are more or less common. Second, the lines of code (LOC) that make up modern software applications tend to be in the millions. LOC adds complexity to computer systems, in particular when software needs to run in parallel or on top of other software applications. Because of typical software's dynamic nature and complexity, selecting the most compatible software is important for a robust DL model.

1. Operating System

An OS is the layer between hardware and all other applications. OSs provide the communications link that transforms application requests into executable tasks for the hardware platform. Several companies offer different types of OSs for different hardware and software platforms. The degree of mobility in a particular device influences the type of hardware used and consequently the type of OS installed on each device. As shown in Figure 22, the most popular OSs for stationary computing devices such as desktop PCs and laptops include the Microsoft Windows, Mac OS, and Linux families of OSs

(Hopkins, Vizzaccari, & Fuller, 2016). In mobile hardware, also shown in Figure 22, the most predominant OSs include different versions of iOS or Android OSs (Hopkins et al., 2016). Using popular OSs and platforms is more efficient because DL users are already familiar with the software and hardware. Current OS availability in the market and the type of hardware platform most commonly used are factors that need consideration for a more technologically efficient alternative to the MFR DL model.

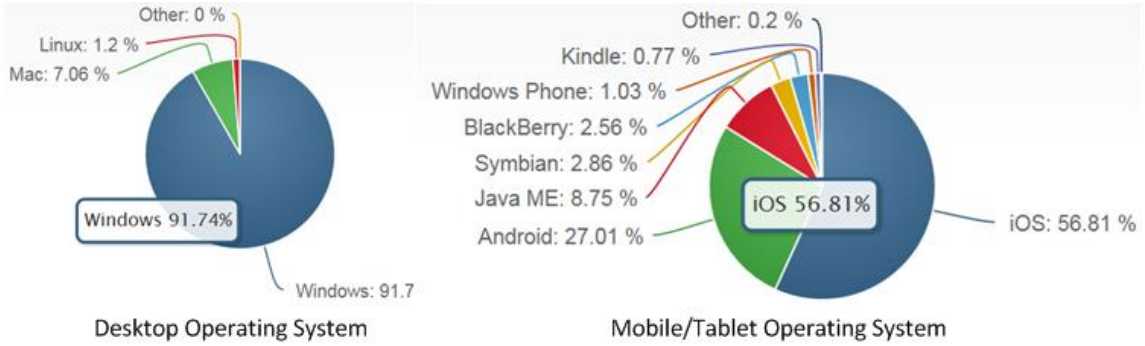


Figure 22. Desktop & Mobile/Tablet Operating System Market Share. Source: Hopkins et al. (2016).

2. Web Browser

A web browser is the software application on top of the OS that provides the window to the WWW. Software developers provide different features in their web browsers. These dissimilarities make it difficult to standardize the way the LMS servers communicate with the users' web browsers or VM clients. It is not uncommon for individuals using different web browsers to have different experiences when accessing the same website. Compatibility issues are the main source of frustration for users accessing MarineNet from devices other than typical GPDLs. As shown in Figure 23, Google Chrome leads the market for both desktop and mobile/tablet use (Hopkins et al., 2016). This research will utilize Google Chrome as the web browser of choice for all devices because of its domination of the web browser market and compatibility with the courseware.

Figure 23. Desktop & Mobile/Tablet Browser Market Share. Source: Hopkins et al. (2016).

3. Virtual Machine

The NPS servers hosted the VM used for this research. This particular VM was separate and distinct from the typical VM students use while at NPS. Typical VMs assigned to NPS students have restrictions that include a limited amount of RAM, no persistent HD space available to a particular user, and the inability to install additional software or modify the OS environments. To install required software and modify the OS environment to fit one that was fully compatible with MarineNet, the VM used for this research was set up with administrator rights, 8 gigabytes of RAM, and 75 MB of persistent HD space. NPS uses the basic VMware infrastructure depicted in Figure 24. The NPS VM infrastructure proved to be very reliable with always-on access to the VM from any of the devices tested. Access to the NPS VM had no downtime or accessibility glitches, whether it was utilizing the school Wi-Fi or at a public Wi-Fi.

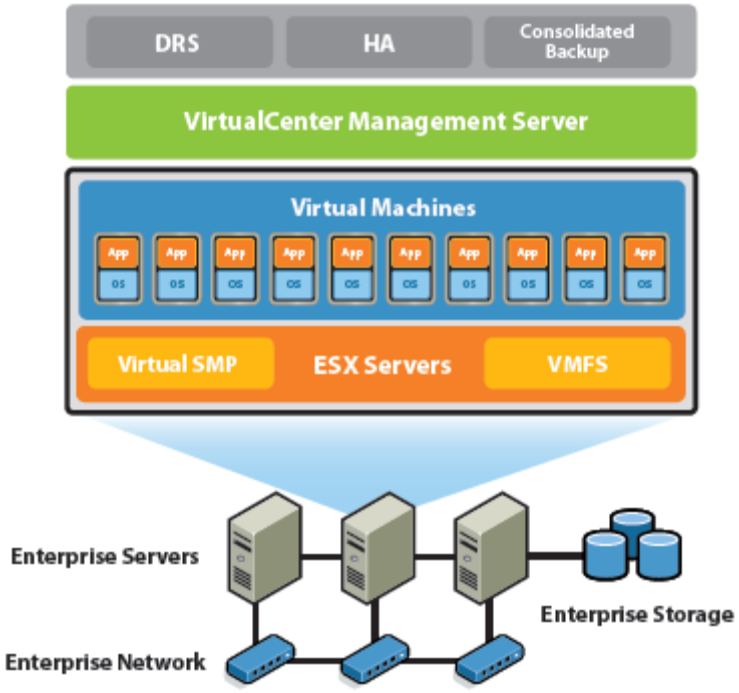


Figure 24. Basic VM Infrastructure. Source: VMware (2016).

4. MarineNet Software Requirements

MarineNet manages courseware built to support the latest OS and web browsers at the time of their design. With new technologies entering the market, some courseware was not compatible with the newest OS or web browser platforms. To enable compatibility with legacy and new courseware, MarineNet has a list of minimum software requirements. Appendix B is the complete list of software required to access MarineNet courseware. For this research, the NPS VM had all the required software as listed in Appendix B before testing. No errors or compatibility issues occurred while using the VM to test access to MarineNet courseware. A wide variety of devices used to access the MarineNet servers were successful in accessing the courses. During testing, all devices listed in Figure 25 had the same level of access to text, video, audio, and animation. No compatibility issues were evident while testing different courses with different levels of interaction between the user and the course. No compatibility issues occurred when the NPS VM was loaded with all courseware requirements and served as the platform interface between the user and MarineNet servers.

C. HARDWARE

As previously discussed, cost and market availability were characteristics considered for equipment tested during this research. Hardware tested consisted of a smart CAC reader and mobile devices. Mobile devices' primary distinctions entailed those of size and portability.

1. CAC Reader

Smart CACs are part of the DOD's two-factor authentication security process. An individual's smart CAC, what a person has, together with an eight-digit pin number, what a person knows, prevent unauthorized access to most of the DOD's secure websites. In case of MarineNet, smart CAC access is one of two options to access their website. The other option is a username and password that MarineNet issues after registration. Both options offer the same access to courseware and DL opportunities.

Biometric Associates offer different models of smart CAC readers. The company specializes in portable smart CAC readers with interfaces that work on most Apple and Android products. Model 301-LT, one of Biometric Associates' smart CAC readers worked with all portable devices tested during this research. This particular model has both a Lightning connector for Apple mobile devices and a micro USB connector for Android mobile devices. The 301-LT worked seamless on the Insignia tablet, and both iPads. This smart CAC reader also worked on an iPhone 6+ that was not part of the experiment. In all cases, inserting the 301-LT in the mobile device I/O port allowed MarineNet to read and authenticate the user's CAC and eight-digit pin number. No additional smart CAC reader's drivers or software were needed to be installed for credentials to be authenticated by MarineNet servers. The remaining mobile devices had USB I/O ports that can integrate typical smart CAC readers currently available throughout the USMC. Devices with a USB I/O port also work with the 301-LT in a similar manner; allowing the smart CAC user to be authenticated by MarineNet servers.

2. Devices

Figure 25 lists the different characteristics for devices tested during this research. The main distinction in terms of software is the type of OS each device supports. The four types of platforms tested were the Microsoft Windows, Android, iOS, and OSX family of OSs. The Microsoft Windows OS family is the most abundant in the market today. Because of its market dominance, Microsoft Windows has better compatibility with most computer software available today. The OSX OS from Apple is the second most abundant OS in the market. Lastly, the Android OS is gaining market share, primarily in the mobile device market. Regardless of the OS platform, VMware, the software running the virtual desktop, has a proprietary VM client that worked harmonious with the host OS of all devices tested.

The definition of what is a full laptop and what is a tablet are blending with modern devices because of emerging technologies that make it possible to produce smaller devices that are faster and less expensive. This is the case with the Dell Venue 11 tested in this research. The Venue 11 is as powerful as a typical laptop in the market today but its size, weigh, and portability are characteristics that classify it as a tablet. This tablet comes with a full copy of Windows 8 and enough hardware capabilities to run and clearly display MarineNet courseware.

Lastly, the Kangaroo MiniPC is in a class of its own. This device has all the components of a typical desktop computer but at a fraction of the price, size, and weight. At 0.44 pounds, the Kangaroo is extremely portable but with the qualities of a larger device. The Kangaroo comes with Windows 10 OS which makes is compatible with most software found in the market today. The downside of this device is that it does not come with a monitor, keyboard, or mouse. This device works by connecting it to a monitor or TV via a HDMI cable and attaching a keyboard and mouse via its UBS port. In addition, it has Wi-Fi and Bluetooth to connect it to a wireless network and Bluetooth devices respectively. The HDMI port, Wi-Fi, Bluetooth, and USB interfaces make it a versatile device with an affordable price.

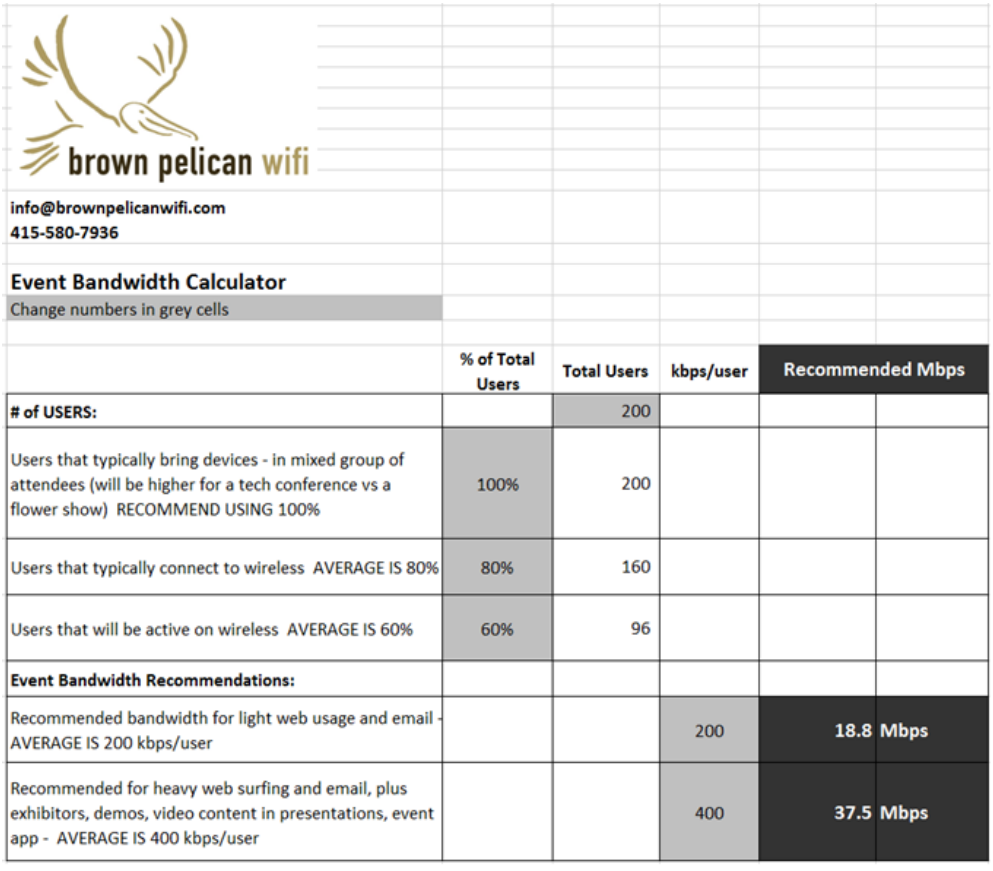
Type	Tablet	Tablet	Tablet	Tablet	Laptop	Laptop	Mini PC
Vendor	Insignia	Apple	Apple	Dell	Apple	Lenovo	Kangaroo
Name	Insignia Flex 10.1	iPad mini	Apple 2	Venue 11 Pro	MacBook Pro 8,2	Lenovo Edge	Kangaroo MD2B
Model#	NS-P10A6100	MD530LL/A	MD328LL/A	Venue 7139	MC723LL/A	Edge 2-1580	MD2D, SD1B
OS	Android Lolipop	iOS	iOS	Windows 8	OS X El Capitan	Windows 10	Windows 10
OS ver #	5.0.1	iOS 9.35	iOS 9.35	6.3.9600 Build 9600	10.11.6	10.0.14393 Build 14393	10.0.10586 built 10586
RAM	1 GB	512 MB	512 MB	8GB	6GB	8GB	2GB
Storage	32GB	64GB	16GB	256GB	750GB	1TB	32 GB
CPU name	MediaTek MT8127B	A5	A5	Intel	Intel	Intel	Intel
CPU speed	1.2GHz	2.4GHz	1GHz	1.60GHz i5	2.2GHz i7	2.5 GHz i7	1.44 GHz
CPU Cores	4	2	2	2	4	2	4
Screen size	10.1-inch	7.9-inch	9.7-inch	11-inch	15-inch	15.6-inch	Variable
Graphics	3D graphics (OpenGL|ES 2.0)	PowerVR SGX543MP2	PowerVR SGX543MP2	Intel HD Graphics 4200	AMD Radeon HD 6750M	NVIDIA GeForce 940M	Intel Graphics Gen8
Resolution	1280x800	1024x768	1024×768	1920x1080	1280 by 800	1920 x 1080	1600x900
VM Client ver.	4.1.0	4.1.0	4.1.0	3.4.0 (2769709)	3.5.2 (3151577)	3.5.2 (31550477)	4.1.0
Chrome ver.	43.0.2357.93	52.0.2743.84	52.0.2743.84	52.0.2743.116	52.0.2743.116 (64-bit)	52.0.2743.116	52.0.2743.116
Weight	1.1 lbs	0.68 lbs	1.33 lbs	1.55 lbs	5.6 lbs	5.06 lbs	0.44 lbs
Battery life	10 hours	10 hours	10 hours	8 hours	7 hours	5 hours	4 hours
Approx. Price	$110	$300	$400	$530	$2,000	$800	$100
Touchscreen	Yes	Yes	Yes	Yes	No	Yes	Yes/No

Figure 25. Internet Access Devices Tested.

D. INTERNET ACCESS

The ability to access the Internet is essential for any DL program. GPDLs provide the only government-provided Internet access for reserve Marines stationed away from LRCs. As previously mentioned, the number of GPDLs is extremely limited compared with the number of reserve Marines typically assigned to an HTC. Chapter II discusses solutions to close this gap. Internet access has become a ubiquitous service, offered free in libraries and many municipalities. Also, many businesses now offer free Wi-Fi access

to their customers. Another solution is to offer free access to Wi-Fi at the reserve Marine's HTCs. Offering free Wi-Fi access at the HTCs ensures that every Marine will have access to the Internet. The cost for DOD is minimal when compared with other options such as setting up LRCs or increasing the number of GPDLs. In a budget-constrained environment, neither are viable options. The cost of Wi-Fi is proportional to the amount of bandwidth required. For a HTC with 200 reserve Marines, approximately 40 Mb/s are required as shown in Figure 26. In August 2016, the cost to purchase sufficient amounts of Internet service bandwidth from Verizon is $189.99/month (Verizon, n.d.). Comparable bandwidth services from Comcast costs $199.95/month (Comcast, n.d.).



	% of Total Users	Total Users	kbps/user	Recommended Mbps	
# of USERS:		200			
Users that typically bring devices - in mixed group of attendees (will be higher for a tech conference vs a flower show) RECOMMEND USING 100%	100%	200			
Users that typically connect to wireless AVERAGE IS 80%	80%	160			
Users that will be active on wireless AVERAGE IS 60%	60%	96			
Event Bandwidth Recommendations:					
Recommended bandwidth for light web usage and email - AVERAGE IS 200 kbps/user			200	18.8	Mbps
Recommended for heavy web surfing and email, plus exhibitors, demos, video content in presentations, event app - AVERAGE IS 400 kbps/user			400	37.5	Mbps

Figure 26. Bandwidth Requirements for 200 Users.
Source: Brownpelicanwifi (n.d.).

E. TESTING

Equipment listed in Figure 25 was tested in the library basement of NPS. One wireless router located in the basement provides wireless access to devices within reach of the wireless router. This particular wireless router connects to the Internet via an Ethernet cable and the NPS network backbone. Because of the router's location, it is uncommon to find students working in the area who are using the router. Testing for devices listed in Figure 25 occur when the router had only one logged in device. As a result, the wireless connection to that router and the Internet was isolated to the devices tested for this research.

1. Wi-Fi Connection Speed Analyzer

According to the Keuwlsoft application run on the Insignia Android tablet, the Wi-Fi connection in the testing area had an average link speed of 65 Mbps with a Received Signal Strength Indicator (RSSI) of -37 dBm (Keuwlsoft, 2016). These results were comparable with similar testing conducted throughout the NPS library. The difference between the router used for this research and others throughout the NPS library was the number of logged in users. The RSSI is an index used by the application to compare signal strengths at different places. The closer the RSSI approaches zero the better signal strength is available in that area (Keuwlsoft, 2016). RSSI readings higher than -50 dBm proved to be effective in accessing the NPS VM and run courseware from MarineNet successfully. Areas with RSSI readings lower than -50 dBm tended to have longer latencies and sluggish web browsing experiences when accessing MarineNet through the VM.

Figure 27 shows signal strength information in the area used to test the equipment for this research. Noteworthy is the fact that readings shown in Figure 27 correspond to the signal received by the Insignia Android tablet and not the strength of the signal radiated from the wireless router. Other devices would have different measurements at the same time and locating depending on the wireless capabilities of each device. Measurements taken by the Keuwlsoft application were used for comparing signal strengths at different locations inside the NPS library.

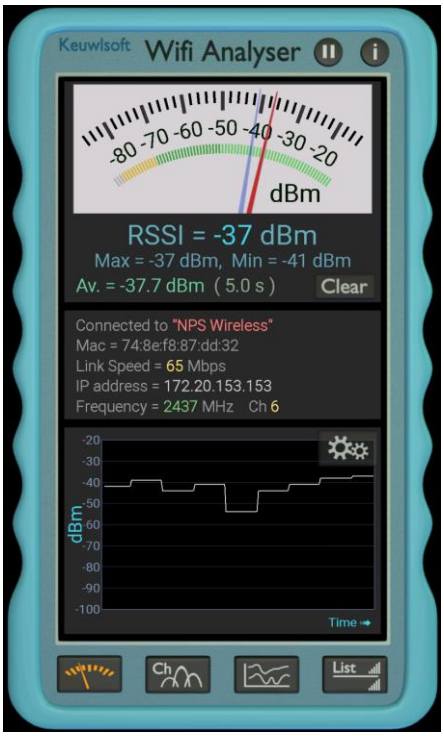


Figure 27. NPS Library Wi-Fi Connection Speed Analyzer Results. Source: Keuwlsoft (2016).

2. Internet Access Benchmark

Table 3 lists the Wi-Fi benchmark results for devices tested during this research. Test results in the first three columns of Table 3—ping, download, and upload speeds—originated from the Speedtest software, an Ookla product, and applications loaded on the devices. The results shown on the first three columns of Table 3 are the average scores for three Speedtest experiments. Results on the fourth and fifth column of Table 3 correspond to iPerf3 bandwidth tests. Specifically, the fourth column shows the number of megabytes transferred to test Internet access bandwidth. The last column of Table 3 shows ping tests run from either the command prompt in the laptops or an application in the mobile devices.

Faster devices, such as the MacBook Pro, had higher download, upload, transfer, and bandwidth test results while slower devices, such as the Insignia Android tablet, had lower scores. Ping results on the other hand, are lower for faster devices and higher for slower devices. Because of this difference, ping tests results shown in Table 3 were

converted to show an inverse proportion of the actual results. For instance, the Speedtest ping in the MacBook Pro was 7.3 microseconds, which was converted to 0.94 in Table 3. The iPad 2's Speedtest ping run at 10.6 microseconds, which was converted to 0.53 in Table 3. In both cases, faster devices now show higher ping results while slower devices show lower ping results.

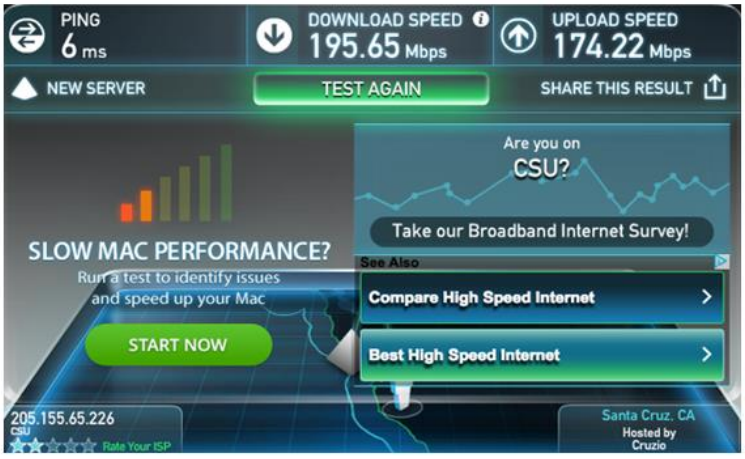
Table 3. Wi-Fi Benchmark Results Table. Source: Ookla (2016) & iPerf.fr (2016).

Application	Speedtest	Speedtest	Speedtest	iPerf	iPerf	Command Prompt
Units	Avg Ms	Mbps	Mbps	MBytes	Mbps	Avg ms
Activity	Ping Test w/app	Download	Upload	Transfer	Bandwidth	Ping Test w/CMD
MacBook Pro OSX Laptop	0.94	192.40	193.79	242.00	203.00	0.25
Lenovo Edge Windows Laptop	0.77	173.09	191.98	203.00	170.00	0.25
Kangaroo Pi MiniPC Windows	0.94	152.14	78.31	198.00	166.00	0.13
Dell Surface Tablet Windows	0.89	171.79	66.46	110.00	92.30	1.00
iPad 2	0.53	19.62	60.57	172.50	143.00	0.04
iPad Mini	0.74	28.40	32.48	50.00	40.16	0.02
Insignia Tablet Android	0.81	20.90	17.85	35.01	29.37	0.11

Figures 28 and 29 show sample screenshots of Speedtest, iPerf3 and command prompt pings speed testing. To minimize typical Internet service provider speed variations, tests were conducted on the same day at approximately the same time. In addition, for every test, the Speedtest application utilized the same servers in Santa Cruz, California. Speedtest form Ookla is the most popular Internet speed tool available. It diagnoses the speeds at which a device connects to the Internet (Ookla, 2016). The results are specific to the device where the tests were conducted. The individualized tests run on each device demonstrated the ability of each device to connect to the Internet (Ookla, 2016). For instance, when the MacBook Pro laptop and the Insignia Android tablet were tested at the same time and with the same network connection, the former had higher download and upload speeds than the latter. Specifically, the MacBook Pro's download speed was 192.4 megabytes per second while the Android tablet's download speed had an average of 20.90 megabytes per second. This represents a substantial difference between

these two devices. This difference also corroborates the fact that Speedtest measures actual Internet speeds from the device's web browser to Speedtest servers.

SpeedTest on iPad



SpeedTest on MacBook Pro

Cumulative Speedtest Results on the Kangaroo MiniPC

Figure 28. Speedtest Wi-Fi Latency Results. Source: Ookla (2016).

Additionally, iPerf3 was used as a secondary tool to measure the speed at which each device connects to the Internet (iPerf.fr., 2016). Screenshot samples of iPerf3 test conducted on the Lenovo Edge, MacBook Pro, and iPad 2 are shown in Figure 29. iPerf3 is similar to Speedtest in that it measures the Internet speed achieved at the device's web browser (iPerf.fr., 2016). The difference lies in the destination server against which Internet speed tests are conducted. In the case of Speedtest, the target system was the Ookla servers. For iPerf3, which allows targeting a specific Internet protocol address, the

destination server used was the NPS VM. Even though both Speedtest and iPerf3 use different algorithms, data packages, and destination servers, test results are proportionally similar as previously shown in Table 3.

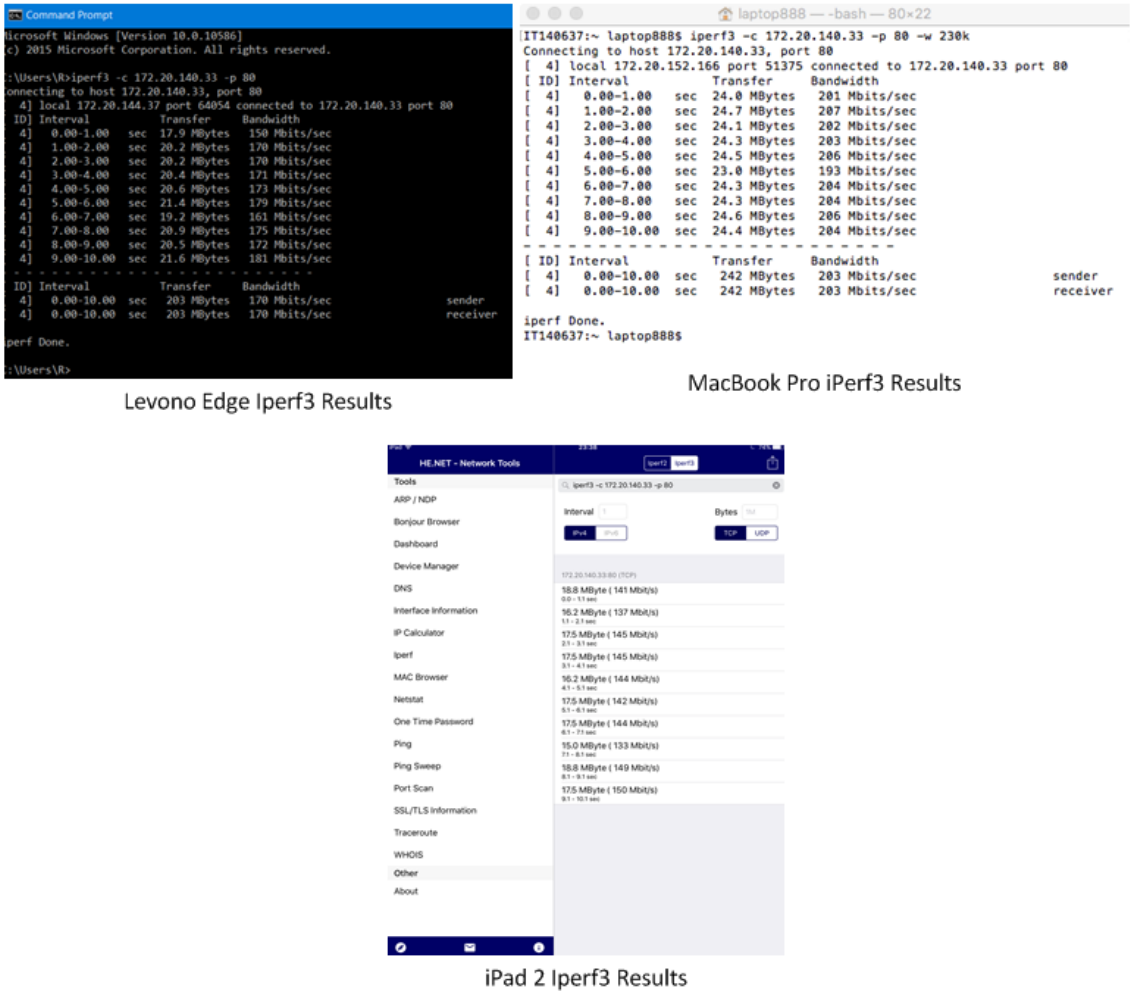


Figure 29. Sample iPerf Wi-Fi Latency Results. Source: iPerf.fr. (2016).

3. Results

Figure 30 shows the results of Wi-Fi benchmark testing. With a few exceptions, a relationship between the cost of a device and Wi-Fi latency results was found. The most expensive device, the MacBook Pro, scored the highest when compared with least expensive devices such as the Insignia Android tablet. There were outliers, such as the Kangaroo MiniPC that scored relatively similar to devices that cost between ten to twenty

times more. Significantly, the Insignia Android tablet performance was sufficient to access the NPS VM and MarineNet network. This tablet, along with the signal strength shown in Figure 27, allowed the researcher to login to the NPS VM and run MarineNet courseware successfully.

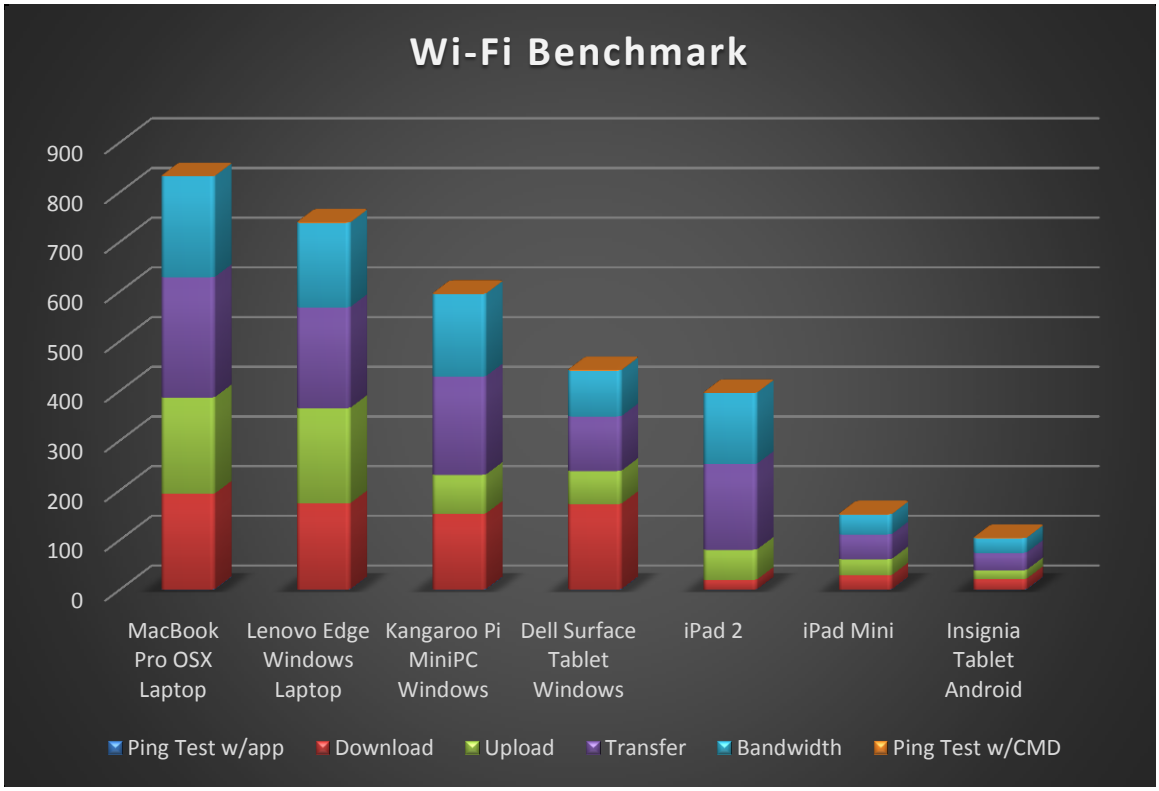


Figure 30. Wi-Fi Benchmark Chart Results.

Based on testing conducted for this research, the Insignia Android tablet, or a tablet with similar characteristics, provide a technologically efficient alternative to access MarineNet courseware. When combined with the VM, this tablet was proven to access MarineNet courseware successfully and with no compatibility anomalies. Free Wi-Fi access at HTCs around the United States are a needed complement to the DOD-provided devices and VMs.

V. CONCLUSION

A technologically efficient alternative for MFR personnel to access MarineNet DL courseware requires the DOD to provide a mobile device, free Wi-Fi at the HTCs, and to set up VMware servers. The Insignia Android tablet provided the necessary hardware and software to access the VM and subsequently MarineNet servers. Free Wi-Fi access at the HTCs is essential to give every reserve Marine stationed away from typical military installations access to DOD servers. Lastly, VMware VMs provided the foundation to set up virtual environments that are adaptable to MFR needs.

A. DESIGNING THE CORRECT ARCHITECTURE

According to Guthrie, Lowe, & Coleman, three facets are essential to designing a solid IT architecture: the organizational, technical, and operational (2013). These facets need to be considered, evaluated, and implemented in the context of satisfying the end user requirements or functional requirements (Guthrie et al., 2013). Functional requirements represent the left and right lateral limits that can keep the organizational, technical, and operational facets focused on what the design should do and not what the design can do (Guthrie et al., 2013). The preceding facet makes a huge difference because, more often than not, organizations tend to acquire the newest technologies rather than focus on what they actually need. As shown in Figure 31, functional requirements are the boundaries of the design facets. The Organizational facet focuses on identifying personnel and describing their responsibilities (Guthrie et al., 2013). Some of the decisions include deciding who will manage the environment, configure the network, handle troubleshooting, and take responsibilities for security (Guthrie et al., 2013). The technical facet includes decisions about actual software and hardware environment required to support the functional requirements (Guthrie et al., 2013). The decisions made in this facet range from determining the brand of the server, CPU type, type of storage, network configuration, and any additional software (Guthrie et al., 2013). Lastly, the decisions in the operational phase include how to manage hosts, create VMs, make backups, and provision storage (Guthrie et al., 2013).

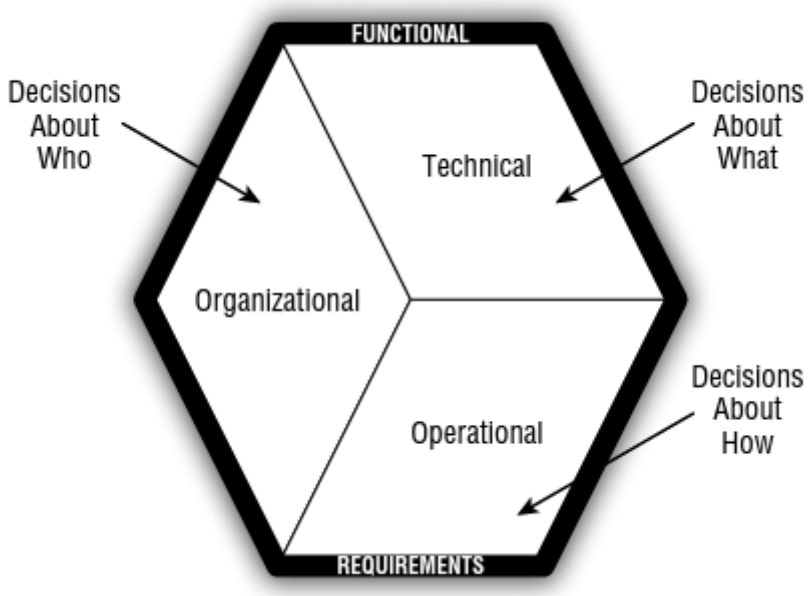


Figure 31. Designing VM Environment Model. Source: Guthrie et al. (2013).

B. PROPOSED ARCHITECTURE

MarineNet's DL functional requirement is to provide courseware access to all Marines regardless of their geo-location. VMs using VMware helps fulfill this requirement by eliminating the software and hardware compatibility problems and it is flexible enough to adapt to emerging technologies in the future. A VM is technologically efficient when compared to physical devices such as the ones found in typical LRCs. As technology improves and new courseware is developed, the virtualized environment will adjust to the new courseware requirements in a manner that is transparent to the end user. MarineNet has the personnel and organizational structure to manage the proposed model. Cost savings from a more efficient architecture can augment any potential increase in the number of personnel required or additional hardware to support the updated structure. The technical aspect of this architecture uses existing technologies in terms of the virtual desktop architecture and access devices. During the operational facet of the proposed architecture, outsourcing the hosting and management of VM servers can be considered as a means to streamline the program and increase efficiencies.

The proposed architecture in Figure 32 shows virtual servers at the center of the architecture. As proven in Chapter IV, as long as a user can successfully access the virtual environment, the VM will act as the link between the user and MarineNet courseware. Issues with MarineNet compatibility and accessibility can be minimized by using a more technologically efficient architecture as sown in Figure 32. At the bottom right of Figure 32, a reserve Marine has many more options to access MarineNet. These options include using free Wi-Fi access at the HTC, some public buildings, private businesses or private access to the Internet at home. In this scenario, a reserve Marine is not limited to the few GPDLs at the HTC but has a wide range of devices he can use to access courseware.

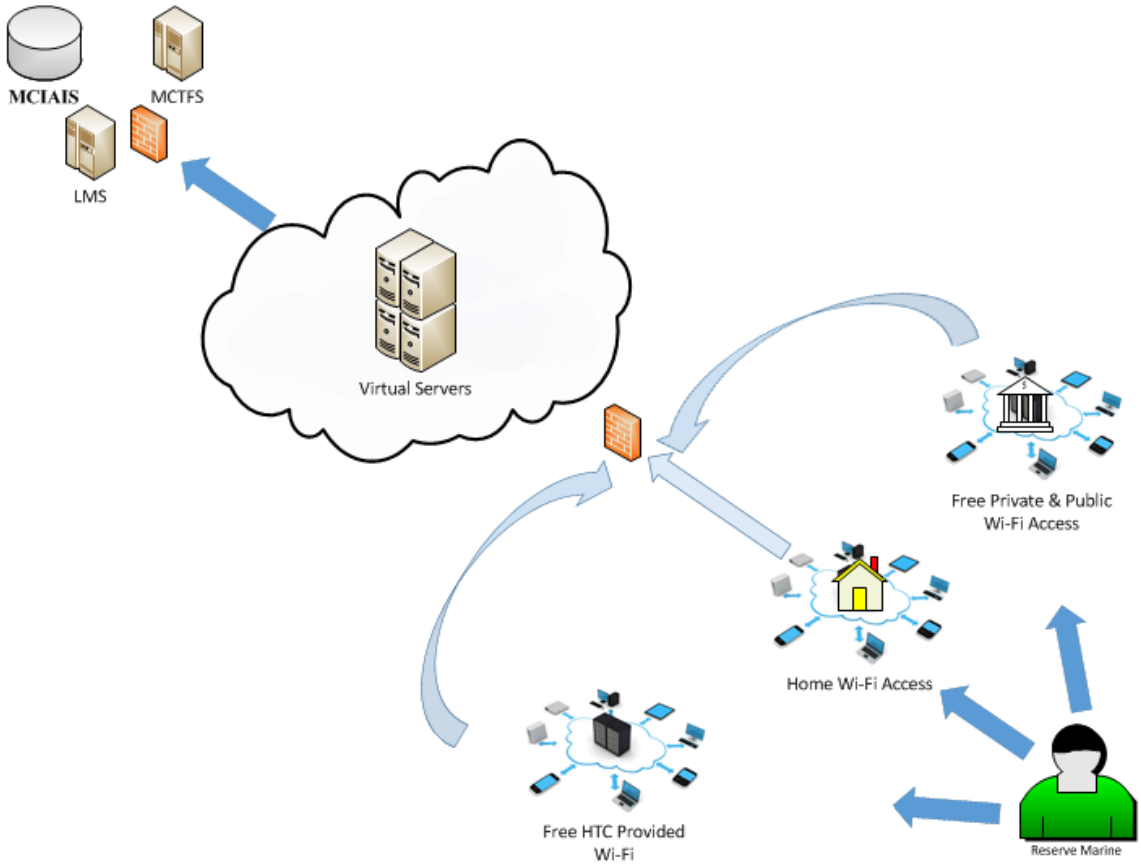


Figure 32. Proposed Architecture for MFR Personnel Access to MarineNet.

Figure 25 lists the seven devices that successfully connected to the NPS VM. This list is not inclusive, but rather a small sample of devices currently available in the market. The devices selected for this research had different hardware and software platforms. This diversity of hardware and OSs tested provides possible applicability on a larger number of devices in the market with similar characteristics. The attribute that generated better results was Wi-Fi speed rather that the device itself. Based on this study, it is recommended to have a Wi-Fi speed no lower than -37dBm and 65 megabits per second as measured with Keuwlsoft's Wi-Fi connection speed analyzer (shown in Figure 27). Slower Wi-Fi speeds tended to degrade the quality of the Internet connection to the VM. Considering the Wi-Fi benchmark results in Figure 30, the slowest device, the Insignia Android tablet, was sufficient to access the VM and courseware successfully. In closing, the researcher recommends all three components—a government provided tablet, free Wi-Fi access at the HTCs, and a VM infrastructure—to provide a technologically efficient alternative for reserve personnel located away from LRCs to access MarineNet courseware.

C. FUTURE RESEARCH

The results of this research include the building blocks and proposed architecture that efficiently support MFR DL needs. These results did not consider specific security or policy concerns that can apply to the DOD. In addition, the use of VMs can be applied in other DOD systems to mitigate difficulties with compatibility and availability.

1. Security

Cyber-attacks can occur at the VM portal. Additional studies based on the proposed architecture in Figure 32 need to be done in data encryption and user authentication to prevent a NIPRNET security breach through the VM or user devices. Because the VM will interact directly with edge devices, security measures—such as intrusion detection systems, vulnerability scanners, gateways, firewalls, and encryption software—need to be set up and configured correctly. Additional questions include:

- What are the network security guidelines that need to be put in place to protect the NIPRNET from cyber-attacks?

- What are the VM's cyber-security safeguards needed to protect the NIPRNET?

2. VM DOD Policies

The DOD's policies affecting the implementation of the proposed architecture need to be evaluated. The DOD is a large organization that spans the entire globe. Because of its size and reach, adapting to existing or new technologies has always been a challenge for the organization. The proposed model would need to be validated with existing DOD policies that can potentially restrict the capabilities VMs offer to MFR DL, making VMs inefficient in the process. Additional question includes:

- Do existing DOD policies support or limit the proposed DL model for MFR personnel?

3. Other DOD Systems

Recommendations from this research can support other DOD IT efforts such as the Joint Information Environment (JIE) and Global Combat Support Systems (GCSSs). According to the Government Accountability Office, the JIE aims "to consolidate IT infrastructure in order to achieve savings and improve network security (GAO, 2016, p. 1). Because the JIE is a joint effort, the IT infrastructure involves consolidating thousands of IT systems that, in the majority of cases, have disparate technologies. Compatibility and accessibility issues are bound to exist, which will increase the complexity of the final JIE IT infrastructure. VMs can potentially decrease compatibility and accessibility difficulties by consolidating systems and programs in a virtual environment. A consolidated virtual environment would reduce the end user computer's requirements in terms of both hardware and software. As for GCSSs, computers around the world accessing its servers and running the program locally experience increased latency issues. A VM co-located or in close proximity to the GCSSs servers that performs all tasks requested by the customer would be substantially faster than the current setup.

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APPENDIX A. MCBUL 1500 EXCERPT

Appendix A is the complete list of requirements all U.S. Marines need to complete during the period given (USMC, 2015b). This list is made up of T&E that applies to all Marines regardless of MOS, rank, or location (USMC, 2015b).

Annual Training Requirement	Mandate Authority	Order		Waiver	Delivery Method	Training per Fiscal (FY)/ Calendar (CY) Year
Marine Corps Water Survival Training (MCWST)	MC	MCO 1500.52D, Marine Corps Water Survival Training (MCWST), dtd 10 Nov 10	Qualification - Requalification: Page 1-2, paragraph 8	Commanding Generals Page 8-1, paragraph 2	Unit Training[1]	To be determined by the first general officer in the chain of command.
Hazing	DON SECNAVINST 1610.2A	MCO 1700.28B, Hazing, dtd 20 May 13	Page 2, paragraph 4.b	No waivers or exemptions	Unit Training[1]	(CY) - Refresher training
Sexual Assault Prevention and Response (SAPR)	DOD DODI 6495.02	MCO 1752.5B, Sexual Assault Prevention and Response Program, dtd 01 Mar 13 (SAPR) MARADMIN 234/13	Page 3-7, paragraph 6.a. and 6.b. and Page 8-1, paragraph 3	No waivers or exemptions	Unit Training[1]	(FY)
The Marine Corps Operations Security (OPSEC) Program	DOD DODD 5205.02E	MCO 3070.2A MARADMIN 701/11 Annual Operations Security (OPSEC) Training	Paragraph 3 - 5	No waivers or exemptions	Unit Training[1] or MarineNet OPSECUS001	(CY) - Refresher training
Chemical, Biological, Radiological and Nuclear Defense Training Requirements	MC	MCO 3400.3G, Chemical, Biological, Radiological and Nuclear Defense Training Requirements dtd 07 Dec 11	Exempt Personnel: Page 4, paragraph 8.e	CG MCCDC (C 152) and Commanders MARFOR page 4, paragraph 8.d	Unit Training[1]	Active component individual training: Every 2 fiscal years and at least 6 months prior to deployment Reserve component: At least 6 months prior to deployment[5]
Marine Corps Combat Marksmanship - Rifle	MC	MCO 3574.2L, Marine Corps Combat Marksmanship Programs, dtd 04 Sep 14		MCO 3574.2L, Marine Corps Combat Marksmanship Programs, dtd 04 Sep 14	Unit Training[1]	(FY)

Annual Training Requirement	Mandate Authority	Order		Waiver	Delivery Method	Training Hours per Fiscal (FY)/ Calendar (CY) Year
Marine Corps Combat Marksmanship - Pistol	MC	MCO 3574.2L, Marine Corps Combat Marksmanship Programs, dtd 04 Sep 14		MCO 3574.2L, Marine Corps Combat Marksmanship Programs, dtd 04 Sep 14	Unit Training[1]	Active Component FY Reserve Component: At least 6 months prior to deployment. Marines selected to SSgt will conduct initial qualification w/in 2 years of promotion.
Operational Risk Management (ORM)	DOD DODI 6055.1	MCO 3500.27B W/ERRATUM, Operational Risk Management (ORM), dtd 05 May 04	Page 3, paragraph 5	No waivers or exemptions	Unit Training[1]	Active component: Every 2 calendar years Reserve Component: Every 3 calendar years
Marine Corps Equal Opportunity (EO) and Sexual Harassment	DOD DODD 1350.2 DON SECNAVINST 5350.16A	MCO P5354.1D W/CH 1 Marine Corps Equal Opportunity (EO) Manual, dtd 14 Apr 03	Page 4-3, paragraph 4001.2	No waivers or exemptions	Unit Training[1]	(CY)
Marine Corps Physical Fitness Program-PFT	MC	MCO 6100.13 W/CH 1, Marine Corps Physical Fitness Program, dtd 01 Aug 08	Encl (1), page 2-1, paragraph 2.a	DC M&RA, CG MCCDC, Commanders MARFORCOM, MARFORPAC, MARFORRES, MARSOC, and MEF Commanders Enclosure (1), page 1-12, paragraph 7.b	Unit Training[1]	(CY)
Marine Corps Physical Fitness Program - CFT	MC	MCO 6100.13 W/CH 1, Marine Corps Physical Fitness Program, dtd 01 Aug 08	Encl (1), page 3-1, paragraph 2.a	DC M&RA, CG MCCDC, Commanders MARFORCOM, MARFORPAC, MARFORRES, MARSOC, and MEF Commanders Enclosure (1), page 1-12, paragraph 7.b	Unit Training[1]	(CY)

Annual Training Requirement	Mandate Authority	Order		Waiver	Delivery Method	Training Hours per Fiscal (FY)/ Calendar (CY) Year
Level I AT Awareness Training / Counter Intelligence Awareness and Reporting	DOD DODI 2000.12 DODD 5240.06	MCO 3302.1E, Marine Corps Antiterrorism (AT) Program, dtd 8 Mar 2009	Page 10, paragraph 7.a	No waivers or exemptions	Unit Training[1] or MarineNet JATLV10000	(CY)
Annual Cyber Awareness / PII Training	DOD DOD 8570.01-M	MARADMIN 288/13 Updates to Annual Cyber Awareness Training	Paragraph 4.A	No waivers or exemptions	Marine Net is required CYBERM0000	(FY)
Violence Prevention Awareness Training	DOD DODI 1438.06	MCO 5580.3, Violence Prevention Program, dtd 01 Dec 2012	Paragraph 3.b(8) and Appendix D	No waivers or exemptions	Unit Training[1] or MarineNet ILEVPPA01A	(CY)
Tobacco Cessation (Semper Fit)	DOD 32 CFR 85.6	MCO 1700.29, Marine Corps Semper Fit Program Manual, dtd 08 Jan 13	Page 6-7, paragraph 4.b (9)(c)	CMC (MR), Page 1-4, paragraph 12	Unit Training[1] or Marine Net SFTOBCESS0	(CY) Note 3
Unit Marine Awareness and Prevention Integrated Training (UMAPIT)	DOD Multiple DODD and DODI; DOD DODD 6490.14; DOD DODI 1010.04	MCO 5300.17, Marine Corps Substance Abuse Program; MCO 1754.11, Family Advocacy; MCO 1720.2 Marine Corps Suicide Prevention Program	MCO 5300.17 Page 2-1, paragraph 1.c; MCO 1754.11 Paragraph 3.b.(7)(h); MCO 1720.2 Page 7,2.b.(13)(c) Paragraph 2.A-C	No waivers or exemptions	Unit Training	(CY) Note 4
Records Management Training	DOD DODD 5015.2 DON SECNAV M-5210.1	MARADMIN 593/12 Mandatory Annual Records Management Training MCO 5210.11F, Marine Corps Records Management Program	MARADMIN 593/12 Paragraph 5; MCO 5210.11F Paragraph 4.c.(3)(d)	No waivers or exemptions	Unit Training[1] or MarineNet M01RMT0700	(CY)
Combating Trafficking in Persons (CTIP)	DOD DODI 2200.01 DON OPNAVINST 5300.11	MARADMIN 101/10 Combating Trafficking in Persons Annual Training Requirement	Page 5, paragraph 5.8.3 paragraph 3	MARADMIN 101/10, paragraph 4	Unit Training with DoD provided materials or MarineNet DD01AO0000	(FY) Refresher course authorized if full course completed in previous 3 years

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APPENDIX B. MINIMUM MARINENET REQUIREMENTS

Appendix B is the complete list of software requirements to access MarineNet courseware (MarineNet, 2016b). This list of requirements ensures the device can run all courseware available in MarineNet servers, old and new (MarineNet, 2016b).

Applications		
OS	**Software Description**	**Version**
WXP	XP Citrix Web Client	12.1
Windows 7	Citrix Web Client	5.4.0.36
WXP	Microsoft Office Suite (includes Word, Excel, PowerPoint, Access, Outlook, and InfoPath)	2003 SP3
WXP	Office 2007 Suite	(SP2)
Windows 7	Office Suite 2007	12.0.6545.5002 (SP2)
Windows 7	Office 2010 Suite	(SP1)
Windows 7	Data Center Operations (DCO) XXMP Client	5.4.0.36
WXP	Office 2007 Compatibility Pack	SP2
Windows 7	Adobe Connect	7.5
WXP	Net-Centric Enterprise Services (NCES) Collaboration Suite: IBM Lotus SameTime DCO XXMP Client Adobe Connect Adobe FlashPaper	 8.01 5.4.0.36 9 2
Windows 7	Reflection	14.1
WXP	Reflection	14.0.2
WXP	WXP Total Records Information Management (TRIM) Context	6.1.1
Windows 7	WinZip	14.5.9095
WXP	WinZip	11.2
Windows 7	Windows Help	50.1.7600.16386

Base OS and Components		
OS	**Software Description**	**Version**
Windows 7	Windows 7 Enterprise	Service Pack 1 (SP1)
WXP	WXP	Service Pack 3 (SP3)
WXP	Microsoft Data Access Components (MDAC)	2.8
Windows 7	MDAC	6.1.7600.16385
WXP	InstallShield Script	7, 8, 9, 10, 10.5, 11, 11.5
Windows 7	Microsoft DirectX	11
WXP	DirectX	9.0c
Windows 7	Microsoft Internet Explorer	11.0
WXP	Internet Explorer	7.0 (128-bit)
Windows 7	Microsoft .NET Framework	3.5 SP1 4.0
WXP	Microsoft .NET Framework	1.1 SP1 2.0 SP1 3.5 SP1A
Windows 7	Windows Installer	5.0.7600.16385
WXP	Windows Installer	3.1
Windows 7	Windows Media Player	12.0.7600.16667
WXP	Windows Media Player (WMP)	11.0
Windows 7	Microsoft XML Parser 3.0	8.110.7600.16605
WXP	Microsoft Extensible Markup Language (XML) Parser 3.0	3.0 SP7
Windows 7	XML Core Services 6	6.30.7601
WXP	WXP XML Core Services 4	4 SP2
WXP	WXP XML Core Services 6 (SP2)	6.20.1099.0
Windows 7 / WXP	Sun Java Runtime	1.6.0_33

Enterprise Tools		
OS	**Software Description**	**Version**
Windows 7	HP Client Automation Enterprise (CAE)	7.9
Windows 7	System Center Configuration Manager (SCCM) Client	4.00.6487.2000
Windows 7 / WXP	ActivClient	6.2
WXP	Client Problem Repair (CPR)	1.12
WXP	Desktop Validator	4.9.2
WXP	Encryption Anywhere	9.1
Windows 7	Enterprise Management Tools	1.0
Windows 7	Desktop Validator	4.11
Windows 7	Encryption Anywhere Framework (DAR)	9
Windows 7	Encryption Anywhere Hard Disk (DAR)	9
Windows 7	Encryption Anywhere Removable Storage (DAR)	9
Windows 7	McAfee Host Intrusion Prevention System (HIPS)	4.5.0
Windows 7 / WXP	Net Banner(Classification Banner)	2.2.0
WXP	Radia Client	4.5
Windows 7	Radia Client	7.8
WXP	Hercules Patch Management System	4.5
WXP	McAfee HIPS	7.0.0
WXP	NMCIUtils	2.0
Windows 7 / WXP	Symantec Endpoint Protection (SEP)	11

Portable Utilities (for unclassified portable Client Data seats *only*)		
OS	**Software Description**	**Version**
Windows 7 / WXP	Juniper NetConnect Secure Sockets Layer (SSL) virtual private network (VPN)	7.1
WXP	WXP NetScreen-Remote VPN Client	10.8.10
WXP	WXP Remote Access Service (RAS) Tools (unclassified)	(USMC) 4.0.4 (USN) 4.0.5
Windows 7	WXP RAS Tools (unclassified)	(USN) 5.0

System Tools		
OS	**Software Description**	**Version**
Windows 7	DELL OpenManage Client Instrumentation (OMCI) System Tool	8.0.1.150
Windows 7	HP CMI System Tool	1.5.0A

APPENDIX C. MFR UNIT LOCATIONS

Appendix C is the entire list of MFR unit locations (MFR, 2014). Some of the locations coincide with military installations. A vast majority are not located in close proximity to any military installation. This fact prevents MFR personnel from having access to DL opportunities provided by LRCs.

ALABAMA

• BTRY K 2ND BN 14TH MAR REGT
3506 SOUTH MEMORIAL PKWY
HUNTSVILLE, 35801
256-755-1265

• 3RD FORCE RECON CO
• 4TH GRD SENSOR PLAT HQSVC CO
INTEL SPT BN
1630 S. BROAD
MOBILE, 36605
251-402-5211

• CO L 3RD BN 23RD MAR REGT
• DET CO L, 3RD BN 23RD MAR REGT
1650 FEDERAL DR
MONTGOMERY, 36107
334-294-7087

ALASKA

• DET MP CO D 4TH LAW ENF BN
15920 27TH ST
JOINT BASE ELMENDORF
RICHARDSON, 99506
907-552-7069

ARIZONA

• BULK FUEL CO C
6TH ENGR SPT BN
14063 W GILLESPIE
LUKE AIR FORCE BASE, 85309
623-856-2418

• VMFT-401, MAG-41
P.O. BOX 99270, BLDG. 146
MCAS YUMA, 85369
928-269-2806

• BULK FUEL CO A(-)
6TH ENGR SPT BN
3655 S WILMONT RD
TUCSON, 85730
520-228-6300

ARKANSAS

• CO I 3RD BN 23RD MAR REGT
• DET CO I 3RD BN 23RD MAR REGT
8005 CAMP ROBINSON RD
NORTH LITTLE ROCK, 72118
501-952-0336

CALIFORNIA

• 2ND INTEL PRODUCTION TM CO A
INTEL SPT BN
2144 CLEMENT AVE
ALAMEDA, 94501
858-537-8053

• 4TH RECON BN
2144 CLEMENT AVE
ALAMEDA, 94501
210-867-4267

• 4D1 4TH DENTAL BN
5631 RICKENBACKER RD
BELL, 90201
323-980-7131

• 3RD AIR & NAVAL
GUNFIRE LIAISON CO
5631 RICKENBACKER RD
BELL, 90201
310-863-6569

• 1ST CIVIL AFFAIRS GROUP
BOX 555123, BLDG 210822,
DEL MAR
CAMP PENDLETON, 90255
760-725-6006

• HQSVC CO (-) 4TH LAR BN
• CO A 4TH LAR BN
PO BOX 555225, 100 NELSON RD,
LOS FLORES
CAMP PENDLETON, 92055
760-725-4908

• CO A 4TH TANK BN
BLDG 50, 9955 POMERADO RD
CAMP PENDLETON, 92055
760-725-0297

• RESERVE SUPPORT UNIT/
DEPLOYMENT PROCESSING
COMMAND WEST
PO BOX 555111
CAMP PENDLETON, 92055
760-725-5922

• DET 1 HQ CO 4TH LAW ENF BN
PO BOX 555123 BLDG 210822
CAMP PENDLETON, 92055
760-725-5922

• HUMAN EXPLOITATION PLT CO A
INTEL SPT BN
BLDG 210822, DEL MAR
CAMP PENDLETON, 90255
858-537-8053

• VMU-4 MACG-48
BLDG 64444, CAMP TALEGA
CAMP PENDLETON, 92055
928-750-5016

• 6TH AIR AND NAVAL
GUNFIRE LIAISON CO.
3225 WILLOW PASS RD
CONCORD, 94519
925-825-1775

• TRANSPORT CO CLB 23 CLR 4
400 E ROTH RD
LATHROP, 95330
209-969-0946

• DET A MWSS-473 MWSG-47
BLDG 783, FRANKLIN AVE
LEMOORE, 93246
559-998-3787

• 3RD INTEL PRODUCTION TM
CO A INTEL SPT BN
MARINE CORPS RESERVE
TRAINING CENTER, BLDG 20, FL 1
LOS ALAMITOS, 90720
858-537-8053
• HQ CO 2ND BN 23RD MAR REGT
2699 PALOMA ST
PASADENA, 91107
626-831-0562

• DET HQ 2ND BN 23RD MAR REGT
• CO G 2ND BN 23RD MAR REGT
3551 S SAN GABRIEL RIVER PKWY
PICO RIVERA, 90660
562-536-2232

• WPNS CO 2ND BN
23RD MAR REGT
4832 PACIFIC RD, BLDG 6
PORT HUENEME, 93043
805-207-1496

• MAINT SERVICES CO CLB 23 CLR 4
• 4D3, 4TH DENTAL BN
8277 ELDER CREEK RD
SACRAMENTO, 95828
916-387-7123/7100

• DS TM 23RD MAR REGT
• CO E 2ND BN 23RD MAR REGT
900 COMMODORE DR
SAN BRUNO, 94066
650-537-2404

• HQ CO 23RD MAR REGT
900 COMMODORE DR
SAN BRUNO, 94066
650-537-2404

• SITE SUPPORT MIRAMAR
• MWCS 48 DET A FWD
MCAS MIRAMAR, BLDG 6030
SAN DIEGO, 92145
858-500-6533

• MWSS 473 (-)
MCAS MIRAMAR, BLDG 6030
SAN DIEGO, 92145
517-214-3650

• ALL-SOURCE FUSION PLAT CO A
INTEL SPT BN
• CO A(-) INTEL SPT BN
• COUNTER INTEL PLAT CO A
INTEL SPT BN
9955 POMERADO RD, BLDG
20302
SAN DIEGO, 92147-5101
858-537-8053

• 4D4 4TH DENTAL BN
9955 POMERADO RD
SAN DIEGO, 92131
916-387-7100

• HQSVC 4TH MED BN
9955 POMERADO RD
SAN DIEGO, 92131
858-537-8130

• DET HQSVC CO 4TH TANK BN
BLDG 50, 9955 POMERADO RD
SAN DIEGO, 92131
858-967-3698

• HQSVC CO 4TH TANK BN
BLDG 50, 9955 POMERADO RD
SAN DIEGO, 92131
858-537-8009

• MALS-41 DET, MAG-41
MCAS MIRAMAR, PO BOX 452024
SAN DIEGO, 92145
877-432-2215

• VMM-764 MAG-41
MCAS MIRAMAR, BUIDING 9277
SAN DIEGO, 92145
817-807-3914

• RESERVE SUPPORT UNIT
AIR STATION WEST
MCAS MIRAMAR, PO BOX 452020
SAN DIEGO, 92145
858-577-4562

• MASS-6 DET A, MACG-48
BLDG 6030 PHIPTS AVE,
MCAS MIRAMAR
SAN DIEGO, 92145
858-500-6533/ 858-577-6089

• DET 4 MAINT CO CLB 453 CLR 4
• SUPPLY CO CLB 453 CLR 4
901 E MISSION ST
SAN JOSE, 95112
408-286-6501

• DET HQ BTRY 5TH BN 14TH MAR
• DET HQ BTRY 14TH MAR REGT
• BTRY N 5TH BN 14TH MAR REGT
• BTRY O 5TH BN 14TH MAR REGT
• HQ BTRY 5TH BN 14TH MAR REGT
800 SEAL BEACH BLVD, BLDG 14
SEAL BEACH, 90640
562-626-6191
• CO D 4TH TANK BN
BLDG 2070, 13TH STREET
TWENTYNINE PALMS, 92277
760-830-0966

COLORADO

- 1ST HUMAN INTEL SUPPORT TM
  CO B INTEL SPT BN
  7 N SNOWMASS ST, STOP 61
  AURORA, 80011
  720-847-7685

- 1ST INTEL PRODUCTION TM CO B
  INTEL SPT BN
- 2ND INTEL PRODUCTION TM (JRIC) CO
  B INTEL SPT BN
  N SNOWMASS ST, STOP 61
  AURORA, 80011
  720-847-7680

- ALL-SOURCE FUSION PLAT
  CO B INTEL SPT BN
- CO B(-) INTEL SPT BN
- IMAGERY INTERPRETATION PLT
  CO B INTEL SPT BN
  7 N SNOWMASS ST, STOP 61
  AURORA, 80011
  720-847-7681

- HQ CO CLB 453 CLR 4
  7 N SNOWMASS ST, STOP 61
  AURORA, 80011
  325-513-3667

- BTRY Q 5TH BN 14TH MAR REGT
  7 N SNOWMASS ST, BLDG 1301
  AURORA, 80011
  303-961-4616

CONNECTICUT

- MAINT SERVICE CO CLB 25 CLR 45
  30 WOODWARD AVE
  NEW HAVEN, 06512
  203-467-5322

- CO F 2ND BN 25TH MAR REGT
  1 LINSLEY DRIVE
  PLAINVILLE, 06062
  860-913-3265

- DET HQ BN 1ST BN 25TH MAR REGT
  1 LINSLEY DRIVE
  PLAINVILLE, 06062
  978-796-2828

DISTRICT OF COLUMBIA

- 2ND CIVIL AFFAIRS GROUP
  BLDG 351
  190 POREMBA CT SW
  WASHINGTON, 20373
  202-433-0178

- DET 2 SUPPLY CO CLB 451 CLR 45
  BLDG 351
  190 POREMBA CT SW
  WASHINGTON, 20373
  202-685-2295

- DET PRP CO CLR 45
  BLDG 351
  190 POREMBA CT SW
  WASHINGTON, 20373
  202-685-0894

- SCOB (HQ) 4TH MED BN
  190 POREMBA CT SW
  WASHINGTON, 20373
  910-433-3150

DELAWARE

- BULK FUEL CO B(-)
  6TH ENGR SPT BN
  3920 KIRKWOOD HWY
  WILMINGTON, 19808
  302-252-3401

FLORIDA

- 2ND HUMAN INTEL SUPPORT TM
  CO C INTEL SPT BN
- 4TH CIVIL AFFAIRS GROUP
  18650 NW 62ND AVE
  HIALEAH, 33015
  305-628-5173

- CO B(-) 4TH AA BN
  8820 SOMERS RD S
  JACKSONVILLE, 32218
  904-237-1346

- MARINE AVIATION TRAINING
  SUPPORT GROUP 42
  211 FARAR RD, BLDG 3450
  NAS PENSACOLA, 32508
  850-452-8762

- 2ND INTEL PRODUCTION TM
  CO C INTEL SPT BN
  595 PRIMROSE AVE
  ORLANDO, FL 32803
  571-379-3535

- 24 D1 4TH DENTAL BN
- HQSVC DET 3 4TH MED BN
- MOTOR T CO CLB 451 CLR 45
  STE 300, 9500 ARMED FORCES
  RESERVE DR
  ORLANDO, 32827
  407-240-5939

- 2ND & 3RD PLT
  CO E ANTI-TERRORISM BN
  2910 ROBERTS AVE
  TALLAHASSEE, 32310
  850-591-0263

- HQSVC CO 4TH AA BN
- CO D 4TH LAR BN
- 4TH ASSAULT AMPHIBIAN BN
- HQ CO(-) 4TH AA BN
  5121 W GANDY BLVD
  TAMPA, 33611
  813-267-4156

- 4TH AIR & NAVAL GUNFIRE
  LIAISON CO
  1226 MARINE DR
  WEST PALM BEACH, 33409
  561-719-3497

GEORGIA

- 24TH HQ 4TH DENTAL BN
- HQ CO 4TH DENTAL BN
  1210 NAVAL FORCES CT
  ALTANTA, 30069
  678-655-4395

- HQ CO CLR 45
  BLDG 440, 1210 NAVAL FORCES CT
  MARIETTA, 30069
  678-655-4365

- DET 2 SUPPLY CO CLB 453 CLR 4
  814 RADFORD RD, BLDG 7106
  MCLB ALBANY, 31704
  229-639-5476

- HMLA-773(-) MAG-49
- HQ, DET. A, MAG-49
- MALS 49 DET. A, MAG 49
  420 BEALE DR, BLDG 2071
  ROBINS AIR FORCE BASE, 31098
  478-222-5461

- LNDG SPT CO CLR 45
  BLDG 1281, 62 LEONARD-NEAL ST
  SAVANNAH, 31409
  912-656-1118

- CO B 4TH RECON BN
  1880 ROSWELL ST SE
  SMYRNA, 30080
  404-326-0583

- PRP CO (-) CLR 45
- I&I STAFF SMYRNA CLR 45
  1880 ROSWELL ST
  SMYRNA, 30080
  678-655-7307

- FOOD SERVICE CO CLR 45
  1880 ROSWELL ST
  SMYRNA, 30080
  678-655-7303

HAWAII

- 2ND & 3RD PLT., CO F, ANTI-
  TERRORISM BN
  1811 SUMNER RD
  MCB KANEOHE BAY, 96734
  808-348-4530

IDAHO

- CO C 4TH TANK BN
  BLDG 800, 4087 W HARVARD ST
  BOISE, 83705
  208-963-3217

COLOR KEY

-----> Division
-------> Wing
--------> MLG
---> FHG/Other

ILLINOIS

- 2ND HUMAN INTEL SUPPORT TM
  CO B INTEL SPT BN
  3034 WEST FOSTER AVE
  CHICAGO, 60625
  303-807-0204

- HQ CO 2ND BN 24TH MAR REGT
  3034 W FOSTER AVE
  CHICAGO, 60625
  773-539-6464 X 318

- WPNS CO(-) 2ND BN
  24TH MAR REGT
  3155 BLACKHAWK DR, STE 701
  FORT SHERIDAN, 60037
  847-266-3069

- MACG-48 HQ
- AC2T MACG-48
- MTACS 48 MACG-48
- MWCS 48(-) MACG-48
- MWCS 48 DET A MACG 48
- 3RD CIVIL AFFAIRS GROUP
  BLDG 3200, STE 200,
  2205 DEPOT DR
  GREAT LAKES, 60088
  847-722-9073

- 14 D3 4TH DENTAL BN
  614 BARRY RD
  GREAT LAKES, 60088
  847-688-3760

- DET HQSVC CO 4TH RECON BN
- CO E 4TH RECON BN
  2711 MCDONOUGH ST
  JOLIET, 60436
  815-341-2434

- ENGINEER CO C 6TH ESB
  7117 W PLANK RD
  PEORIA, 61604
  309-697-8497

- MAINT CO CLB 451 CLR 45
  BLDG 218, ROCK ISLAND ARSENAL
  ROCK ISLAND, 61299
  309-782-6044

INDIANA

- DET COMM CO
- DET COMM CO HQ BN
  N WHITE RIVER PKWY E DR
  INDIANAPOLIS, 46208
  317-402-1180

- DET 3 MAINT CO CLB 451 CLR 45
  3010 WHITE RIVER PKWY E DR
  INDIANAPOLIS, 46208
  317-923-1584

- DET 1 COMM CO CLR 45
  4780 LEATHERNECK DR
  PERU, 46971
  765-688-4404

- ENGR SERVICE CO CLB 25 CLR 45
  1901 STH KEMBLE AVE
  SOUTH BEND, 46613
  504-206-6007

- CO K, 3RD BN, 24TH MAR REGT
- CO B, 1RD BN, 24TH MAR REGT
  200 S FRUITRIDGE AVE
  TERRE HAUTE, 47803
  314-277-4337

IOWA

- CO E(-) 2ND BN 24TH MAR REGT
  NMCRTC BLDG 47 DICKMAN AVE
  DES MOINES, 50315
  515-285-2616

KANSAS

- DET 1 SUPPLY CO CLB 453 CLR 4
  2014 S E WASHINGTON ST
  TOPEKA, 66607
  785-230-0057

- DET 2 MAINT CO CLB 453 CLR 4
  3026 S GEORGE
  WASHINGTON BLVD
  WICHITA, 67210
  316-682-3252

KENTUCKY

- CO E 4TH TANK BN
  595 7TH ARMOR DIV RD
  BLDG 7241
  FORT KNOX, 40121
  502-608-6623

- MP CO A, 4TH LAW ENF BN
  151 OPPORTUNITY WAY
  LEXINGTON, 40511
  859-245-0360

LOUISIANA

- WPNS CO(-) 3RD BN
  23RD MAR REGT
  8110 GSR-I ROAD
  BATON ROUGE, 70820
  225-279-1088

- CO B 1ST BN 23RD MAR REGT
  1440 SWAN LAKE RD
  BOSSIER CITY, 71111
  318-349-3309

- VMR BELLE CHASSE
  400 RUSSELL AVE, BOX 30
  NEW ORLEANS, 70143
  504-343-2696

- ENVIRONMENTAL SVCS DIV
- FORCE HEADQUARTERS GROUP
- HQ (-) 4TH MLG
- HQ 4TH MARDIV
- HQ 4TH MAW
- HQ BN, MARINE FORCES RESERVE
- HQ CO HQ BN MARFORRES
- HQ CO(-) HQ BN
- HQ CO(-) INTEL SPT BN
- MARINE CORPS INDIVIDUAL
  RESERVE SUPPORT ACTIVITY
  2000 OPELOUSAS AVE
  NEW ORLEANS, 70146
  504-616-9448

- HQ DET. C, MAG-49
  400 RUSSELL AVE, BOX 30
  NEW ORLEANS, 70143
  504-678-3115

- HMLA-773 DET. A, MAG-49
- MALS 49 DET. C, MAG-49
  400 RUSSELL AVE, BOX 30
  NEW ORLEANS, 70143
  504-940-4905

MAINE

- CO A(-) 1ST BN 25TH MAR REGT
  101 FRANKLIN ST
  SACO, 04072
  207-751-6610

MARYLAND

- 24 D2 4TH DENTAL BN
  1 SAN DIEGO LOOP
  ANDREWS AFB, 20762
  240-857-4880

- DET HQSVC CO 4TH CBT ENGR BN
- DET CO A 4TH CBT ENGR BN
- DET HQ CO 4TH CBT ENGR BN
- ENGT SPT CO(-) 4TH CBT ENGR BN
- HQ CO 4TH CBT ENGR BN
  7000 HAMLET AVE
  BALTIMORE, 21234
  443-864-1211

- CO B 4TH LAR BN
  1276 BASE RD
  FORT DETRICK, 21702
  343-619-7136

- VMR ANDREWS
  1 SAN DIEGO LOOP, BLDG 3148
  JOINT BASE ANDREWS, 20762
  410-451-2071

MASSACHUSETTS

- DET 5 MAINT CO CLB 451 CLR 4
  115 BARNUM RD
  AYER, 01434
  978-784-1845

- DET B, MWSS-472 MWSG-47
- MASS-6(-) MACG-48
  570 PATRIOT AVE
  CHICOPEE, 01022
  413-374-3844

- HQ CO 1ST BN 25TH MAR REGT
- WPNS CO(-) 1ST BN
  25TH MAR REGT
- DET CO A 1ST BN 25TH MAR REGT
  53 QUEBEC ST
  DEVENS, 01434
  978-509-8775

- HQ CO 25TH MAR REGT
  4 LEXINGTON ST, BLDG 642
  FORT DEVENS, 01434
  978-796-3761

- MACHINE GUN PLAT SPT
  CO ANTI-TERRORISM BN
  700 EAGLE DR BLDG 3103 AFRC
  WESTOVER, 01022
  413-315-7426

MICHIGAN

- BRIDGE CO A 6TH ENGR SPT BN
- ENGR SPT CO(-) 6TH ENGR SPT BN
  101 BASE AVE
  BATTLE CREEK, 49015
  269-964-8882

- CO A 1ST BN 24TH MAR REGT
  1863 MONROE NW
  GRAND RAPIDS, 49505
  616-813-5579

- CO C 1ST BN 24TH MAR REGT
  3423 N MARTIN LUTHER
  KING JR BLVD
  LANSING, 48906
  517-819-0560

- DET B, MWSS-471 MWSG-47
  1435 N PERIMETER RD
  MOUNT CLEMENS, 48045
  586-405-0510

- 14 D4 4TH DENTAL BN
  25660 ELLSWORTH ST, BLDG 1409
  SELFRIDGE, 48045
  586-239-6289

- HQ CO 1ST BN 24TH MAR REGT
  27601 C ST, BLDG 1060
  SELFRIDGE, 48045
  313-647-1663

MINNESOTA

- MWSS-471(-)
  5905 34TH AVE S
  MINNEAPOLIS, 55450
  612-685-4803

- 4TH LAW ENFORCEMENT BN
  6400 BLOOMINGTON RD
  ST. PAUL, 55111
  619-726-1313

MISSISSIPPI

- DET 2 MAINT CO CLB 451 CLR 45
  4901 3RD ST BLDG 114
  GULFPORT, 39501
  228-871-3101

MISSOURI

- HQSVC CO 3RD BN 23RD MAR REGT
  10810 LAMBERT INTERNATIONAL BLVD
  BLDG 100
  BRIDGETON, 63044
  314-263-6434

- 14 D1 4TH DENTAL BN
  3100 EMANUEL CLEAVER II BLVD
  KANSAS CITY, 64130
  816-923-2341

- CLR 4 HQ CO
  3805 E 155TH ST, DYESS HALL
  KANSAS CITY, 64147
  816-843-3559
- NBC DEFENSE PLT CLR 4
  3805 E 155TH ST, DYESS HALL
  KANSAS CITY, 64147
  816-843-3545

MONTANA

- MP CO. D (-) LAW ENFORCEMENT BN
  2913 GABEL ROAD
  BILLINGS, 59102
  406-671-8404

NEBRASKA

- DET 1 MAINT CO CLB 451 CLR 45
  5808 N 30TH STREET
  OMAHA, 68111
  402-453-8807

NEVADA

- DET CO F 2ND BN
  23RD MAR REGT
  BLDG 1032, 5095 RANGE RD
  LAS VEGAS, 89115
  702-581-3315

NEW HAMPSHIRE

- CO B 1ST BN 25TH MAR REGT
  STE 107, 64 HARVEY RD
  LONDONDERRY, 03053
  978-766-1774

NEW JERSEY

- CO G 2ND BN 25TH MAR REGT
  BLDG 3306 PICATINNY ARSENAL
  DOVER, 07806
  973-885-3577

- 14TH HQ 4TH DENTAL BN
  5951 NEWPORT ST
  JOINT BASE MCGUIRE-DIX-
  LAKEHURST, 08640
  404-895-3637

- 1ST INTEL PRODUCTION TM
  CO C INTEL SPT BN
  BLDG 3601
  JOINT BASE MCGUIRE-
  DIX-LAKEHURST, 08640
  571-379-3535

- BTRY G 3RD BN 14TH MAR REGT
  BLDG 8610 RANGE RD
  JOINT BASE MCGUIRE-DIX-
  LAKEHURST, 08640
  609-847-7932

- HMLA-773 DET B, MAG-49
- HMM-772, MAG-49
- MAG-49 HQ
- MALS-49 DET B, MAG-49
- MWSS-472(-) MWSG-47
  4401 TEXAS AVE
  JOINT BASE MCGUIRE-DIX-
  LAKEHURST, 08640
  609-562-8711 (8721)(8713)

- ENVIRONMENTAL SERVICE DET
- HQSVC CO CLB 25 CLR 45
  338 NEWMAN SPRINGS ROAD
  RED BANK, 07701
  732-530-4500

NEW MEXICO

- CO D 4TH RECON BN
  8810 S ST SE, BLDG 20616
  ALBUQUERQUE, 87117
  505-604-2679

NEW YORK

- CO C 1ST BN 25TH MAR REGT
  3 PORTER AVE
  BUFFALO, 14202
  518-210-6729

- GS COMM CO 6TH COMM BN
- SVC CO(-) 6TH COMM BN
- HQ CO(-) 6TH COMM BN
- 6TH COMM BN
  1 AVIATION RD,
  FLOYD BENNETT FIELD
  BROOKLYN, 11234
  718-252-3100

- DET 2 HQ CO 4TH LAW ENF BN
  1 AVIATION RD,
  BROOKLYN, 11234
  718-252-3100

- CO I 3RD BN 25TH MAR REGT
  3 PORTER AVE
  BUFFALO, 14201
  426-467-2193

- DS COMM CO, 6TH COMM BN
- DET HQ CO, 6TH COMM BN
- DET SVC CO, 6TH COMM BN
  21 BAITING PLACE
  FARMINGDALE, 11735
  646-523-5746

- WPNS CO(-) 2ND BN
  25TH MAR REGT
  605 STEWART AVE
  GARDEN CITY, 11530
  516-642-7297

- HQ CO 2ND BN 25TH MAR REGT
  605 STEWART AVE
  GARDEN CITY, 11530
  516-228-5671

- MALS-49 MAG-49
  10 MCDONALD ST
  NEWBURGH, 12550
  845-857-4459

- VMGR-452 MAG-49
  10 MCDONALD ST
  NEWBURGH, 12550
  845-563-2956

- MAG-49 DET B
  10 MCDONALD ST
  NEWBURGH, 12550
  845-563-2956

- 14 D2 4TH DENTAL BN
  4 PENNYFIELD AVE
  NEW YORK, 10465
  718-892-0312

- CO E 4TH LAR BN
  1099 E MOLLOY & TOWN LINE RD
  SYRACUSE, 13211
  315-454-9577 X 1001

NORTH CAROLINA

- CO F 4TH TANK BN
  RR-120 RANGE RD
  CAMP LEJEUNE, 28542
  910-612-0930

- DET 1 TRANS SVC CO CLB 25 CLR 45
  PSC BOX 20110
  CAMP LEJEUNE, 28542
  910-440-2842

- RESERVE SPT UNIT/ DEPLOYMENT
  PROCESSING COMMAND EAST
  PSC BOX 20081
  CAMP LEJEUNE, 28542
  910-612-0930

- HQSVC CO CLB 451 CLR 45
  6115 NORTH HILLS CIRCLE
  CHARLOTTE, 28213
  704-598-0015

COLOR KEY

- COMM CO CLR 45
- DET 4 MAINT CO CLB 451 CLR 45
  7838 MCCLOUD RD
  GREENSBORO, 27409
  336-668-0866

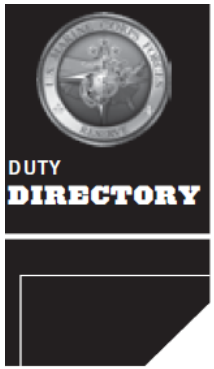
- SUPPLY CO CLB 451 CLR 45
  4725 WESTERN BLVD
  RALEIGH, 27602
  919-834-0003

NORTH DAKOTA

- DET MP SPT CO 4TH LAW ENF BN
  2003 4TH ST M STE A
  WAHPETON, 58075
  701-642-8001

OHIO

- HQ CO 3RD BN 25TH MAR REGT
  5572 SMITH RD
  BROOK PARK, 44142
  216-233-1575



- COMM CO(-) HQ BN
  3190 GILBERT AVE
  CINCINNATI, 45207
  513-256-5474

- CO L 3RD BN 25TH MAR REGT
  7221 SECOND ST
  COLUMBUS, 43217
  614-492-2971

- MP CO C, 4TH LAW ENF BN
  2936 SHERWOOD ST
  WRIGHT PATTERSON AFB, OH 45433
  937-257-0192

- WPNS CO(-) 3RD BN 25TH MAR REGT
  5986 W AIRPORT DR
  NORTH CANTON, 44720
  330-208-7776

- WPNS CO(-) 1ST BN 24TH MAR REGT
  28828 GLENWOOD ROAD
  PERRYSBURG, 43551
  419-392-3952

- DET 3 MAINT CO CLB 453 CLR 4
  BLDG 540, UNIT 90,
  3976 KING GRAVES RD
  VIENNA, 44473
  330-609-1910

OKLAHOMA

- ANTI-TANK TRAINING CO
- TOW SECT 1ST BN 23RD MAR REGT
- TOW SECT 1ST BN 24TH MAR REGT
- TOW SECT 1ST BN 25TH MAR REGT
- TOW SECT 2ND BN 23RD MAR REGT
- TOW SECT 2ND BN 24TH MAR REGT
- TOW SECT 2ND BN 25TH MAR REGT
- TOW SECT 3RD BN 23RD MAR REGT
- TOW SECT 3RD BN 24TH MAR REGT
- TOW SECT 3RD BN 25TH MAR REGT
  8000 E NEW ORLEANS
  BROKEN ARROW, 74014
  918-279-3812

- BTRY F, 2ND BN, 14TH MAR REGT
  5316 S DOUGLAS BLVD
  OKLAHOMA CITY, 73150
  405-370-7617

OREGON

- 4D2 4TH DENTAL BN
  6735 N BASIN AVE
  PORTLAND, 97217
  503-285-4566

- HQSVC CO(-) 6TH ENGR SPT BN
  6735 N BASIN AVE
  PORTLAND, 97217
  503-286-3962

- ENGR SVC CO CLB 23 CLR 4
  3106 PIERCE PKWY STE C
  SPRINGFIELD, 97477
  541-463-7296

PENNSYLVANIA

- BTRY I 3RD BN 14TH MAR REGT
  1400 POSTAL RD
  ALLENTOWN, 18109
  484-824-1435

- HQ BTRY 3RD BN 14TH MAR REGT
  2501 FORD RD
  BRISTOL, 19007
  267-236-4732

- 1ST & 2ND PLAT TRK CO
  25TH MAR REGT
  261 INDUSTRIAL PARK RD
  EBENSBURG, 15931
  814-241-7441

- TRUCK CO(-) 25TH MAR REGT
  3938 OLD FRENCH RD
  ERIE, 16504
  814-434-9116

- BRIDGE CO B 6TH ENGR SPT BN
  601 KEDRON AVENUES
  FOLSOM, 19033
  610-532-7959

- CO E 2ND BN 25TH MAR REGT
  2991 NORTH 2ND ST
  HARRISBURG, 17110
  717-421-6169

- DET A MWSS-471, MAG-41
  200 AVIATION DR
  JOHNSTON, 15902
  814-329-3983

- CO K 3RD BN 25TH MAR REGT
  625 E PITTSBURGH/MCKEESPORT
  NORTH VERSAILLES, 15137
  304-238-6282

- MP CO B, 4TH LAW ENF BN
  625 E PITTSBURGH/MCKEESPORT
  NORTH VERSAILLES, 15137
  412-672-3472

- SURG CO A(-) 4TH MED BN
  625 E PITTSBURGH/MCKEESPORT
  NORTH VERSAILLES, 15137
  412-672-3208

- MWSS-472 DET A, MWSG-47
  1118 WYOMING AVE
  WYOMING, 18644
  570-228-1947

PUERTO RICO

- DET 1 LNDG SPT CO CLR 45
  611 S TERMINAL RD
  FT BUCHANAN, 00934
  253-320-5776

RHODE ISLAND

- TRANS SVC CO CLB 25 CLR 45
  1 NARAGANSETT ST
  PROVIDENCE, RI 02905
  401-784-4108

SOUTH CAROLINA

- CO F 4TH LAR BN
  BLDG 3430, 5405 LEESBURG RD
  EASTOVER, 29044
  803-783-0759 X 11

- DET 3 SUPPLY CO CLB 451 CLR 45
  MCRC 2517 VECTOR AVE
  CHARLESTON, 29418
  843-743-2220

- DET 3 SUPLY CO CLB 453 CLR 4
  3976 KING GRAVES RD
  CHARLESTON, 29406
  843-794-2853

- DET 1 SUPPLY CO CLB 451 CLR 45
  669 PERIMETER RD
  GREENVILLE, 29605
  864-299-3937

TENNESSEE

- BTRY M 5TH BN 14TH MAR REGT
  4051 AMNICOLA HWY
  CHATTANOOGA, 37406
  423-242-8983

- CO D 4TH CBT ENGR BN
  2101 ALCOA HWY
  KNOXVILLE, 37920
  865-673-0407

- A DET 1 4TH MED BN
  2101 ALCOA HWY
  KNOXVILLE, 37920
  865-673-0407

- BRIDGE CO C, 6TH ESB
  3114 JACKSON AVE, BLDG 3114
  MEMPHIS, 38112
  901-324-8107

- CO K 3RD BN 23RD MAR REGT
  3114 JACKSON AVE, BLDG 3114
  MEMPHIS, 38112
  314-263-6204 X 250

TEXAS

- DET 1 MAINT CO CLB 453 CLR 4
  220 2ND ST
  ABILENE, 79607
  325-696-6878

- WPNS CO(-) 1ST BN
  23RD MAR REGT
  5102 EMMA BROWNING AVE
  AUSTIN, 78719
  512-497-0976

- BTRY D 2ND BN 14TH MAR REGT
  4810 POLLARD ST
  EL PASO, 79930
  915-726-3845

- 4TH HQ 4TH DENTAL BN
  1803 DOOLITTLE AVE
  FORT WORTH, 76127
  817-782-1805

- CO C 4TH AA BN
  MCRTC TWO FORT POINT BLDG 6B
  GALVESTON, 77550
  409-682-4368

- HQ BTRY 2ND BN 14TH MAR REGT
  312 MARINE FORCES DR
  GRAND PRAIRIE, 75051
  469-853-8424

- DET CO C 1ST BN 23RD MAR REGT
  1300 TEEGE AVE
  HARLINGEN, 78550
  956-202-3587

- CO A 1ST BN 23RD MAR REGT
- HQSVC CO 1ST BN
  23RD MAR REGT
  10949 AEROSPACE AVE
  HOUSTON, 77034
  713-419-3498

- 4D5 4TH DENTAL BN
10949 AEROSPACE AVE
HOUSTON, 77034
832-380-7400

- MOTOR T CO CLB 453 CLR 4
STE 1137, 301 E REGIS ST
LUBBOCK, 79403
806-763-2853

- CO C(-) 1ST BN 23RD MAR REGT
STE 134, 1430 DIMMIT DR
NAS CORPUS CHRISTI, 78419
361-815-3895

- DET B, MWSS-473
1410 BOYINGTON RD
NAS JRB FORT WORTH, 76127
817-782-2718/ 817-807-3917

- MAG-41 HQ
- MALS-41(-) MAG-41
1068 BOYINGTON DR
NAS JRB FORT WORTH, 76127
817-782-2718/ 817-807-3917

- MACS 24 ATC DET MACG-48
1068 BOYINGTON DR
NAS JRB FORT WORTH, 76127
817-782-2848

- VMFA-112 MAG-41
1048 BOYINGTON DR
NAS JRB FORT WORTH, 76127
817-782-2718/ 817-807-3917
- VMGR-234 MAG-41
1050 BOYINGTON RD
NAS JRB FORT WORTH, 76127
807-782-2933

- HQ BTRY 14TH MAR REGT
4210 HERCULES RD
SAN ANTONIO, 78219
817-822-8157

- CO C 4TH RECON BN
3837 BINZ-ENGLEMANN RD
SAN ANTONIO, 78219
210-867-4267

- HQ CO 4TH RECON BN
3837 BINZ-ENGLEMANN RD
SAN ANTONIO, 78219
210-867-4267

- DET 1 SUPPLY CO CLB 453 CLR 4
2515 COLLEGE DR
TEXARKANA, 75501
903-838-4341

- MAINT CO CLB 453 CLR 4
2100 N NEW RD
WACO, 76707
254-772-5541

UTAH

- CO C 4TH LAR BN
17800 CAMP WILLIAMS RD
RIVERTON, 84074
801-878-5801

- DET HQSVC CO 4TH LAR BN
17800 CAMP WILLIAMS RD
RIVERTON, 84074
760-725-7638

- CO F(-) 2ND BN 23RD MAR REGT
116 POLLOCK RD
SALT LAKE CITY, 84113
801-514-9779

VIRGINIA

- CO C 4TH CBT ENGR BN
314 GRAVES MILL ROAD
LYNCHBURG, 24502
540-295-0072

- HMM-774, MAG-49
- MALS-49 DET D, MAG-49
1430 CV TOWWAY DR
NAS NORFOLK, 23511
757-444-7818

- 24 D3 4TH DENTAL BN
1 NAVY DR
NAS NORFOLK, 23521
757-318-4500

- 3RD INTEL PRODUCTION TM
CO C INTEL SPT BN
- ALL-SOURCE FUSION PLT
CO C INTEL SPT BN
- CO C(-) INTEL SPT BN
- CO D 4TH LAR BN
- COUNTER-INTEL PLT CO C
INTEL SPT BN
26100 BAILEY AVE
QUANTICO, 22143
571-379-3535

- CO D 4TH LAR BN
26100 BAILEY AVE
QUANTICO, 22143
703-784-2798

- BTRY H 3RD BN 14TH MAR REGT
6000 STRATHMORE RD
RICHMOND, 23234
804-640-8635

- CO B 4TH CBT ENGR BN
5301 BARNES AVE NW
ROANOKE, 24019
540-295-0286

- CO A(-) 4TH AA BN
1 NAVY DR, SGT HARPER HALL
VIRGINIA BEACH, 23459
757-636-3484

- HUMAN EXPLOITATION PLT (-)
CO C INTEL SPT BN
1325 S BIRDNECK RD
VIRGINIA BEACH, 23451
571-379-3535

- MACS-24(-) MACG-48
- MACS-24 TAOC DET
- MACS-24 EWC DET
1325 S BIRDNECK RD
VIRGINIA BEACH, 23451
757-639-7939

WASHINGTON

- DET BULK FUEL CO A 6TH ESB
BLDG 9690, BOX 339500
FORT LEWIS, 98433
253-968-7119

- 1ST INTEL PRODUCTION TM CO A
INTEL SPT BN
BOX 339500, MIL STOP 105
JOINT BASE LEWIS
MCCHORD, 98433
858-537-8053

- HQSVC CO CLB 23 CLR 4
BLDG 9690, N L ST
FORT LEWIS, 98433
253-988-1071

- BTRY P 5TH BN 14TH MAR REGT
5101 N ASSEMBLY ST
SPOKANE, 99205
509-990-6416

- CO B 4TH TANK BN
1702 TAHOMA AVE
YAKIMA, 98902
509--728-3841

WEST VIRGINIA

- CO A 4TH CBT ENGR BN
103 LAKEVIEW DR
CHARLESTON, 25313
304-377-7043

WISCONSIN

- DET BULK FUEL CO B 6TH ESB
2949 RAMADA WAY
GREEN BAY, 54304
920-336-3070

- CO G 2ND BN 24TH MAR REGT
6001 MANUFACTURERS DR
MADISON, 53704
608-241-2022

- CO F 2ND BN 24TH MAR REGT
2401 S LINCOLN MEMORIAL DR
MILWAUKEE, 53207
414-481-3860

WYOMING

- E/WC DET MACS-23 MACG-48
BLDG 245, 5609 RANDALL AVE
F.E. WARREN AFB, 82005
303-947-3419

COLOR KEY

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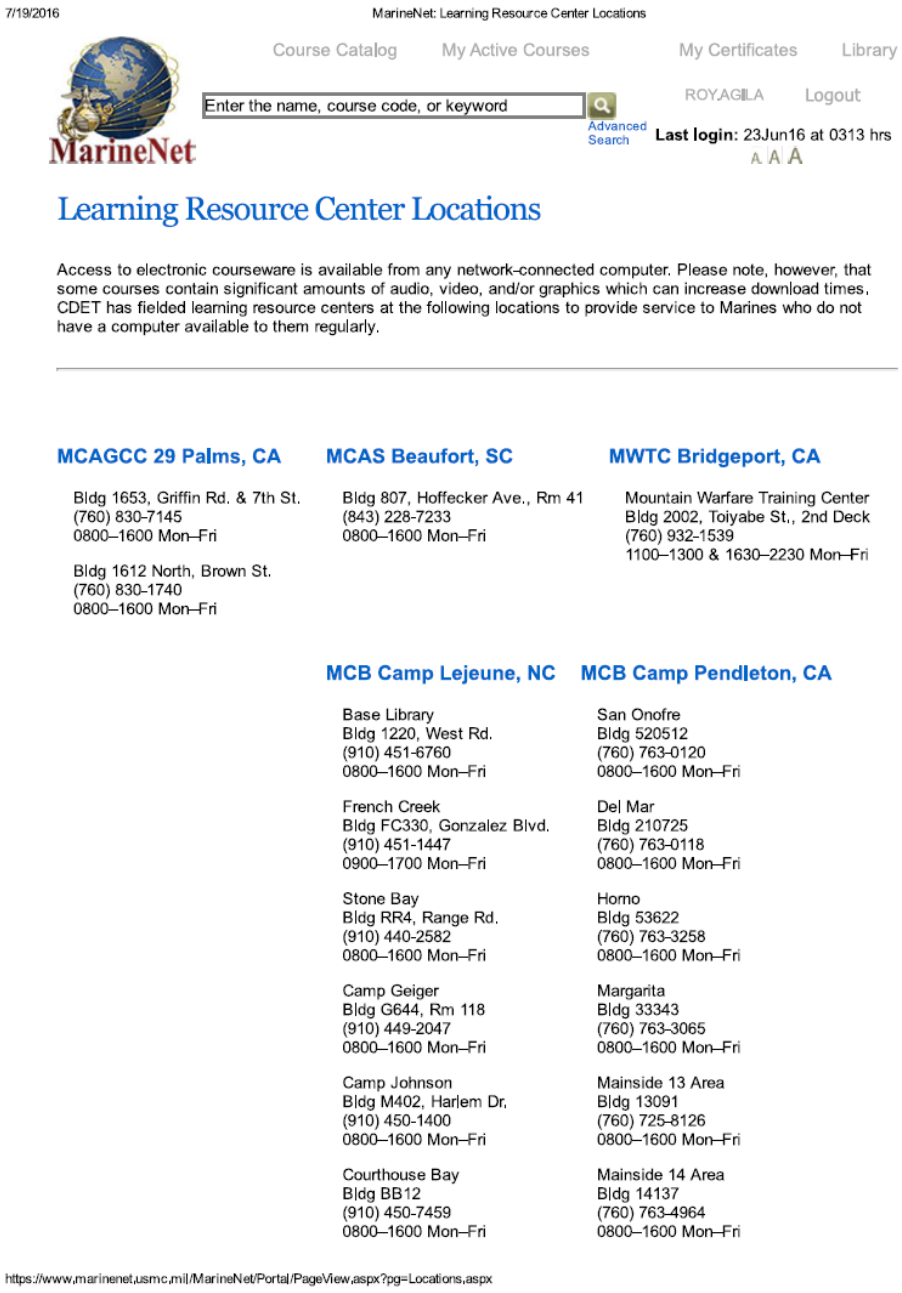
APPENDIX D. LRC LOCATIONS

Appendix D lists the locations of all LRCs (MarineNet, 2016a). When comparing both this appendix and Appendix C it is evident that the vast majority of MFR personnel does not have access to LRCs.



7/19/2016 MarineNet: Learning Resource Center Locations

Course Catalog My Active Courses My Certificates Library

MarineNet

Enter the name, course code, or keyword

Advanced Search

ROY.AGILA Logout

Last login: 23Jun16 at 0313 hrs

A A A

Learning Resource Center Locations

Access to electronic courseware is available from any network-connected computer. Please note, however, that some courses contain significant amounts of audio, video, and/or graphics which can increase download times. CDET has fielded learning resource centers at the following locations to provide service to Marines who do not have a computer available to them regularly.

MCAGCC 29 Palms, CA

Bldg 1653, Griffin Rd. & 7th St.
(760) 830-7145
0800–1600 Mon–Fri

Bldg 1612 North, Brown St.
(760) 830-1740
0800–1600 Mon–Fri

MCAS Beaufort, SC

Bldg 807, Hoffecker Ave., Rm 41
(843) 228-7233
0800–1600 Mon–Fri

MWTC Bridgeport, CA

Mountain Warfare Training Center
Bldg 2002, Toiyabe St., 2nd Deck
(760) 932-1539
1100–1300 & 1630–2230 Mon–Fri

MCB Camp Lejeune, NC

Base Library
Bldg 1220, West Rd.
(910) 451-6760
0800–1600 Mon–Fri

French Creek
Bldg FC330, Gonzalez Blvd.
(910) 451-1447
0900–1700 Mon–Fri

Stone Bay
Bldg RR4, Range Rd.
(910) 440-2582
0800–1600 Mon–Fri

Camp Geiger
Bldg G644, Rm 118
(910) 449-2047
0800–1600 Mon–Fri

Camp Johnson
Bldg M402, Harlem Dr.
(910) 450-1400
0800–1600 Mon–Fri

Courthouse Bay
Bldg BB12
(910) 450-7459
0800–1600 Mon–Fri

MCB Camp Pendleton, CA

San Onofre
Bldg 520512
(760) 763-0120
0800–1600 Mon–Fri

Del Mar
Bldg 210725
(760) 763-0118
0800–1600 Mon–Fri

Horno
Bldg 53622
(760) 763-3258
0800–1600 Mon–Fri

Margarita
Bldg 33343
(760) 763-3065
0800–1600 Mon–Fri

Mainside 13 Area
Bldg 13091
(760) 725-8126
0800–1600 Mon–Fri

Mainside 14 Area
Bldg 14137
(760) 763-4964
0800–1600 Mon–Fri

https://www.marinenet.usmc.mil/MarineNet/Portal/PageView.aspx?pg=Locations.aspx

8th Marine Regiment
Bldg 114, A St,
(910) 450-9486
0800–1600 Mon–Fri

2nd Marine Div
Bldg 510, N St,
(910) 449-9793
0800–1600 Mon–Fri

Camp Lejeune
Bldg 524, McHugh Blvd.
(910) 450-5168
0800–1600 Mon–Fri

Bldg 219, F St,
2 Mar Reg area
(910)-451-0920
0800–1600 Mon–Fri

Chappo
Bldg 220165
(760) 763-5035
0800–1600 Mon–Fri

Las Flores
Bldg 4157B
(760) 763-4654
0800–1600 Mon–Fri

Las Pulgas
Bldg 430406
(760) 763-1908
0800–1600 Mon–Fri

San Mateo
Bldg 62330
(760) 763-5280
0800–1600 Mon–Fri

MCAS Cherry Point, NC

Education Center
Bldg 4335, C St,
(252) 466-7190
0800–1600 Mon–Fri

MCDLP Fort Leonard Wood, MO

Bldg 1760, Cooley Ave.
(573) 596-0131 ext. 62797
0800–1800 Mon–Fri
1200–1700 Sat–Sun

MCB Hawaii, Kaneohe Bay, HI

Bldg 221, Rm 108
(808) 257-8724
0900–1700 Mon–Fri

Bldg 1045
(808) 257-8724
1200–2000 Mon–Fri

CBIRF Indian Head, MD

Bldg 3399, Strauss Ave., Rm 212
(301) 744-2037
0800–1600 Mon–Fri

MCAS Iwakuni, Japan

Bldg 497
0800–1600 Mon–Fri

MCAS Miramar, CA

Bldg 5305, Miramar Way
(858) 577-8743
0800–1600 Mon–Fri

MCAS New River, NC

HQ Area
Bldg AS 213, Bancroft St.
(910) 499-6737
0800–1600 Mon–Fri

MCB Okinawa, Japan

Camp Foster
Base Library
Bldg 5679
645-8002
0900–1700 Mon–Fri

Camp Schwab

MCRD Parris Island, SC

Bldg 923, Chosin Reservoir Rd., Rm 27B
(843) 228-3546
0800–1600 Mon–Fri

Base Education Center
Bldg 3429, Rm 213
625-3017
0800–1600 Mon–Fri

Camp Hansen
Base Education Center
Bldg 2339, Rm 206B
623-3037
0800–1600 Mon–Fri

Camp Kinser
Base Education Center
Bldg 1220, Rm 119
637-7600
0800–1600 Mon–Fri

MATSG-21 Pensacola, FL

3450 Farrar Rd,, Room D400
(850) 452-9460 ext. 3107
0800–1600 Mon–Fri

MCB Quantico, VA

Bldg 2006, Hawkins Ave,, Rm 332
(703) 784-4288
0800–1600 Mon–Fri

MCAS Yuma, AZ

Bldg 328, 2nd Deck
(928) 269-6501
0800–1600 Mon–Fri

Course Catalog
Military Training
Professional Military Education (PME)
Language and Culture
Family and Personal
Civilian Workforce Training
Professional Development Courses

Library
Reference Pubs/Docs
Career Course Seminar Materials
CSCDEP Materials
Enlisted PME
EWSDEP Materials
Job Aids
Language
MCNOSC
Multimedia
New Equipment Training Packages
Non-Lethal
Non-Tracked Courses
Officer PME
Optics
TAMIS

Help
Help Desk Contact Info
Help Yourself Topics
FAQs
Capture Browser Information

How Do I..
..Become a Proctor?
..Enroll in a Course?
..Check Computer Requirements?

MarineNet
Getting Access
Related Resources
Course Development

United States Marine Corps
COLLEGE OF DISTANCE EDUCATION AND TRAINING
TRAINING AND EDUCATION COMMAND
2300 A Louis Road
Quantico, VA 22134

Server: LMSIS2 **Version:** 5.1.6.5

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