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China's aggressive development of advanced energy weapons and long-range delivery systems — combined with an analysis of their strategic publications and discourse — demonstrate their desire to develop an asymmetric first-strike warfare capability to counter United States military assets in the Pacific. With eleven nuclear powered aircraft carriers and their supporting battle groups, the United States Navy continues to possess the world's foremost power projection capabilities. Although the Chinese are attempting to develop a similar capability, they are many years away from being able to match the U.S. in controlling the seas with naval forces. The Chinese are attempting to bridge this capability gap with technological solutions in the form of directed energy and electromagnetic pulse weapons. Data suggests that China may seek to level the playing field by utilizing these weapons in a surprise attack scenario to counter superior U.S. capabilities and technology. This paper will update and review current and developing advanced energy weapons technologies while analyzing China's progress in these areas of endeavor and assessing their intentions in the Pacific.

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MASTER OF MILITARY STUDIES

Leveling the Playing Field:
China's Development of Advanced Energy Weapons

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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United States Marine Corps

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DISCLAIMER

Executive Summary

Title: Leveling the Playing Field: China's Development of Advanced Energy Weapons

Author: Maj Brian P. Dennis, United States Marine Corps

Thesis: China's aggressive development of advanced energy weapons and long-range delivery systems — combined with an analysis of their strategic publications and discourse — demonstrate their desire to develop an asymmetric first-strike warfare capability to counter United States military assets in the Pacific.

Discussion: With eleven nuclear powered aircraft carriers and their supporting battle groups, the United States Navy continues to possess the world's foremost power projection capabilities. Although the Chinese are attempting to develop a similar capability, they are many years away from being able to match the U.S. in controlling the seas with naval forces. The Chinese are attempting to bridge this capability gap with technological solutions in the form of directed energy and electromagnetic pulse weapons. Data suggests that China may seek to level the playing field by utilizing these weapons in a surprise attack scenario to counter superior U.S. capabilities and technology. This paper will update and review current and developing advanced energy weapons technologies while analyzing China's progress in these areas of endeavor and assessing their intentions in the Pacific.

Conclusion: The United States military's dependence on technology is a potential weakness that could be exploited by a savvy adversary. The U.S. faces the challenge of striving to avoid conflict with a rapidly emerging power in the Pacific while developing the ability to counter advanced capabilities that have the potential to make current weapons and tactics obsolete. While prosperous peace in the Pacific is the overall objective, the United States must prepare for the worst-case scenario — a large-scale military conflict with China in the Pacific involving advanced energy weapons.

Preface

Since the first man picked up a rock and hurled it at another man, humans have been striving to find better and more efficient ways to defeat one another in combat. The technological arms race continues today as nation states strive to get to the next "game changing" breakthrough that will give them the decisive edge over their adversaries in time of war. China's pursuit of advanced energy weapons is just a present-day manifestation of this very phenomenon. Researching another project, I came across a declassified National Ground Intelligence Center report illustrating China's interest in advanced energy weapons; this certainly piqued my interest. The more I read, the more I became concerned with the U.S. getting caught off guard by technologies we weren't prepared to face. This paper will explain why the United States, while striving to improve and grow our partnership with China, must also keep a close eye on the military technologies they are developing.

I would like to express my appreciation to my advisor, Dr. Craig Swanson for taking on my project so late in the game; I'm truly thankful for his patience and mentorship. I also am indebted to the hard working personnel at the Gray Research Center, especially Rachel Kincaid; without their help, I couldn't have done any of this.

Glossary of Acronyms and Intialisms

A2AD:	Anti-Access/Area Denial
AAW:	Anti-Aircraft Warfare
ADS:	Active Denial System
AI:	Air Interdiction
AOC:	Air Operations Center
ASAT:	Anti-Satellite
BMD:	Ballistic Missile Defense
BVR:	Beyond Visual Range
C4i:	Command, Control, Communications, Computers, and Intelligence
C4ISR:	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAS:	Close Air Support
CIWS:	Close-In Weapons System
COIL:	Chemical Oxygen Iodine Laser
CVBG:	Carrier Battle Group
DEW:	Directed Energy Weapon
DPP:	Democratic Progressive Party
EMP:	Electromagnetic Pulse
FCG:	Flux Compression Generator
FEL:	Free-Electron Laser
GDL:	Gas Dynamic Laser
GPS:	Global Positioning System
HEL:	High Energy Laser
HEMP:	High-altitude Electromagnetic Pulse
HPM:	High-Powered Microwave
IADS:	Integrated Air Defense System
ICBM:	Intercontinental Ballistic Missile
IED:	Improvised Explosive Device
ISR:	Intelligence, Surveillance, and Reconnaissance
KMT:	Kuomintang Party
LWD:	Laser Warning Device
MANPADS:	Man-Portable Air Defense Systems
NCW:	Network Centric Warfare
NNEMP:	Non-Nuclear Electromagnetic Pulse
OSD:	Office of the Secretary of Defense
PBW:	Particle Beam Weapon
PGM:	Precision-Guided Munition
PLA:	People's Liberation Army
PRC:	People's Republic of China
RAM:	Rockets, Artillery, and Mortars
RF:	Radio Frequency
ROC:	Republic of China
SEAD:	Suppression of Enemy Air Defenses
UAV:	Unmanned Aerial Vehicle

> The country that best exploits the electromagnetic spectrum will win the next war. – Fleet Admiral Groshkov, Soviet Navy, 1974

Advantage, United States

During the late summer of 1958, tensions escalated into hostilities during the Second Taiwan Strait Crisis between the Republic of China (ROC, now known as Taiwan) and the People's Republic of China (PRC). On September 24, 1958, a flight of four U.S. built ROC F-86 Sabres launched as escorts for a photoreconnaissance mission over the mainland.[1] They gained a tally on an approaching flight of four PRC MiG-17 Frescos high above and initiated an intercept. Unknown to the MiG-17 pilots, the F-86s had secretly been equipped by the United States with the new GAR-8 Sidewinder missile (later to be redesignated the AIM-9) under a secret program called Operation Black Magic.[2] A small detachment of pilots and maintainers from Marine Fighter Squadron 323 was tasked with fitting the F-86s with the new missiles and teaching the ROC pilots how to use them.[3] The PRC pilots in their MiG-17s — though easily spotted due to their contrails while flying at 40,000 feet — thought they were safe, realizing that they were well outside of gun range and the reach of the F-86s due to their inferior performance at high altitudes.[4] Their perceived sanctuary was shattered when the first of their four-ship exploded in mid-formation; this moment would mark the world's first air-to-air missile kill.[5] The remaining MiGs were forced to engage the closing F-86s; the subsequent air battle would see another eight MiG-17s join the fray.[6] The end result of the engagement was ten PRC MiG-17s shot down — six of them by Sidewinders — with no ROC losses.[7]

From the time of Baron von Richthofen in World War I until that first Sidewinder kill, the basic tenets of air-to-air tactics had remained essentially unchanged: maneuver to your adversary's six-o'clock position, close to a distance of approximately 500 feet, and employ your guns until the enemy aircraft is destroyed or falls from the sky. Now a breakthrough in technology had changed all of that. It was possible for aircraft to employ weapons at far greater ranges and from higher angles in the rear quarter than ever before. Fuselage alignment and pulling lead were no longer necessary; after seeker acquisition and lock-on, the Sidewinder missile was a "fire and forget" weapon that could be launched from up to two miles away. It homed in on the infrared energy of the adversary's aircraft, closed the distance with incredible speed, and detonated its warhead, destroying the target or knocking it from the sky. These advantages became more pronounced through the years as ranges increased and the missiles attained all-aspect capability; the Sidewinder would go on to become the most lethal air-to-air missile in history, responsible for more than 300 subsequent kills.[8] The September 24th skirmish over the Taiwan Straits marked a quantum leap forward in air combat tactics; the world witnessed the birth of a new technology and the game of dog-fighting would never be the same.

The first employment of the Sidewinder in combat demonstrated how indeed there are technologies that are nothing short of game-changing. And while there have been many leaps in military technology since the dawn of air-to-air missiles in combat, perhaps none have the ability to rewrite the rules as much as advanced energy weapons, particularly in the form of directed energy weapons (DEWs) and electromagnetic pulse (EMP). As the U.S. was able to exploit a technological edge on the Chinese (by proxy via the ROC) with the Sidewinder missile system, China is actively looking to do the same with aggressive research and development in these highly complex fields in order to counter their potential American adversaries in the Pacific. This paper will review the basic concepts of DEWs and EMP weapons, assess China's current and future capabilities regarding these technologies, and analyze how they may look to exploit this capability in the future.

The Problem

In 2003, then Secretary of Defense Donald Rumsfeld stated in his *Transformational Planning Guidance*, "we must achieve: fundamentally joint, network-centric, distributed forces capable of rapid decision superiority and massed effects across the battlespace."[9] Network-centric warfare (NCW) became yet another "buzz-concept" for the future fight. The way ahead would be to "generate increased combat power by networking sensors, decision makers, and shooters to achieve shared awareness, increased speed of command, high tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization."[10]

The United States' experiences with Operations Enduring Freedom and Iraqi Freedom have demonstrated the full potential of NCW. During the past ten years, the speed at which warfare can be waged has progressed at a frantic pace. Lighting-fast lethal effects are delivered on order, facilitated by digital command, control, communications, computers and intelligence (C4i) integrated throughout the battlespace.[11] The ability of high-tech, computer-based systems and weapons to rapidly achieve success on the battlefield has become more and more impressive — and subsequently, addictive.[12] "Data links, displays, intelligence, surveillance, and reconnaissance (ISR) assets, satellite communications, computerized planning systems, global positioning system (GPS) receivers, radios, smart munitions, vehicles, aircraft, and all other systems required to support the networked force will derive their power, and potentially their doom, from fragile electronic systems."[13] The American way of war has become increasingly reliant on technology; this reliance is a critical vulnerability that could be exploited against the U.S. when facing a technologically savvy foe striving to attain an asymmetric advantage. The problem with most of the systems required to conduct NCW is that they are susceptible to DEWs and EMP weapons. Even without the network, most of our hardware faces the same problem; all of the systems listed above, from satellites to smart weapons, are vulnerable in one form or another to advanced energy weapons. Now that the problem has been framed, it's time to take a closer look at these potentially troublesome capabilities.

Game Changers: A Review

Energy, among the most basic components of our universe, also plays a fundamental part of every weapon; light, heat, sound, motion, explosive blast — all are forms of energy.[14] DEWs encompass a family of weapons that use some form of concentrated and directed energy to effect or destroy a target. The primary difference between DEWs and conventional weapons is that the latter typically relies on kinetic energy in the form of a projectile traveling at subsonic to supersonic speeds, while the former involves subatomic particles or electromagnetic radiation moving at, or near, the speed of light.[15] The capabilities of these weapons run the gamut from man-portable, non-lethal systems designed for crowd control, to advanced ground-based lasers designed to shoot down satellites, aircraft, and missiles.[16] Developed fully, this technology has the ability to revolutionize and change many aspects of warfare. DEWs can be broken down into three major categories: laser weapons, high-powered microwave (HPM) weapons, and particle beam weapons (PBWs).[17] However, currently DEWs primarily refer to laser and HPM weapons only. Although PBWs have a great deal of destructive power, research has demonstrated that the beams are very difficult to generate and propagate through the atmosphere with consistency.[18] This fact combined with the complicated power supply problems inherent in these weapons — and the exceedingly high costs required to solve them — make PBWs unlikely candidates for full-scale development in the foreseeable future.[19]

Laser Weapons

Laser weapons have been developed around the world for over forty years.[20] For the sake of brevity, this paper will forgo any discussions on lasers used for some of the more mundane tasks such as weapons guidance and range finding, and focus purely on weapons-grade high-energy lasers (HELs). HELs provide several distinct advantages over conventional weapons to include speed of light response, precision effects, limiting collateral damage, deep magazines, and low cost per kill.[21] As weapons, HELs can be broken down into two primary classifications: Low/medium-power applications and high-power applications.[22]

Low/medium-power HELs have a host of tactical uses on the battlefield. Known current and near-term capabilities include laser dazzlers (devices to warn or incapacitate individuals), aircraft self-protection lasers (in the form of infrared countermeasures), high-altitude precision air interdiction (AI), close air support (CAS), unmanned aerial vehicle (UAV) disruption/defeat, ISR disruption/defeat, and augmented air defenses against rockets, artillery, and mortars (RAM).[23]

High-powered HELs — usually in the form of chemical lasers — provide a heavier punch and make up the majority of the strategic applications that we would associate with some of the more varsity missions. The wide-ranging current and near-term capabilities of these powerful lasers include anti-satellite missions (ASAT), airborne ballistic missile defense (BMD), ground-based BMD, anti-aircraft warfare (AAW), maritime self-defense, and once again AI and CAS.[24] Figure 1 demonstrates the potential AAW capability of a high-powered HEL. The sequence depicts a Russian ground-based gas dynamic laser (GDL) engaging and destroying a target drone during the 1990s. Frame (1) shows the target before illumination, frame (2) shows the target during illumination, and frame (3) shows target breakup post illumination.

HEL DRONE ENAGMENT SEQUENCE

Figure 1.[25]

In addition to having the ability to defeat key technologies that militaries leverage for success on the modern battlefield, fully developed laser weapons have the potential to instantly render an entire generation of kinetic weapons obsolete. As an example, take beyond visual range (BVR) air-to-air missile employment. Virtually all tactics involving these weapons are predicated on the kinematic capabilities of the missiles and the associated "air-to-air timelines." U.S. fighter aircraft shoot missiles at their adversaries at various ranges and seek to exploit advantages based on factors such as the threat weapon's assessed range and speed. Subsequently, assumptions are made based on threat aircraft capabilities and limitations and the associated time-of-flight of their missiles. These factors and concepts drive all fighter tactics. A powerful and technologically advanced airborne HEL would render current tactics useless, as there is no time-of-flight to consider; an aircraft engaged by such a system would be destroyed, for all practical purposes, instantaneously.

HPM Weapons

HPM weapons include microwave and millimeter wave systems for mostly tactical or operational applications, but with growing strategic implications as well; the capabilities range from anti-sensor missions to lethal-effects anti-personnel weapons.[26] In the simplest terms, they have the ability to harm or kill humans and destroy and disrupt electronics and computer systems. There is some overlap and comparability with EMP weapons as some HPM weapons are designed with the same desired effects in mind. They operate primarily in the 1 MHz to 1 GHz frequency range and vary greatly in effectiveness and capabilities.[27] Their design characteristics are predicated on a multitude of parameters; for this reason these weapons are often characterized first by band ratio for the sake of simplicity:[28]

- Narrowband/continuous wave (band ratio about 1 percent)
- Narrowband/pulsed (band ratio about 1 percent)
- Wideband (band ratio < 100 percent)
- Ultrawideband (band ratio > 100 percent)

The U.S. currently has two HPM weapons that are programs of record, one of which is in service with the United States Marine Corps (the active denial system or ADS). Raytheon began developing the ADS in the mid-1990s; it became known in some circles as the "pain ray."[29] An HPM beam is focused on a human target, instantly heating the outermost layer of skin to 130° F.[30] The beam is designed not to inflict burns or any permanent damage, but the intense pain causes the targeted individual to flee.[31] Of course it is only a matter of tunable power output to make this weapon system lethal. The other program is the Vigilant Eagle Anti-Missile Defense System; based on a classified technology demonstrator, this HPM device is designed to defend aircraft against man-portable air-defense systems (MANPADS).[32] If fully developed, Vigilant Eagle could work as an alternative or complement to current infrared and radio frequency (RF) countermeasures installed on military aircraft.[33]

Nanotechnologies and component miniaturization are rapidly driving HPM weapons development. As electronics and computers continue to get smaller and cheaper, capabilities will steadily improve. While the programs listed above give U.S. examples of HPM weapons, Britain, China, France, India, Israel, Russia, and Ukraine all have comparable technologies.[34] Additional current and near-term capabilities include counter-improvised explosive device (IED), counter-vehicle (shutting vehicles down via electronic disruption/attack), counter-RAM (via disrupting guidance systems and fusing), counter-command, control, communications, computer, intelligence, surveillance and reconnaissance (C4ISR), suppression of enemy air-defenses (SEAD), and ASAT. Figure 2 depicts an example of an HPM weapon coupled with a cruise missile executing a SEAD mission.

HPM WEAPON PAIRED WITH CRUISE MISSILE

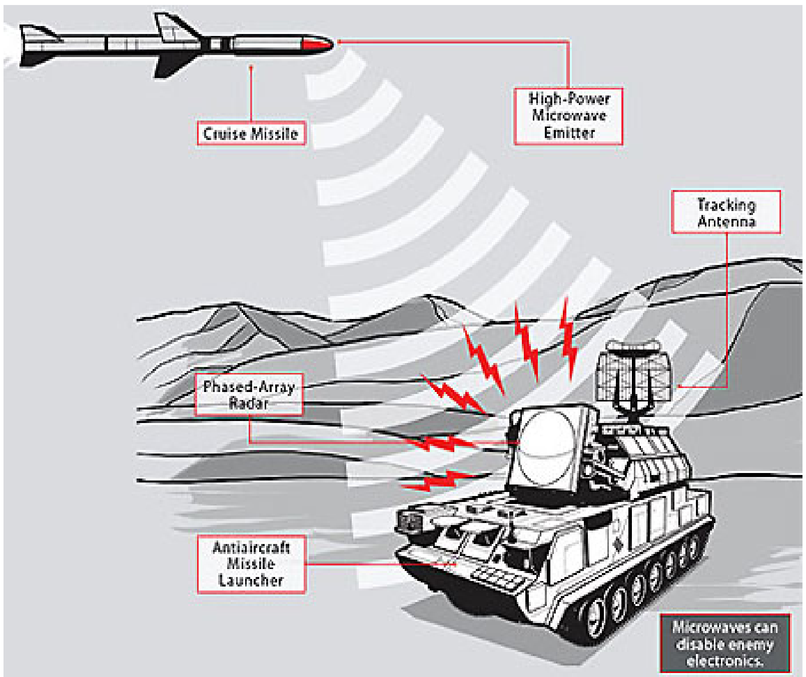

Figure 2.[35]

EMP Weapons

EMP weapons utilize a pulse of electromagnetic radiation to exploit the technology required for a given system to operate. Any type of solid-state electronics or computer-based systems would be vulnerable to such an attack. Generally speaking, the less sophisticated the technology, the more resilient the system is to EMP; simple technologies such as vacuum tubes and basic machinery would be unaffected by EMP weapons. The effect on anything run by computers, microchips, or processors would range from temporary incapacitation to permanent, irreversible damage, depending on the size and proximity of the EMP.[36] As mentioned previously, the U.S. military is heavily reliant on electronics and computer based systems; this presents an obvious problem.

EMP weapons provide a number of advantages to the user. First, EMP weapons do not require a detailed understanding of the systems they strike, nor do they require complicated weaponeering.[37] They indiscriminately attack all electronic systems, producing the desired effects through the destruction of circuits.[38] They are effective in all weather conditions and are scalable to a desired "effects footprint;" a single EMP weapon can limit its effects to an area the size of a basketball court or shut down an entire country.[39] EMP weapons can be difficult and costly to defend against; combat systems must be hardened throughout to protect against their effects.[40] Finally, EMP weapons do not directly harm human beings, which obviously has a tremendous amount of strategic applicability.[41] A massive, catastrophic attack could be conducted against a state without harming a single individual, perhaps lessening potential military or political responses.[42] These weapons can be classified into two primary categories: nuclear high-altitude electromagnetic pulse (HEMP) and non-nuclear electromagnetic pulse (NNEMP).

HEMP Weapons

HEMP weapons are the most powerful and technologically advanced of electromagnetic weapons.[43] The two basic components are a nuclear device and a delivery system. The concept of operation is to detonate a nuclear weapon between twenty-five and seventy miles above the earth's surface for optimized effects.[44] However, employment at altitudes of up to 250 miles with a 1-2 megaton device could shut down a country as large as the United States.[45] Employment of EMP on this scale is obviously problematic due to the technologies and hardware required. At the present time, the United States, China, France, India, Israel, Pakistan, Russia, and the United Kingdom have the ability to produce HEMP, with eleven other known countries diligently working to attain the same capabilities.[46] Figure 3 depicts the effective ranges of HEMP bursts at altitudes of 30, 120, and 300 miles.

HEMP EFFECTS RANGE RINGS

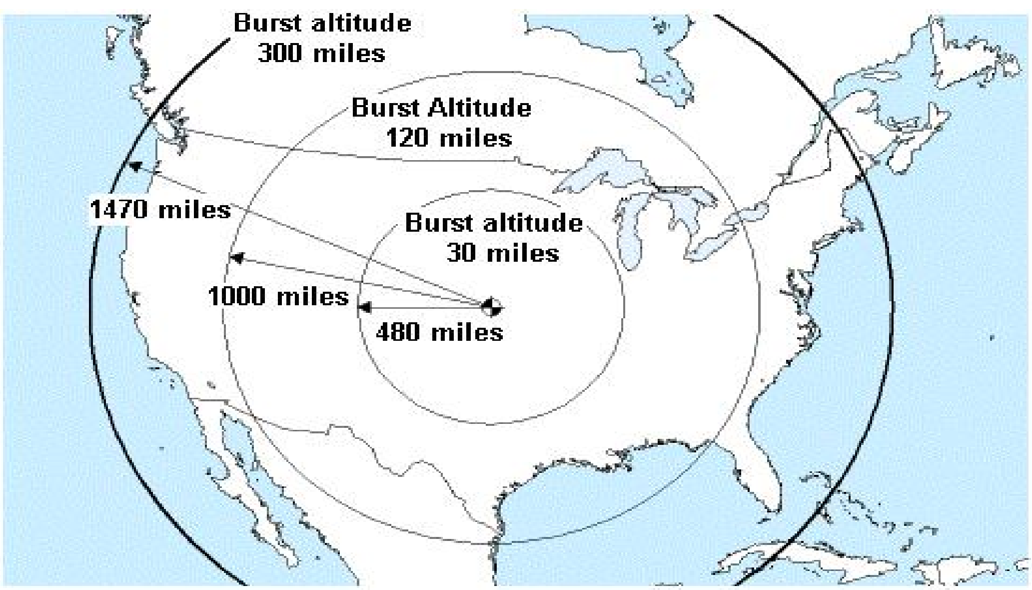

Figure 3.[47]

NNEMP Weapons

The world of NNEMP weapons includes any type of weaponized EMP not involving a nuclear detonation. As mentioned earlier, there are HPM weapons which fall into this category; these weapons straddle the line as DEWs that are capable of producing EMP effects. Since HPM weapons were covered earlier, this section will focus on the remaining major NNEMP weapons category: Electromagnetic Bombs, also known as E-bombs.

E-bombs utilize "conventional explosives to destroy a pre-charged electric circuit in a way that produces a desired electromagnetic wave. Since they destroy themselves to generate the pulse, they are inherently single-use devices suited to projectile munitions or suitcase bombs."[48] The two most prolific examples of the E-bomb are the explosively pumped coaxial flux compression generator (FCG) and the virtual cathode oscillator (vircator).[49] Without delving too deeply into the technological details of these weapons, suffice to say that FCGs and vircators need to be much closer to the intended target for the desired effects as compared to a HEMP weapon; the effective ranges are measured in meters and miles as opposed to countries and continents.[50] As with HPM, nanotechnologies and shrinking components are rapidly advancing this sector. Virtually all of the top industrialized nations currently have the capability to produce these weapons in one form or another.[51]

For warfighting applicability, consider an EMP attack on a U.S. aircraft carrier and its battle group. An EMP of sufficient size would have the ability to shut down all electrical systems on the ship. Communications, radar, and navigation systems — not to mention the ship's self-protection capabilities in the form of the SM-2 missile and the

Phalanx close-in weapons system (CIWS) — would all be disabled. Aircraft flying in the vicinity of the carrier are equally vulnerable; with their dependence on computers and electronic circuits to manage all aspects of flight, U.S. planes would literally fall from the sky.

China's Pursuit of Game Changers

As mentioned previously, all of the world's major powers, including the United States, are actively pursuing technologies in these areas. And China as a burgeoning superpower is assessed by several sources to have among the world's most highly developed and secretive advanced energy weapons programs.

In the mid-to-late 1980s, the Soviet Union was assessed to possess technologies in DEWs and EMP weapons roughly akin to that of the United States. Although stymied by the post-Cold War collapse of their economy and the restructuring of their government and defense industries, modern-day Russia has continued to develop some very advanced technologies in this field of endeavor. Historically, the Russians have sold or shared many of their weapons systems to China; the Chinese continue to attain these systems through various means and have demonstrated an ability to reverse-engineer and produce them indigenously.[52] The Chinese have also proven themselves to be exceptionally skilled at industrial and technological espionage; "the PRC has utilized its intelligence services and employed other illicit approaches that violate U.S. laws and export controls"[53] on many occasions. Two recent cases were highlighted in the OSD's (Office of the Secretary of Defense's) *Security Developments Involving the People's Republic of China 2011*:

- In August 2010, Noshir Gowadia was convicted of providing the PRC with classified U.S. defense technology. Gowadia assisted the PRC in developing a low-signature cruise missile exhaust system capable of rendering a cruise missile resistant to detection by infrared missiles.[54]

- In September 2010, Chi Tong Kuok was convicted for conspiracy to illegally export U.S. military encryption technology and smuggle it to Macau and Hong Kong. The relevant technology included encryption, communications equipment, and GPS equipment used by U.S. and NATO forces.[55]

Although neither of these cases involved advanced energy weapons, they speak volumes about China's intentions regarding the aggressive pursuit of cutting-edge technologies to advance their defense sector. Perhaps China's future ambitions regarding DEWs and EMP weapons are best summed up in the following assessment of the technologies they currently have or are in the process of developing:

> Long-range beam weapons would use narrow RF beams to engage targets such as aircraft or PGMs (Precision Guided Munitions). Short-range systems would be packaged into missiles or artillery shells and launched into the vicinity of targets such as radars or command posts before releasing an RF pulse. In recent years, the application of RF weapons has expanded to include deployment on small vehicles or in suitcases for targeting critical military or civilian infrastructures where close access is possible.[56]
>
> PRC officials have publicly indicated their intent to acquire RF weapons as a means of defeating technologically advanced military forces. Chinese writings have suggested that RF weapons could be used against C4ISR, guided missiles, computer networks, electronically-fused mines, aircraft carrier battle groups, and satellites in orbit.[57]
>
> Analysis of Chinese technical literature indicates a major effort is underway to develop the technologies required for RF weapons, including high-power energy sources, prime-power generators, and antennas to radiate RF pulses. Chinese scientists are also investigating the effects of RF pulses on electronics and the propagation of these pulses through building walls and through the atmosphere. Furthermore, China appears to be assessing its own vulnerability to RF weapons and exploring ways to "harden" electronics.[58]

The PRC is strong in both of the major fields of energy weapons, but has been particularly busy with its DEWs program. In 2008 an Australian Defense Journal determined that the Chinese have a major research program dedicated to the development of high-powered lasers for military use.[59] Technologies are being pursued in the fields of chemical oxygen iodine lasers (COIL) and free electron lasers (FEL), both critical for the weaponization of these systems.[60] The Australians found no less than thirteen papers covering COIL physics, demonstrating a keen understanding of the technologies required to advance in this highly complex field. Another twenty-five papers were found regarding FEL physics showing the same trend.[61] As early as 1999, intelligence reports indicated that more than 10,000 personnel — to include 3,000 engineers in 300 scientific research organizations — were dedicated to the research and development of high-powered lasers; at the time, this devoted over forty percent of their laser research efforts directly to military applications.[62] The data shows that concerning DEWs, the Chinese are quite advanced and intend to aggressively expand these capabilities.

China's development of EMP weapons and technology follows similar trends. As mentioned earlier, the PRC already possess the capability to employ HEMP. It is also clear that they have NNEMP technologies and will continue to improve them.[63] A recently declassified U.S. defense intelligence report revealed Chinese medical tests which had applicability to EMP weapons, specifically HPM variants. Analysts deduced that the tests were likely conducted to establish baselines of safe exposure for humans operating HPM devices.[64] Similar to the assessment of their DEWs programs, the PRC is currently very capable in the arena of EMP weapons and continues to progress steadily.

China's Intentions

China's *Defense White Paper for 2010* summarized the national defense strategy with four primary goals:[65]

- Safeguarding national sovereignty, security and interests of national development
- Maintaining social harmony and stability
- Accelerating the modernization of national defense and the armed forces
- Maintaining world peace and stability

While these ideas sound rather non-threatening, there are still several sources of tension with the U.S. which could escalate and result in hostilities, perhaps the most obvious being the situation with Taiwan. The OSD's 2011 Congressional Report concluded, "The possibility of a military conflict with Taiwan, including U.S. military intervention, remains a pressing, long-term focus for the PLA (People's Liberation Army). In the absence of a peaceful cross-Strait resolution or long-term non-aggression pact, the Taiwan mission will likely continue to dominate PLA modernization and operational planning."[66]

And while the PRC claims a defense only security strategy (their stated policy is to attack only if attacked first), recent rhetoric suggests they may act otherwise.[67] A work titled *The Science of Military Strategy* published by the PLA's Academy of Science states:

> The definition of an enemy strike is not limited to conventional, kinetic, military operations. Rather, an enemy strike may also be defined in political terms. Thus: Striking only after the enemy has struck does not mean waiting for the enemy's strike passively . . . It doesn't mean to give up the "advantageous chances" in campaign or tactical operations, for the "first shot" on the plane of politics must be differentiated from the "first shot" on that of tactics . . .

> If any country or organization violates the other country's sovereignty and territorial integrity, the other side will have the right to "fire the first shot" on the plane of tactics.[68]

This form of logic could be used to defend the Japanese attack on Pearl Harbor in 1941. If China purports to recognize some form of political action as a "strike," this significantly alters the idea of an "attack only if attacked" national strategy. It can therefore be deduced that this writing implies that PLA forces may be employed preemptively in the name of "defense."[69]

This idea is corroborated by a defense intelligence report which suggests that China may seek to use advanced energy weapons as part of what they refer to as an "Assassin's Mace" or "Trump Card" (*Sha Shou Jian* in Chinese) strategy, intended to negate the firepower and reach of U.S. Navy carrier battle groups (CVBGs).[70] This could come in the form of a combined-arms attack utilizing the full spectrum of DEWs and EMP weapons.

When paired with China's newest anti-access/area-denial (A2AD) delivery systems, precision guided NNEMP weapons could currently range out to nearly 1,200 miles from shore; future capabilities are predicted to be able to range out to 2,000 miles[71] (Figure 4 below breaks down the available number of various delivery systems as of 2011). This will effectively give China the ability to influence and potentially destroy ships (or surface targets for that matter) as far away as Guam. If precision is not required, an inter-continental ballistic missile (ICBM) could be used to deliver a HEMP weapon over 7,000 miles away.[72] Finally, if the ability to employ advanced energy weapons were to be paired with China's growing submarine fleet, they would have the capability to attack targets around the world with little response time, to include U.S. military bases, cities, and CVBGs.

AVAILABLE DELIVERY SYSTEMS

China's Missile Force			
System	Missiles	Launchers	Range
ICBM	50-75	50-75	2,900-7,000+ nm
IRBM	5-20	5-20	1,600+ nm
MRBM	75-100	75-100	950+ nm
SRBM	1,000-1,200	200-250	160-320+ nm
GLCM	200-500	40-55	800+ nm

Figure 4.[73]

There is no shortage of discussion and speculation on how China intends to use such technologies and what their plans are for power projection in the Pacific. Although they profess a policy of non-aggression, these weapons certainly give them a first-strike capability against U.S. assets and allies throughout the Pacific Rim[74] (see Figure 5 below). At the very least, if fully developed, they provide an extremely powerful deterrent and negotiating tool that is at least as persuasive as a U.S. CVBG. Finally, keep in mind that all of the information in this paper is via open and unclassified sources and does not speak to what the Chinese have achieved or are developing in secrecy.

DELIVERY SYSTEM RANGES

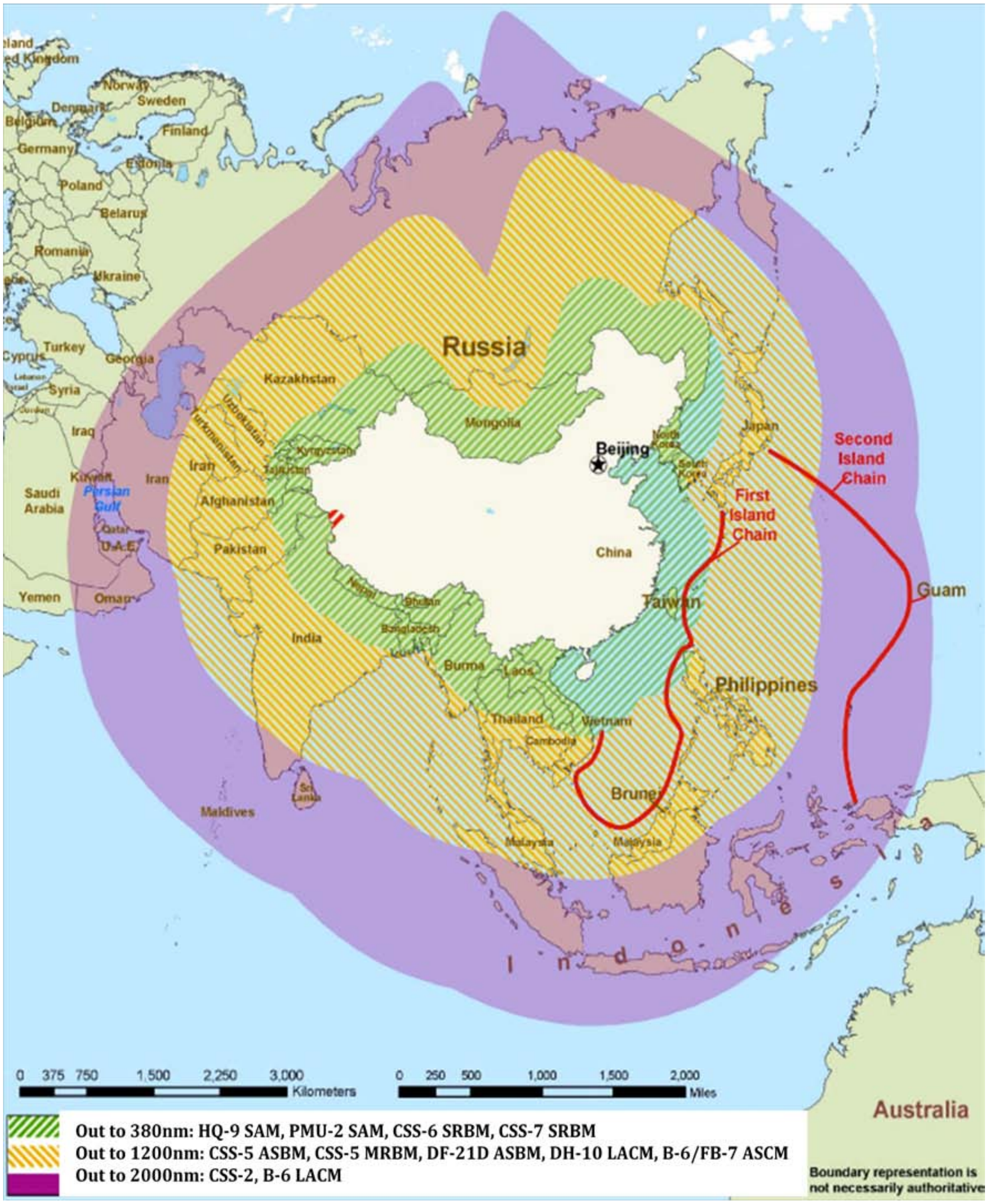

Figure 5. [75]

Western Pacific Battle Scenario 2020

So how might an advanced energy weapons engagement between the U.S. and China unfold? The following is a fictional scenario that examines future capabilities that could be used against the U.S. and Taiwan during a cross-Straight escalation of hostilities:[76]

It's early December, 2020. After winning the presidential election for the first time since 2008, the Democratic Progressive Party (DPP) has been pressing their separatist agenda with China and the U.S for several months. Seeing this as a regression from the movement towards reunification made possible over the previous twelve years by the ruling Kuomintang party (KMT), leadership in Beijing has had enough.

Over a period of several weeks, a contingent of eighty PLA special operations forces has infiltrated Taiwan. They blend into the populace as they mill about in civilian clothes. Just before dawn on December 7th, they plant an array of suit case bombs containing FCGs around major power plants, communications centers, air traffic control stations, and air defense radar sites throughout the island nation. All seventy of the FCGs detonate at precisely 0400 local time, plunging Taiwan into a total power and communications blackout. At the same time, twenty-five ground-based HEL lasers fire at U.S. reconnaissance satellites in a coordinated attack, effectively blinding the senior military leadership of the United States and Taiwan.[77]

At 0405 a massive volley of 200 CSS-6 GPS-guided missiles is launched against Taiwan's air defense radars, Patriot missile batteries, military airfields, and ballistic missile launchers. Without any communications or cueing, the integrated air defense systems (IADS) are helpless to defend against the massive attack. Within twenty minutes, Taiwan is blind, deaf, and virtually defenseless, with over ninety percent of its IADS and all of its usable runways destroyed. It will be another four days before any essential power or communications services are restored.[78]

As the FCGs were detonating all over Taiwan, a coordinated NNEMP strike was launched on the USS *Ronald Reagan* carrier battle group cruising 400 miles southwest of Taiwan. The CVBG had been dispatched to the area as a deterrent to the deteriorating situation; needless to say, the ploy did not work. The surprise attack on the *Reagan* and its battle group utilizes a combination of hundreds of stealthy cruise missiles and tactical decoys, with launches coordinated from the mainland and eight Chinese submarines. The cruise missiles use millimeter-wave terminal guidance to get in close enough to detonate their conventional vircators. All efforts were concentrated on the carrier itself and the battle group's Aegis cruiser, USS *Vicksburg*. The CVBG's defenses are overwhelmed; the *Reagan* and *Vicksburg* are taken off the grid by EMP and the battle group is now, for all intent and purposes, combat ineffective and defenseless. Several pilots flying in the vicinity of the carrier have to eject as their flight control computers fail and their digital displays go blank.[79]

The Joint Chiefs are scrambling for information after the president informs the chairman that the Chinese president is on the red phone; he wants to discuss the reunification of "One China" while simultaneously apologizing for turning the lights out on a U.S. carrier battle group and ruining a few of our reconnaissance satellites.[80]

How likely is the above scenario? It is certainly debatable, but it illustrates how a technologically savvy adversary could render all of the United States' NCW super-toys worthless in a matter of minutes if it is not prepared. It further demonstrates how effective a coordinated suitcase bomb attack by special operations forces or terrorists could be on U.S. assets, home or abroad. How difficult would it be to carry this out against Kadena Air Base or Marine Corps Air Station Iwakuni while executing an even more aggressive attack?

Conclusion

China's declared strategies, actions, and their pursuit of advanced energy weapons warrant vigilance on the part of the U.S. It is apparent that they are attempting to find a capabilities gap in order to exploit the United States' reliance on technology and provide an asymmetric counter to its powerful Navy in the event of hostilities. Although the United States should continue to foster friendship with the Chinese via diplomacy, economic engagement, and strategic communications, U.S. forces must prepare for the worst — the possibility of a major conflict in the Pacific Rim involving advanced energy weapons. There are many points of stress which could strain relations in the future to include the situation with Taiwan, competition for resources in disputed territories, U.S. military expansion in the region, and continued trade imbalance between the two powers.

Preparing for the worst means fixing what is broken. First the U.S. must harden its combat systems to be resistant to advanced energy weapons. Robust electromagnetic protection should be built into systems during the design phase; it is estimated that an increase of only one to five percent of total production cost is incurred protecting systems from EMP.[81] Additionally, preemptive measures should be taken in any combat environment where EMP could be encountered. In a paper analyzing EMP threats, Colin R. Miller offered some seemingly simple measures that could be taken to protect U.S. combat systems:

> Shielding the environment is a cost-effective solution for EMP protection when a large number of essential electronic devices are collocated. An air operations center (AOC) provides a good example. Incorporating a grounded metallic shield into the building structure and surge protecting power, communications, and antenna lines could protect an entire AOC from EMP. Mobile systems require a different means, such as a Faraday cage, which can protect individual components. A Faraday cage is simply a metallic mesh built around an electronic circuit (such as a fighter aircraft flight control computer) that protects it from EMP.[82]

In addition to preemption and hardening current systems, the U.S. military must leverage technologies that are resistant to advanced energy weapons when designing future combat systems. A promising field in this arena is that of advanced fiber-optics. Electromagnetic waveforms cannot harm or disrupt an optical fiber due to the fact there are no electrical conductors in the fiber.[83] During the 1950s, U.S. missile silos were connected to the outside world with fiber-optic cables to resist the EMP that would accompany a nuclear strike.[84] This is an old page in the playbook that has just as much relevance today as it did sixty years ago. Fiber-optic technology developed as the backbone of the Internet has advanced to the point where it can replace wire in most electronics and many electrical power applications.[85]

Another EMP resistant technology is all-optical computers and circuitry. Connections in optically integrated circuits are via optical waveguides; optical fiber is used between the individual chips.[86] There are no metal or electronic parts as information and power is conveyed with photons.[87] Photons are uncharged particles and, unlike electrons, are unaffected by electromagnetic interference.[88]

In addition to protecting systems from the EMP threat, future combat systems will need laser protection as well. Special coatings are one solution to this problem, but will not stop some of the more robust and powerful lasers in development.[89] Laser countermeasures are another answer to this threat; these can be in the form of aerosols, smoke, or any other obscurant that can breakup or weaken the beam being fired at the targeted system. A final technology that could help with laser protection is that of laser warning devices (LWDs). LWDs are sensors that detect laser energy, providing early warning to the system being targeted. The challenge lies in building LWDs that can detect the threat laser light fast enough for the target to evade the offending beam or launch countermeasures to protect itself.[90]

Perhaps more important than any technology or magic bullet that can save U.S. forces from advanced energy weapons is training. Simply put, the United States military must train to the threat of operating against DEWs and EMP weapons. Whether it is a platoon of Marine infantry, or a full carrier battle group, commanders must ensure they are ready to operate in this environment. Staffs should thoroughly explore the realm of "what ifs" that should be raised when considering the capabilities of advanced energy weapons. What if the Link-16 system (a vital combat data link) is taken out? What if the radars are down? What if they've blinded all of our ISR assets? What if communications are down between all players? Is there a back up plan? The time to be considering these contingencies is not as a PLA vircator is being employed over your headquarters. The Romans had an old saying: *Amat Victorium Curam*, translation: Victory Loves Preparation. And while conducting training and exercises under such conditions will be painful and frustrating, they will ensure the high level of readiness required to deal with the worst-case scenario.

Throughout history there have been watershed moments in technology which have changed all the rules. From repeating rifles to machineguns to nuclear weapons, from balloons to biplanes to supersonic jet aircraft, nations have either stayed ahead of the technological power curve or suffered the consequences. The United States' current relationship with technology presents a paradox. While it is incumbent upon the U.S. to stay ahead of its potential adversaries in advanced technologies, it also needs to reduce its dependence on what could be viewed as a crutch that could be kicked out from under it in time of war. The many years that have transpired since the end of the Cold War have desensitized the latest generation to the threat of EMP. Combined with DEWs, these capabilities present what are perhaps the largest asymmetric threats that could be presented in modern warfare. The United States cannot afford to stumble into a fight where its primary warfighting systems and tactics are rendered useless by the adversary's first volley, lest metaphorically, U.S. troops find themselves in the cockpit of a guns-only MiG-17 battling a Sidewinder equipped adversary in his shiny F-86 Sabre.

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