DIGITIZATION'S EFFECT ON FIRE SUPPORT COORDINATION MEASURES

A Monograph
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ABSTRACT

TO BE OR NOT TO BE - THE EFFECTS OF DIGITIZATION ON FIRE SUPPORT COORDINATION MEASURES by MAJ Robert M. Algermissen, USA, 56 pages.

This monograph explores the potential effects of digitizing the armed forces on fire support coordination measures. Digitization's inherrent enhanced speed and breadth of information transfer capabilities increases battlefield tempo, forcing a reexamination of core combat/tactical processes to determine their most efficient execution. Fire support coordination measures are one of the core processes that must be reexamined.

This monograph first examines technology's impact on the development and relevance of current fire support coordination measures. Next examined is the current digitization of the battlefield and the battlefield architecture for the immediate future to speculate on the effect that horizontal and vertical integration of the battlefield will have on the fire support system. Current tactical fire support doctrine is examined, focusing on current problems in fire support. Next, force digitization and its effects on fire support coordination measures is analyzed.

The monograph concludes that the application of digital technology will change some, but not all, fire support coordination measures. The monograph also addresses implications for joint and coalition operations when different levels of digital technology are available throughout the battle area.

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INTRODUCTION

To be effective, combined arms and joint forces commanders must be able to integrate the warfighting functions and the capabilities of all available forces and service components. The goal of today's military leaders is to learn to use evolving digital communications technology to ensure that all the services are functionally integrated and, thereby, truly interoperable.[1]

Interoperability is, "The ability of systems, units, or forces to provide services to, and to accept services from other systems, units or forces, and to use the exchanged services to operate effectively together."[2] To achieve interoperability through the use of digital technology requires a paradigm shift in current doctrinal processes. The enhanced situational awareness provided by the new digital technology is expected to increase friendly operational tempo to a point where our forces will outpace any adversary. The challenge is to define the core combat/tactical processes and find the most efficient ways to accomplish them across branch and service boundaries.[3]

The fire support coordination system is one of the core systems that must be reexamined. One of the areas already mentioned by various Army leaders for possible refinement or elimination is the use (and necessity for) fire support coordination measures (FSCMs) designed to coordinate fires of all sorts with maneuver forces.[4] Specifically this paper asks: Will there be a reduced requirement for fire support coordination measures in a digitized force?

Clearly the requirement for such measures would be diminished if the digitized forces' equipment would facilitate the rapid engagement of targets, and could equal or improve force protection better than do current fire support coordination measures. To improve safeguards, equipment would have to improve the capability to track friendly soldiers and vehicles in a unit's battlespace, and prevent friendly units from firing on other friendly soldiers in the absence of deliberately over-riding the digital system.

The structure of current fire support coordination procedures affects their efficiency. The system is layered. A request for fire support at any level must be processed through at least one superior fire support element before it is forwarded to the appropriate fire support headquarters. From there it is transmitted to the "shooter" (artillery battery, Army aviation or Air Force aircraft, or electronic warfare system). Limitations of current communications systems force this layering. As a consequence the fire support system is slow. Every level where the request for fire is reviewed before being forwarded to the "shooter", adds to the time it takes for the mission to be executed and effects on the enemy target realized.

In order to examine the continuing requirements for fire support coordination measures in a digitized force, this paper is organized as follows. Section One reviews the history, development and relevance of current FSCMs with particular attention paid to historical examples of the impact of technology on their evolution. Section Two discusses the current digitization of the battlefield and the battlefield architecture for the immediate future to speculate on the effect that horizontal and vertical integration will have on the overall fire support system. It also reviews current tactical fire support doctrine. The analysis focuses on the current problems in fire support, including problems with digital equipment already in the field. Section Three analyzes the effects of digitizing the force on fire support coordination measures. Section Four presents a final analysis and conclusions. Implications for the fire support community are determined.

THE EVOLUTION AND NECESSITY FOR FIRE SUPPORT COORDINATION MEASURES

"Every battle will present distinctive features of its own, necessitating adoption of methods suitable to the requirements of the case."[5]

Fire support coordination measures are designed to assist prosecuting war. They "are designed to facilitate the rapid engagement of targets and, at the same time, provide safeguards for friendly forces. They ensure that fire support will not jeopardize troops safety, will interface with other fire support means, and/or will not disrupt adjacent unit operations."[6] In order to maintain the tempo of modern operations, "commanders will use the minimum measures necessary for effective control of combat and sustaining activities."[7]

Fire support coordination measures are joint. Those currently used by the Army are also used by the rest of the US Armed Forces. This reduces confusion and potential misunderstanding when the sister services operate together in war.

Throughout history the employment of fire support assets on the battlefield has been influenced greatly by advances in technology. A review of the history of fire support coordination measures demonstrates the paradigm shift that occurs when major advances in technology are applied in the fire support arena. The birth of indirect fire support began an era when increased lethality of direct fire weapons forced the foot soldier to depend increasingly upon artillery fired from defilade to prepare his way. In general, infantry operations were predicated on the availability of artillery coverage.[8]

The new method of indirect fire support led to the development of fire support coordination measures. Early fire support coordination measures consisted of boundaries and phase lines. The boundaries separated unit areas of responsibility. The artillery fired beyond the phase lines, thus separating the effects of artillery fires from the supported maneuver forces.

The lack of effective communications prevented the infantry from speaking with their supporting artillery. Various methods were attempted to help observers, who were restricted from moving forward by the immobile field telephone, determine the location of friendly troops. Advancing forces sewed white cloths on the backs of their uniforms. Colored flares and signal lamps were also used.[9] These visual signals were effective only during periods of good visibility. The smoke and dust raised during an attack often obscured the forward forces from the observers early on in battle.

The more sophisticated armies began using aircraft pilots as artillery observers. Again, poor communications between the observers (pilots), the artillery, and the maneuver forces limited the effective integration of fires with maneuver. Artillery planning and fire control were centralized at high levels due to the crude nature of communications and artillery procedures. The result was a fire support system that was not responsive to unanticipated changes in the tactical situation. This unresponsiveness often made the artillery as dangerous to the supported forces as to the enemy.

Fire support coordination became more sophisticated in World War II. The War Department updated Field Manual 6-20, Field Artillery Tactical Employment, which specified zones of fire responsibility for artillery units, responsibilities for coordinating observation of the battlefield through the use of forward observers, liaison officers (LNOs, the precursors to today's Fire support Officers -- FSOs), observation posts and sound and flash units.[10] Of note, artillery units had air observers and aircraft organic to their units. They were used to supplement the ground observers and extend the range of observation.

Two major technological advances improved the overall flexibility and responsiveness of the fire support coordination system. Radio communications allowed maneuver forces to communicate directly with their supporting artillery. Additionally, officers at Fort Sill's Artillery School developed an arithmetic method of fire control that allowed artillery units to mass fires on targets of opportunity.

The artillery's field manuals reflected the improvement in capabilities to coordinate fires by specifying that: "The efficiency with which artillery fires are maneuvered depends upon the adequate control, close liaison with supported troops, and efficient communications and observation."[11] The manuals also divided the battlefield into zones of fire for the direct and general support artillery. Although fratricide prevention is not specifically mentioned, the fire supporters were instructed to know the location of the leading elements of the attack echelons and to stay abreast of the plans of the supported units.[12]

Difficulty in the use of aircraft to provide close air support in WW II is a classic example of what can happen when technology outpaces doctrine. The lack of sound fire support coordination doctrine for close air support employment, combined with the lack of training and poor communications between the Army and Air Corps, led to some serious incidents of fratricide. The United States did not develop a formal doctrine and training procedure for air-ground operations until late in the war.[13] The most successful procedures were developed in Italy, where the air and ground forces' headquarters were frequently co-located.[14] The equivalent of today's forward air controller (FAC) was first used during the breakout in France when ground controllers in jeeps rode with the front-line forces. The ground commanders recognized their value and put them in tanks with high-frequency radios. This method was soon adopted throughout the European Theater of Operations. After WW II, the Field Artillery attempted to have forward air controllers assigned to every battalion, but the Air Force resisted, assigning only one per regiment.[15]

After the war the artillery introduced three new fire support coordination measures.[16] A No Fire Line permitted only the direct support artillery unit to fire short of the control measure without coordination. The O-O Line focused the observation efforts between the division artillery (short of the line) and the corps artillery (beyond). The Bomb Safety Line permitted tactical air forces to strike anywhere beyond it. Although not written in the doctrine, the Bomb Safety Line became, in practice, a de facto delineation of battlefield areas of responsibility between the ground forces and the air forces. The Army then had no tactical systems capable of firing at the ranges the Bomb Safety Lines were set.

Early in the Korean War, Army and Air Force units again experienced problems coordinating fire support.[17] The lessons learned from WW II had to be relearned. Air support became almost indispensable, especially in the initial phase when there was only a small amount of artillery available. By the end of the war, the Army had become used to employing massive amounts of firepower at the expense of mobility.[18] This was a consequence of the need to limit casualties and was acceptable because of the limited nature of the conflict on the ground.

Immediately after the war, to improve fire support coordination and ensure clarity of fire support coordination measure employment, the artillery's doctrinal manuals advocated co-locating direct support artillery TOCs with the supported unit's TOC.[19] However, with the advent of the Pentomic Division, direct support artillery TOCs were chosen to serve as the supported unit's alternate command post.[20] Therefore, the TOCs became separated again, relying upon radio communications and liaison for the majority of their coordination.

By the early 1960's major advances in tactical communications resulted in improved communications, greater flexibility in command and control, and increased mobility.[21] Coordination and employment of supporting fires became one of the central features of Army tactics. Artillery support was especially important. Ground units rarely operated outside its limits.

In many ways the Viet Nam War represented the highest point in liaison and cooperation between the ground and air units.[22] This was because there was no real air threat over South Viet Nam. In fact, there was so much support for the ground forces, congressional hearings were conducted to examine the neglect of the air superiority mission.[23]

Sensor and communication technology improved so much during the war that in 1973 the artillery developed more sophisticated fire support coordination measures.[24] These new measures reflected the increased capability for coordination of fires between the maneuver, artillery, and aviation assets.

In 1976, the Army updated its doctrine. It addressed the increasing lethality and longer range of firepower, increased unit mobility, plus the improved command and control capabilities of the armed forces.[25] The senior army leadership sensed that traditional boundaries seemed to hamper larger units' commanders from massing fires or for units to increase their firepower in certain areas. Therefore, they wanted increasing latitude to fire across or shift boundaries. The artillery responded by reducing the number of fire support coordinating measures to basically those that are in effect today.[26]

The only fire support coordination measure that has stirred any significant controversy since the Korean War is the Fire Support Coordination Line (FSCL). By doctrine, it "is a line, established at corps level, to coordinate fires of ground, air or sea weapons systems using any type of ammunition against surface targets... Its purpose is to allow the corps and its subordinate and supporting units to expeditiously attack targets of opportunity beyond the FSCL."[27]

There is disagreement between the services (mostly Army and Air Force) about how the FSCL should be employed on the battlefield. Technological advances have influenced the way this fire support coordination measure is applied. Improvements in sensor systems, Army aviation, and rocket technology, currently give division and corps commanders the capability to sense and attack targets beyond the FSCL. Ground commanders do not want to relinquish control over the area beyond the FSCL to the Air Force. The commanders want to have the freedom to fire across the FSCL without coordination, if necessary. On the other hand, they do not want to locate the FSCL beyond the range (over 100km) of ATACMS thus effectively assuming the CAS mission for Army aviation.

The Air Force wants the FSCL to be restrictive on both ground and air commanders. They want any fires landing beyond the FSCL to be cleared through Air Force channels just as airstrikes short of the line are cleared with the Army. This reduces the risk of fratricide for their pilots and eliminates redundant attacks with the associated risk of pilot loss.

A compromise of sorts is currently in effect. The Army's position is that it will try to coordinate attacks beyond the FSCL with the Air Force. However, the inability to make this coordination will not preclude the attack of targets located there.[28]

In addition to trying to solve their differences over the implications of the fire support coordination line, the Army and Air Force have worked to improve other aspects of fire support (and, hence, fire support coordination doctrine) for the ground forces. One example was the 1984 agreement, known as "The 31 Initiatives", between the Chiefs of Staff for the Army and the Air Force establishing the Joint Assessment Initiatives Office.[29] The Initiatives Office initially addressed seven basic areas of Airland combat, including suppression of enemy air defense (SEAD), joint combat techniques and procedures, and the fusion of combat information applicable to this arena. It made progress on improved night capabilities for close air support aircraft thereby reducing the chances of fratricide of ground forces. The two services are still working on procedures and functional organization for rapid targeting and to enhance the compatibility of collection, intelligence and operations systems. They are also working to develop an IFF system capable of positive identification of hostile forces to permit the employment of beyond-visual-range weapons. This system also would protect the front line forces receiving close air support from being misidentified by friendly aircraft.

The services are integrating current technological capabilities to assist with fratricide prevention and facilitate the attack of enemy targets. The integration of ground- and air- delivered sensors, and acceleration of the cycle of sensor activation and target attack, provides the Army and sister services with unequaled capabilities to strike swiftly and accurately throughout the depth of the battlefield.[30] Better awareness of maneuver unit locations is also having a decided effect on the risk of fratricide by both Army and sister service systems.

There are now individual Global Positioning Receivers with alarms in some unit radios to prevent units inadvertantly crossing boundaries or phase lines. A battalion control center can monitor all its units' radios' positions. Counter-fire radars can apply censor zones in their computers to avoid misidentifying flank unit fires as enemy. It is not yet clear that sister service air delivery units can access this data in real-time either.

However, one must realize that automated systems are nowhere universal nor foolproof. Not all units, especially among coalition forces, will have these systems. Additionally, the ability to use the electronic environment may be degraded or even fail. Back-up or alternate procedures still must be established and practiced to successfully coordinate the full array of fire support effectively and safely.

During this century, the application of technology to battlefield systems has resulted in an evolution in the employment of fire support systems and similarly in fire support coordination measures. The impact of today's application of digital technology has the potential to cause a major paradigm shift. Increased friendly force situational awareness is expected to improve agility, reduce fratricide risk and increase the capabilities to attack the enemy. TRADOC Pamphlet 525-5, Force XXI Operations, foresees digital communications systems providing the situational awareness and real-time information flow to transform today's war into a truly non-linear battlefield without unit boundaries or other fire support coordination measures.[31] It will not, however, eliminate the necessity for standard drills, tactics, techniques and procedures throughout the force.[32] US forces must also have back-up systems in place to operate in a degraded mode which may be necessitated by either unanticipated failure of the digital communications systems or by coalition operations with non-digitally equipped allied forces.

DIGITIZATION AND THE FIRE SUPPORT SYSTEM

"In mechanized warfare, the Germans saw the opportunity to incorporate new technologies of the tank, radio, and aircraft.... Guderian and his compatriots essentially completed a new warfighting paradigm offering a far superior understanding of the tremendous opportunities that technology provided to warfare."[33]

As the twentieth century comes to a close, our nation's leaders want to ensure the United States maintains its position as the dominant military power in the world. To succeed, the armed forces must win the information war. That means we must capitalize on the computer and new means to transmit digitized data to control the communications spectrum and the night. It also means empowering the armed forces to anticipate the enemy's actions and to exploit opportunities faster than the enemy can respond, and finally, it means giving the military the technology to locate the enemy rapidly and to coordinate fire from multiple weapons systems.[34] The technology that will enable the military to maintain its dominance into the early part of the next century is digital communications.

The Army has developed four enabling strategies to improve and enhance the capabilities of the force through the use of digital communications.[35] These are:

-Own the Night
-Battlefield Combat Identification
-Battlefield Synchronization at Brigade and Below-Digitization
-Battlefield Synchronization at Division and Echelons Above Division.

All four strategies will impact upon the way fire support coordination measures are viewed and employed in the future.

"Own the Night", involves the development of all systems that will allow our forces to operate unhindered in all kinds of terrain during periods of reduced visibility. It involves sensors and digital optic night vision capability systems that allow Army forces to detect the enemy before he detects them.

"Battlefield Combat Identification", is the Army's effort to reduce fratricide and provide commanders the capability to distinguish friendly forces from the enemy in their battlespace. Radios emitting digital signals indicating positions, combined with advanced sensors, are the primary systems involved.

"Battlefield Synchronization at Brigade and Below-Digitization", involves efforts to establish rapid exchange of information through high speed digital networks and data transfer systems. It is a matter of getting the right information to the right warfighter at the right time. Information will be transmitted to the fire supporters more rapidly than ever, thus improving the speed with which fire support decisions are made.

Finally, "Battlefield Synchronization at Division and Echelons Above Division", is the effort to produce a targeting architecture that integrates maneuver control, fire support, intelligence and electronic warfare, and communications from a command post perspective. It involves giving the Army a significant advantage in developing multiple targeting objectives, while ensuring sensor-to-shooter times are significantly reduced.

The digitization of the battlefield is defined as "the application of information technologies to acquire, exchange, and employ timely digital information throughout the battlespace, tailored to the needs of each decider (commander), shooter, and supporter...allowing each to maintain a clear and accurate vision of his battlespace necessary to support both planning and execution."[36] This goal requires integration of systems and capabilities across all battlefield operating systems at all levels. The integrated forces will then be able to operate in an environment in which all friendly forces share a relevant common picture of the battlefield while communicating and targeting in real or near-real time. Key to accomplishing this goal is the integration of long-range digital data links throughout the force structure.

Integrating digital communications systems throughout the armed forces (digitization of the battlefield) will improve management and distribution of great amounts of information and, therefore, coordination at all levels. All battlefield operating systems will benefit. Examining the requirements and breadth of digitization, its benefits and the problems of current and near future digital systems, will show how these new tools will affect fire support control and coordination. The new capabilities provided by these digital systems may force a change in the fire support organization and in the way fire support coordination measures are employed.

The Army is not alone in looking to digital communications as a vital element of its modernization strategy. It cannot afford to act in isolation because of the joint nature of all combat operations today. The synergistic effect gained through employment of joint forces is essential to future battlefield success. In order to achieve this joint synergistic effect, the armed forces must work together, not just to develop equipment but also on development of joint doctrine, tactics, techniques and procedures.[37] The Army's focus then must be on interoperability i.e., the ability of people, organizations and equipment to operate together effectively.[38]

Electronics makes interoperability work.[39] There are four fields of communications interoperability. These involve the compatibility of communications hardware, messages, database applications, and operating procedures.[40] The compatibility of communications hardware involves ensuring the rates of transmissions/operations (also known as Baud rates) are the same for the different systems. Compatibility of messages is achieved by ensuring that message length and fields are organized so the receiving systems can decode all transmissions. This is akin to ensuring that the coded messages sent between headquarters are listed in the same formats. Data base application programs, too, need to read data the same way across the spectrum. For example, systems that read dates as 10 May cannot interact with systems that read dates as May 10. Finally, the systems' compatibility of operating procedures pertains to frequencies, patterns of employment, and codes. The focus for digitizing the battlefield is ensuring enough compatibility between the various systems so that horizontal integration is possible.

When horizontal integration is available, then different systems can communicate fully with each other. This is known as internetting. Internetting information improves several aspects of fire support coordination. Combatants save time by coordinating their actions directly (i.e., sharing situational awareness), rather than incurring the time delays associated with having to go through various vertical levels to coordinate actions.[41] Early in 1993 the Chief of Staff of the Army witnessed an internetting demonstration in which a maneuvering force of tanks, infantry fighting vehicles, artillery, aircraft, and an unmanned aerial vehicle (UAV), passed data horizontally, prior to and during live fire engagements.[42] A follow-on to this was the Advanced Warfighting Experiment (the "digital rotation" -- Rotation 94-7) at the National Training Center. Although there were problems with information transfer between various systems, the results showed that the Army is on the right track and that these new systems' advantages will continue to provide land force dominance for the United States.[43]

The enabling strategies for digitization are being implemented through the means of the Horizontal Technology Integration (HTI) process. Horizontal technology integration is defined as, "the application of common technologies across multiple systems to improve the warfighting capability of the force."[44] It is the research, development, and acquisition process that supports an integrated battlefield architecture. Horizontal technology integration enables rapid transfer of information across the battlefield. With horizontal technology integration, weapon systems see, acquire and engage threats while sharing the same information with higher, lower and adjacent units, with equal clarity, using advanced technologies and digital communications. Horizontal technology integration includes the ability to transfer information to sister service elements at all levels.

The field artillery already conducts a form of horizontal technology integration internetting when it assigns a non-standard mission to one of its units to provide fires for a separate observer conducting a special mission. The artillery unit establishes communications with the observer on a non-hierarchical radio net, receives reports of enemy forces in the observers' area, and fires in support of the observer until relieved of the mission. The calls for fire are not transmitted through the normal doctrinal channels, instead going directly to the firing unit(s).

Because the nature of fire support includes coordinating fires from the sister services, the capability to transmit information between the services is critical to ensuring adequate fire support coordination is executed. Two problems recorded in the Gulf War illustrate this point. First, early on, it was decided that the Joint Air Tasking Order (ATO) was to be transmitted electronically, in digital form, through personal computers. But the Navy's computers and software were not up to the volume of traffic. As a result, the ATO had to be flown daily to the carriers and delivered by hand. Second, an Air Force officer justified the reportedly low (15%) percentage of Army nominated targets that were targeted by the Air Force on the basis of "a two-to-three day lag in Army intelligence from CENTAF."[45] The delay was the result of the layered, incompatible communications system, through which the information flowed. The lag forced the targeting group to question the validity of the targeting information (i.e., were the targets still in the reported locations, or had they moved?). Without compatible systems, information flow is slowed or interrupted. Good information flow improves synchronization, control of battlefield tempo, and force application.[46] Recognizing this, and understanding that the nature of all future military operations will be joint, the Department of Defense has established exact protocols for the new digital systems to ensure joint compatibility.[47]

With compatible systems, information can be shared by either pushing (broadcasting to all receivers whether the receivers want the information at that time or not) or pulling (receivers request the information from a specific source). The ability to pull information across normal boundaries is characteristic of non-hierarchical, or internetted systems. The Army Battle Command System concept is the over-riding or umbrella concept under which all future technology is being developed. This concept envisions the integration of all our hierarchical and non-hierarchical (internetted) systems. The systems will broadcast battlefield information that can be displayed graphically on stationary and mobile heads-up displays. They will also display friendly and enemy units in real-time, giving the users a relevant common picture of their required battlespace.[48]

Digital communication is the central element of the Army's modernization vision. Digital communications are more powerful than current analog systems. They are able to send more data in less time. This allows more sophisticated computer programs to be used in the field, and gives units greater overall capabilities. Digital transmission speeds are continually increasing, enabling more data to be transmitted in the same amount of time. The Chief of Staff of the Army set a goal in 1992 of having a digitized division in place by the turn of the century. In order to ensure the different systems under development and in the field can communicate with each other, common software standards, formats and protocols are being developed.[49] To determine digitization's impact on fire support coordination measures, an examination of the fire support system is required.

Fire support is both a process and a result. It is the collective and coordinated use of indirect fire weapons, armed aircraft, and other lethal and non-lethal means, in support of a battle plan. Fire support coordination is the primary means of synchronizing fire support at all echelons of maneuver. The integration of fire support into maneuver operations is a decisive factor in the success of the battle. The Fire Support Coordinator (FSCOORD) at each level is responsible for developing and orchestrating fire support for the maneuver commander. Fire support planning and coordination is the operational linchpin of the fire support system. Formal coordination combines fire support resources, together in a common effort, so that the multiple effects of each fire support means are synchronized with the force commander's battle plan. It is the precise arrangement of coordinated activities in time, space and purpose to produce the most effective fires.

The fire support system is composed of a great variety of people, equipment and systems. They operate in one of three parts: Fire support command, control and coordination (C3) facilities and personnel; target acquisition and battlefield surveillance; and fire support resources... weapons and munitions.[50] The test of effective fire support is the force commander's ability to bring these assets to bear on the enemy in an integrated and coordinated manner, synchronized with the scheme of maneuver. Because of the variety of assets and personnel, the fire support system does not function through a common chain of command like a maneuver system.[51] Instead, the FSCOORD must coordinate outside his chain of command with the commanders of the various systems available for use. Fire support coordination is based on the "D3" methodology.

D3 (Decide - Detect - Deliver) is a pro-active fire planning and execution methodology.[52] It begins when the commander receives his mission. It enables the FSCOORD to develop the fire support plan in conjunction with the development of the scheme of maneuver. Upon receipt of his mission, the commander, together with his staff (usually at least the S2, S3 and FSCOORD), determines which targets to attack, when to attack them, and what effects he wants on the targets. The commander attacks those targets with the highest payoff to his battle plan. The fire support coordination plan focuses priorities for collection management and integrates the target acquisition and battlefield surveillance personnel into the fire support coordination process.

The FSCOORD also determines what types of fire support coordination measures are required to shape the battlefield to facilitate the attack of the enemy targets. Fire support coordination measures are developed and assigned depending on the maneuver commander's intent, the type and range of available weapons, the type of operation (offensive or defensive), forces in the area forward of the forward line of own troops, etc.

The cumulative result of the *decide* phase is a coordinated fire plan that is synchronized with the maneuver commander's battle plan. The *detect* portion of the D3 methodology occurs when designated targeted areas of interest are monitored, and a target identified. The fire supporters notify the appropriate TOC or delivery system upon target detection. Steel on target is the culmination (*deliver* part) of the D3 methodology.

The D3 methodology is used at all tactical levels of fire support. It focuses the fire support coordination effort during planning and, more importantly, during execution, so the commander gains the maximum benefit from the combined synergistic effects of the different fire support systems.[53] As a general rule, the higher the level one must go to obtain fire support, the longer it takes to coordinate and to receive it. This is true for preplanned targets and for targets of opportunity. For example, in the Gulf War targets of opportunity at the maneuver battalion level were fired within minutes (if that long) of the call for fire. However, in some instances, it took hours for ATACMS to be fired because of the problems with airspace deconfliction.[54]

Much of fire support coordination is conducted via voice and digital radio due to the variety of personnel, units, and distances involved. The information flow is hierarchical. Current doctrinal communications radio net structures are often described as "stove-piped", but "grid-ironed" is a more accurate metaphor. The current communications systems are designed for and operate in a very structured, limited grid-type format. To transmit information to/from someone, a unit, or a system, not doctrinally included in one's radio net structure, the request to send/receive information must be relayed to the appropriate level and then across and down to the appropriate person, unit or system. Each battlefield operating system communicates vertically with its own superiors and subordinates on one set of radios, and horizontally on another set of radios with other same-level units, from different operating systems. The fire support coordination system is a good example of the way the Army's coordination communications doctrine is executed.

At each level, from the lowest (forward observer) to the highest (Corps Artillery commander), fire supporters monitor the fire support radio nets of their own units immediately above and below them, and the command and/or the operations nets of their supported units. They are unable to monitor, transmit and receive information from any other radio nets unless they either leave one of their assigned nets, or coordinate with their unit's counterpart. For example, if a brigade FSO wanted to know if the division's long range surveillance detachment

(LRSD) had sighted anything in a certain area, he could either leave his assigned frequency to eavesdrop on a LRSD net, or request the information through a parallel staff channel.

The FSO cannot adjust his communications systems to pull that information or have that information pushed to him automatically. He must degrade his own capabilities while searching for the information on a non-doctrinal net (and risk missing information being passed on the original net), or incur a delay of unknown time when the requested information is relayed to him through however many levels is required. This example demonstrates the constrictions current voice communications capabilities place on personnel and on information transfer. If the information being passed is fire support coordination measures related, the time delay can have disastrous effects.

Examining current fire support doctrine and the impact that existing digital systems have had on its employment reveals that there are costs as well as benefits for digitized forces. Current fire support doctrine is predicated on fire supporters capable of orchestrating a variety of systems to provide the maneuver commander the advantage against the enemy. The "D3" planning methodology provides a proactive, systemic method of integrating fire support coordination measures to ensure the right targets are attacked at the right time with the most effective weapons system. Artillery digital communication systems, although limited in capability to interface outside the artillery battlefield operating system, have proven advantageous for artillery fire support planning, coordination, and execution. However, all has not been without some serious equipment and doctrinal problems.

EFFECTS OF DIGITIZATION ON FIRE SUPPORT COORDINATION MEASURES

"Innovations in technology are the harbingers of change in warfare."[55]

Digitization provides the following advantages to the fire support system: speed of service, throughput, increased data reliability, enhanced data distribution and survivability, and increased fire connectivity. Digital transmissions are faster than analog (voice). Faster transmission times to digitally programmed fire support systems mean faster planning and execution. One aspect of the faster transmission times is that messages and/or information can be sent directly (throughput) to a particular unit without delay by relay through various layers. Once data is entered and sent in a digital format, it arrives the same way it was entered. There is no risk of misinterpretation or mistranscription at the receiving end, which may happen when data is sent by voice. The digital data goes faster and more accurately to the requesting units and is entered in the databases unless deliberately erased. There is less risk of losing it accidentally. On the other hand, if data is input improperly, the system is subject to many of the same problems as the current system, only they will occur faster and to more people. Finally, digitization increases fire-connectivity, the link between the sensor and the shooter. Some sensors have the capability to call for fire directly to the firing weapon platform instead of having to relay the call for fire through the fire support coordination system.

A review of current and near term digital-capable systems demonstrates that digital technology is affecting the use and employment of fire support coordination measures. The systems increase responsiveness, facilitate the attack of enemy targets, and improve force protection by improving IFF systems and providing real-time, or near real-time, relevant common pictures of the battlefield.

The following systems already provide limited horizontal technology integration capabilities: Tactical Fire Direction System (TACFIRE), Interim Fire Support Automation System (IFSAS), Inter-Vehicular Information System (IVIS), and the Maneuver Control System (MCS). The near future systems - Brigade and Below Command and Control system (B2C2), All Source Analysis System (ASAS), the Advanced Field Artillery Tactical Data System (AFATDS), and the Joint Tactical Information Data System (JTIDS), will increase the interoperability.

Digital's "first cousin", the analog-based tactical fire direction system, TACFIRE, was fielded in 1979 and has been continually upgraded.[56] With the recent fielding of other digital systems, TACFIRE can internet to a limited degree with the maneuver units.[57] Compared to all previous manual and automated systems, TACFIRE provides the artillery with a number of improved capabilities. TACFIRE broadcasts fire support plans, including associated fire support control measures, in a fraction of the time previously required. It speeds fire mission processing times by tracking firing unit status and automatically assigning missions to the earliest available units. Additionally, priority missions enter the top of the queue if a number of missions arrived at the battalion fire direction center at the same time. Overall, it greatly reduces the time humans take to make decisions and transmit information.

The Interim Fire Support Automation System (IFSAS) replaces TACFIRE at the mechanized artillery battalion fire direction center, and the FSOs Variable Format Message Entry Devices (VFMEDs) at all levels, with a light-weight computer unit (LCU).[58] The LCUs use common hardware and software in the FSEs and the battalion FDCs. IFSAS is compatible with the other digital systems currently in place or soon to be fielded. The computers are more user friendly than the original TACFIRE system and increase the responsiveness of the system.

The fielding of the M109A6, Paladin, howitzer also increases the artillery's responsiveness to provide fires for maneuver forces. Paladin does not need to stop and occupy positions like its predecessor. It has an on-board position azimuthdetermination system (PADS) which provides the on-board fire direction computer the vehicle location, allowing it to compute its own firing data. With these systems it can receive fire missions on the move, stop and fire within less than a minute, and continue to march behind the front line units. It is available to fire for the maneuver commander more often than any other howitzer system.

The Inter-Vehicular Information System (IVIS) is being fielded in the maneuver community. It is designed to enhance the situational awareness for each vehicle commander by tracking and displaying the other IVIS equipped vehicles in the unit through use of an on-board position-navigation (POSNAV) system.[59] The commander's displays also depict maneuver graphics to assist navigational command and control. These two capabilities result in increased battlefield tempo. Currently, IVIS systems in separate units cannot track each other. This software problem is being corrected.[60] IVIS system operators can call for fire, either through interfaces with the FIST DMD, or through the B2C2 (see below). This capability dramatically increases the number of potential observers and digital calls for fire, increasing the difficulty of controling the calls-for-fire, which may increase the the sensor-to-shooter times if the fire requests get backed up at the artillery battalion's fire direction center.

The Maneuver Control System (MCS) is found at every TOC from battalion to corps.[61] It provides the commander with the capability to collect, coordinate, and act on near-real-time battlefield information displayed graphically and textually. The MCS allows the commanders at the various levels to have the same picture of the battlefield as the commander whose staff input the information. Commanders can access information at local or remote sites without having to experience the delay that voice communications through established hierarchical levels produce.

At the division and corps levels, the deep operations coordination cell (DOCC) already uses available automation equipment to assist with deep operations planning and coordination, and integration of the deep fight with close battlespace operations. However, the automation systems are not capable of deconflicting airspace in a timely manner to attack short-dwell targets with

ATACMS. During Operation Desert Storm manual deconfliction delayed ATACMS firings.[62] Additionally, ATOs, ACOs (Air Coordination Orders), and Special Instructions (SPINS) were not received expeditiously at the division level and below to assist the maneuver commander with shaping the battlefield.

Digital communications will provide the DOCC with the capability to access the preplanned airspace control measures from the ATO, see the real-time air picture, and speed deconfliction. Additionally, AFATDS (see below) software will provide message capability to perform fire support coordination measure violation checks and coordination in its version 1 software. It requires interface with the Air Force's command and control at the Control Reporting Center. The payoff is the capability to shorten sensor-to-shooter times and effectively engage short dwell targets (such as mobile SCUD missiles).

The following systems are scheduled to be fielded by the turn of the century and are expected to have a major impact on the fire support command and control systems including fire support coordination measures: the Brigade and Below Command and Control system (B2C2), the All Source Analysis System (ASAS), Army Field Artillery Tactical Data System (AFATDS), and the Joint Tactical Information Data System (JTIDS).[63]

The Brigade and Below Command and Control (B2C2) system is a system of lightweight computer units (LCUs) placed in all key command and staff vehicles.[64] Much like the IFSAS, the B2C2 provides all users the capability to internet during planning for and execution of the battle. The intent for the B2C2 is to facilitate passing critical information between stations in less time than voice traffic requires. The B2C2 is placed all the way down to the company FIST in the fire support hierarchy.

ASAS, the All Source Analysis System, will be located from the brigade level to the corps.[65] ASAS is designed to provide timely and accurate intelligence and targeting support to the battle commanders. It will provide communications and intelligence processing capabilities to allow sensor and other intelligence data to enter automatically into the all source data base and be available simultaneously at multiple analyst workstations. The ASAS provides ground based situation displays, rapidly disseminates intelligence information, provides target nominations, and helps manage organic intelligence assets. With this knowledge, commanders have a significantly enhanced view of the battlefield and can more effectively conduct the land battle.

The Army Field Artillery Tactical Data System (AFATDS) is a fire support command and control system designed to replace TACFIRE, IFSAS, and the platoon FDC's battery computer system (BCS).[66] It will be fielded from the corps to the firing battery platoon level. It has multiple capabilities, from fire support planning to computing firing data for the platoons it has selected to participate in responding to a request for fire. Additionally, it will meet other fire support needs by collecting and relaying intelligence information. It will be interoperable with all fire support systems (e.g. Firefinder radars, M109A6 Paladin howitzers), the Army Tactical Command and Control System (ATCCS), as well as the fire support command and control systems for Germany, England and France.

The Joint Tactical Information Data System (JTIDS) is designed to be the link through which the services will interface. It allows communication among users by both voice and digital data, as well as providing a common grid to those units on the net.[67] Messages can be transmitted over an extended range of 500 miles since the system can be deployed on the ground, on board ships, and in the air.

Although not a specific system, Local Area Networks (LANs) are another way to take advantage of the capability for digital integration of units on the battlefield. They can assist with fire support coordination, among other message traffic. The Marines used a main frame computer in conjunction with a LAN during the Gulf War to handle vast amounts of data, to include coordinating fire support.[68] They were able to arrange for the ATO to be transmitted over their LAN after receiving it from Riyadh. It often took less than one hour for the transfer to the various Marine units via LAN after receipt. The Marine's air tasking officers also used the LAN to send validated requested missions to CENTCOM. LANs provide multiple capabilities. They include voice, digital data, facsimile, graphics and video imagery. Signals can be sent through fiber optics, millimeter wave radio and antenna multiplexing.

As shown above, the fielding of various digitized systems increases the capabilities of the force overall. Primarily, they increase the battlefield tempo by permitting the commander to see the battlefield better than ever before. The provision of fire support is as affected as any other battlefield operating system. They also will improve capabilities for units to communicate. This improvement promises to increase the responsiveness of the fire support system.

In addition to improving the fire support system's ability to engage targets, the digitization of the battlefield increases force protection. Fratricide reduction will occur from improved situational awareness via the internetting of information from IVIS through B2C2. ASAS' intelligence and targeting support will also improve situational awareness. The following fratricide reduction measures are possible with the internetting provided by digital communications. Identification Friend or Foe (IFF) systems will improve. Battlefield tracking promises to be better at all levels. B2C2 computers in the TOC will provide current unit dispositions. Advanced fire control systems will improve the accuracy of weapons firing. Indicators and warning systems, programmed into AFATDS, for example, will alert operators to dangerous situations. ASAS sensors will identify the enemy further away -- allowing friendly systems to engage the enemy at greater distances from our own troops. Finally, airspace deconfliction will ensure that friendly air crews are not unnecessarily at risk while supporting the forward ground forces and, will radically shorten deconfliction times for deep fire systems such as ATACMS.

The early effects of the impact of digitization have already been documented. Digitization at Desert Hammer VI (NTC rotation 94-07) contributed to the Blue Force's ability to mass and synchronize fires, thereby allowing the commander to shape the battlefield to his advantage. This was due in part to the internetting of the force, allowing orders to be transmitted more accurately and in shorter periods of time, thereby giving commanders more time to focus on rehearsals and finalizing coordination.[69] A byproduct of the increased time to focus on rehearsals and finalize coordination was a reduction in the typical number of fratricides. The maneuver forces were equipped with IVIS.

IVIS is one of the primary digitized systems that will impact on force protection. IVIS equipped units have demonstrated the ability to move faster on the battlefield.[70] They are up to two times faster at planning and at executing missions than non-IVIS equipped units.[71] The improved situational awareness IVIS provides allows units to transfer changes in graphics throughout the force, with fewer errors, speeding unit's reaction time. It also permits the combat vehicle commander to know where his unit's vehicles are in relation to his position, reducing the chances for fratricide through misidentification. The artillery community will be able to track friendly maneuver unit vehicle locations in real-time through IVIS interfaces via B2C2 and ASAS. Software programs can then determine if requests for fire may cause a fratricide (see AFATDS, below).

IVIS also impacts on force protection in other ways. It allows the maneuver commanders to reinvest their time during the planning and preparation phases into activities which result in better synchronization of combat power and therefore, less fratricide. Commanders can use their time to conduct more and better rehearsals, give more time to subordinate leaders, more closely coordinate the proper integration of combat support activities into the battle scheme, and incorporate leaders into unit sustainment and sleep plans.[72] Many leaders are realizing that digitizing the force means improved integration, synchronization and mutual support.[73]

Digitization of the battlefield will improve fire control and will effectively reduce fratricide. The AFATDS software will provide message capability to perform fire support coordination measure violation checks and coordination in its version 1 software. Communications systems will facilitate coordination between joint and coalition forces. Satellites and other improvements will make communications less terrain dependent, improving the range and coverage for vehicular IFF systems. Horizontal technological integration will become a reality.

Many of the innovations mentioned above will impact on improving unit situational awareness. Enemy and friendly locations will be juxtaposed on commanders B2C2 tactical terminals. The JTIDs will provide improved voice and digital communications across the battlefield, facilitating coordination between units. Airspace deconfliction will occur earlier in the battle. Before assuming that the digitized battlefield will quickly solve all communications and coordination problems, an examination of the fire support community's experience with TACFIRE shows that the digitized battlefield may not be perfect in every way.

First, there are equipment problems. In order to transfer information cleanly, the sender and the receiver had to have their radio frequencies aligned to an exacting standard and still have to have the correct "send" and "receive" COMSEC codes entered in their data bases. The codes change with each transmission, so it can be a very trying experience to bring two units on line with each other. Continual operator training is key to maintaining this perishable skill. Additionally, the rapid information transfer rates tend to burn up FM radios if very detailed fire support plans are transmitted, forcing the radios to operate for long periods.

The FIST's interface, the Digital Message Device (DMD), takes longer to enter data for a fire mission request than to use a voice request for fire. Its face is difficult to see at night and it is clumsy to operate outside a vehicle, making it unpopular with the light fighters. These equipment and training problems are fixed relatively easily, especially with operators following correct procedures.

One equipment problem that cannot be fixed is that digital systems require a wide band of radio frequencies on which to operate. The digital signal interferes with voice FM communications on frequencies near the broadcast band and those not near it, but in harmonic resonance with it.

In addition to the equipment problems listed above, there is a major doctrinal problem affecting responsiveness with which the artillery community wrestles. There is no digital capability for the FSCOORD except in his FSE and the TOC/Fire direction center. The nature of the FSCOORD's duties (especially at the battalion level) often keeps him away from his TOC and with the supported commander. Consequently, he is out of the digital loop for extended periods, especially during battles. Doctrinal manuals are ambiguous about where the commander should be located during the planning and execution of the fire support plan.[74] Without a digital capability available to him while forward on the battlefield, the key fire support coordinator at every level from brigade to corps is reduced in capability to operating solely on voice radio nets. Obviously, he will have important messages and reports relayed via FM or other means, but there is a built in time delay when voice messages are forwarded. The FSCOORD is not the only fire supporter facing the decision about where to locate on the battlefield.

The brigade and battalion FSOs are in a similar situation. If they go forward in their HMMWV or a tracked vehicle to see the battle, they have no link to monitor the digital TACFIRE system through which the requests for fire should be sent. If FSOs stay at the TOC, they habitually fall behind the actions on the battlefield, based upon the time delays for units' reports to be received. The risk associated with staying at the TOC is that the FSO cannot influence the supporting fires in real time, resulting in the fire support becoming unsynchronized, and therefore ineffective. An expedient that many, if not all, units employ, is to "plan digitally and execute voice."

The advantages this provides are twofold. First, it uses TACFIRE's superior capabilities to lessen significantly the times to develop and transmit detailed fire support plans. Second, it keeps the FSCOORD and the FSO "in the net" and able to manage where fire support is being provided while located forward to see the battle in real-time.

The disadvantage to using this expedient is that voice communications are used, however briefly, and they are slower than digital communications. The requests for fire are entered in the forward observer's Digital Message Devices while waiting for voice approval/denial from the FSO. If the observer does not use his DMD, additional delays will occur because the voice request for fire must be entered by a computer operator into the TACFIRE system somewhere along the line. Using DMDs, fire missions can be executed more rapidly than if voice fire requests are entered at the artillery battalion's fire direction center or at the artillery battery's platoon fire direction center.

Another potential bottleneck is at the battalion fire direction center. When the artillery battalion fire direction officer (FDO) receives numerous requests for fire, he can lose focus on where the maneuver commander most needs fires at that moment. Often, this results in the FDO firing the missions in the order they are received, resulting in the fire support plan becoming unsynchronized and ineffective. Part of this problem stems from the FSO's positioning dilemma (above) and part stems from separating the fire direction center from the TOC to enhance the operations center's survivability against incoming artillery. The FDO is separated from the S3, who could focus the FDO's efforts ensuring responsiveness for the maneuver commander. (The FDO and S3 will not be separated upon fielding of the next generation digital systems, IFSAS and then AFATDS).

The field artillery's experience with the TACFIRE systems has proven that digital systems can greatly increase unit capabilities. However, there are inherent equipment and training costs as well as potential doctrinal impacts with these systems.

CONCLUSIONS

As stated at the outset, in order to have a reduced requirement for fire support coordination measures in a digitized force, two criteria must be met. First, the digitized force must provide more rapid engagement of targets. Second, it must provide better or equal force protection. The two criteria are linked.

Clearly there will be a reduced requirement for fire support coordination measures in the near future as more digital equipment is fielded throughout the military. The attack of targets will be made faster and more effective by increased situational awareness and speed of information transfer. These same attributes will reduce the chances and likelihood of fratricide. As indicated above, IVIS crews will be able to more positively identify people and equipment as friendly or enemy, thus reducing direct and indirect fire fratricides. The B2C2, through information via the IVIS and the ASAS, will allow commanders and fire supporters to verify target location versus real-time friendly and enemy locations. The JTIDS will improve the required communications connectivity to ensure the various voice and digital systems can communicate. The AFATDS will automatically check to ensure no fire support coordination measure violations occur.

Fielding digital systems throughout the force will affect some fire support coordination measures by either eliminating them or changing their definitions or applicability. In some cases it will have no effect at all.

Because some fire support coordination measures serve functions that are not designed only to facilitate supporting fires and protect the force, they will be largely unaffected by digitization. Restrictive Fire Areas are not designed only or principally to facilitate delivery of fires. Although RFAs may be required less often, commanders will still wish to restrict amounts or types of fires into certain places to ensure force protection or safeguard mobility. For example, a commander would not necessarily want to fire DPICM (because of its bomblet dud rate) into an area where light infantry would later be operating. Consequently, there will still be a need for the restrictive fire area in fire support doctrine. Similarly, though its role for force protection will no longer be required, the No Fire Area will remain as a means to protect sensitive areas or facilities from destruction. The Airspace Coordination Area is specifically designed to protect air craft from the effects of ground forces' fires. None of the digital systems listed here provide fixed-wing aircraft pilots with an on-board system to identify friendly and enemy ground forces. Nor do they have a system to immediately update changes in fire support coordination measures. If these type of systems are developed, and tactical employment of the fighters changes, then the employment and definition of ACAs will have to be re-examined. Absent some other solution, the ACA will need to be retained.

Free Fire Areas will also be unaffected. Although FFAs are not used specifically to facilitate the attack of enemy forces, nor used to protect friendly forces, the various forces will still need areas in which to jettison ammunition (for example, aircraft returning to base with unexpended ammunition).

Therefore, FFAs will still need to be retained in fire support doctrine.

The authors of TRADOC Pam 525-5 speculate that boundaries will be eliminated, based on the relevant common picture that will be shared by units on the battlefield. Although this paper hasaddressed only fire suport coordination measures, it seems there must still be a way to delineate responsibility on the future battlefield. Boundaries then will remain the basic maneuver control measure to delineate unit tactical responsibility. They must also retain their restrictive nature in that no fire support assets may fire into a unit's area of reaponsibility without permission of the appropriate commander, lest one unit interfere with the with the actions of the other.

On the other hand, some fire support coordination measures should be revised. The faster information flow from sensor-to-shooter eliminates the need to facilitate fire beyond the Coordinated Fire Line. Additionally, systems such as ASAS and IVIS will provide commanders and FSOs the ability to identify friendly and enemy forces short of the CFL, obviating thereby the need for the force protection provided by the current concept. A CFL will still be necessary, however, to permit the commander to control which targets are engaged, and when, by fire support assets in his area of operations. The Fire Support Coordination Line will be affected similarly to the CFL. However, the Air Force probably will still want the function or status of the FSCL changed to reflect their position that the FSCL should, in essence, be the ground forces' forward boundary, effectively delineating responsibility for the attack of enemy forces between the services. The potential for increased speed in coordination through employment of automated systems throughout the battle area supports the Air Force's position.

Only the Restrictive Fire Line will be eliminated altogether. The RFL is designed solely for force protection, a function that will become automated through digitization of the battlefield. For example, two forces approaching each other will know each other's locations through the B2C2 and through IVIS systems. The IVIS systems will identify friendly forces in the vehicle commander's area. The B2C2 will permit a check against a request for fire's coordinates and friendly unit locations.

Nevertheless, in the foreseeable future the Army will not be able to rely solely on digital systems. First of all, there are still equipment interface and fielding problems that must be solved. Then too, before any fire support coordination measures are changed or eliminated, some institutional problems currently associated with digital systems must be corrected.[75] The majority of these problems have been identified through the Army's long experience with TACFIRE. The new systems must be user friendly. They must solve the display problem that often requires soldiers to plan on paper maps and transfer the results to a digital medium. They must also resolve the digital band width problem mentioned previously, to ensure voice communications can still be available. Additionally, electronic systems are not invulnerable to interference from electronic warfare, electro-magnetic pulse, or the effects of the environment. When they fail, expedients must already exist. Units will have to be capable of operating in a degraded mode just as they are today.

Moreover, as noted above, in the joint arena there is currently no digital interface existing with our sister services at the tactical level. The most critical need is for a digital system capable of instantly updating fixed-wing aircraft pilots of changes in fire support coordination measures, at the minimum, and in assisting with identifying friendly ground forces, if possible, similar to the IVIS' display.

Finally, if likely coalition partners do not digitize their forces as actively as the US military, then the synchronization of efforts throughout the full force will be very difficult without retention of more primitive fire support coordination measures. Even our major allies are not able to modernize their forces at the same rate we do. This problem is exacerbated when a country with rudimentary forces needs to be included in the operations for political reasons. Consequently, there will likely be an increased need for a pool of interforce liaison officers with a full set of digital equipment able to interface across unit boundaries. Failing that, units sharing boundaries will need to be aware that unmodernized friendly forces are on their flanks and the ROE may require strict hierarchical procedures for identification and clearance of fires to avoid fratricide.

To change a military paradigm (to exploit a new paradigm), three conditions must be met. First, some technological "engine of change" must create the opportunity. Second, the potential must be recognized and articulated. Third, the opportunity must be seized and exploited. The price of clinging too long to an outdated paradigm can be enormous -- so too is the advantage of being the first to shift to a more effective model.[76] Digital communications are today's engine of change. The national military leadership has recognized and articulated the potential of changing our military paradigm from one of overwhelming our enemies with our nation's industrial might, to defeating our enemies by winning the information war through use of digital technology. Exploiting the opportunity is proving to be the hardest part. With the changing world situation, the military's budget is unlikely to provide adequate resources for the development and fielding of all the required systems to completely digitize the force any time soon.[77]

Certainly it has been shown that the use of digital systems on the battlefield will cause major changes in the employment of fire support and, consequently, in the use of fire support coordination measures. Increased information flow will flatten the delivery of fires structure, enhancing the speed and accuracy of delivery of indirect fire support. Additionally, these same attributes will contribute to a greatly increased capability throughout the force to share a relevant common picture of the battlefield, thus increasing force protection by reducing fratricides due to misidentification of forces. The net effect of digitization on fire support coordination measures should be the elimination of one and modification of three of the current measures. Three more will remain the same. If not a paradigm shift, certainly digitization of the battlefield will produce a major change in fire support procedures, a flattening of fire support structures, and an increase in efficiencies.

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[22] Ibid., 37.

[23] House, Towards Combined Arms Warfare, 162.

[24] US Army, Field Manual 6-20, Field Artillery Tactics and Operations, (Washington, DC: August 1973), 6-12 - 6-18. Six new measures were added. They were the Fire Coordination Line (today's Restricted Fire Line), Restricted Fire Plan (today's formal Airspace Coordination Area), Free Fire Area, No Fire Area, Fire Coordination Area, and Nuclear and Chemical safety measures - the same as the Nuclear Safety Line. Another change to the fire support coordinating measures was that the Bomb Safety Line was renamed the Fire Support Coordination Line. The addition of the new measures was not only in response to the technological improvements on the battlefield, but was also a response to the new Field Manual 100-5, Operations, which had just been published. The new fire support coordination measures were the artillery's way of indicating it was staying current with the new doctrinal changes presented in FM 100-5.

[25] Doughty, Evolution of Doctrine, 44.

[26] US Army, Field Manual, 6-20, Fire Support in Combined Arms Operations, (Washington, DC: December 1976), H-11 - H-14. Current fire support coordination measures are: Boundaries, the Coordinated Fire Line, the Fire Support Coordination

Line, the Free Fire Area, the Restrictive Fire Line, The Restrictive Fire Area, The No Fire Area, and the Airspace Coordination Area.

[27] US Army, Field Manual 6-20-40, Fire Support for Brigade Operations (Heavy), (Washington, DC: January 1990), E-3.

[28] Ibid., E-3. Several non-doctrinal methods are currently being employed in different theaters to assign responsibility for different areas of the battlefield to the services. In Korea, the Deep Battle Synchronization Line is used to delineate responsibility. (See US Army, Deep Battle Synchronization Doctrine - Korea, US Forces, Korea, 1993, x.) CENTCOM uses the Long Range Interdiction Line to denote the extent of long range targeting responsibility. (See US Army, USCENTCOM Reg 525-24, US Central Command, 1993, 5.) Neither has been approved for use for the armed forces worldwide.

[29] Richard G. Davis, The 31 Initiatives - A Study in Air Force-Army Cooperation (Washington, DC: Office of Air Force History, US Air Force, 1987), 46, 51, 55, 56, 58, 70.

[30] US Army, Field Manual 100-15 (Draft), Corps Operations, 4-34.

[31] US Army, TRADOC Pamphlet 525-5, Force XXI Operations, 3-3.

[32] Ibid., 3-6.

[33] Richard J. Dunn, III, From Gettysburg to the Gulf and Beyond: Coping With Revolutionary Technological Change in Land Warfare (Washington, DC: Institute for National Strategic Studies, National Defense University, Fort McNair, March 1992), 61-62.

[34] GEN Jimmy D. Ross, "Winning the Information War", (Arlington, VA: Association of the United States Army), Army, February 1994, 27.

[35] MG Jay M. Garner, "Concept Paper on Horizontal Technology Integration, (HTI)", (Washington, DC: Department of the Army, Office of the Deputy Chief of Staff for Operations), 8 November 1993, 1 and 2. The discussion of the four horizontal integration strategies is taken solely from this source.

[36] MG Joe W. Rigby, "Digitization Overview Briefing", (Washington, DC: Army Digitization Office, 26 August 1994), slide 8.

[37] Department of Defense, Joint Chiefs of Staff Publication 2, Unified Action Armed Forces, (Washington, DC: December 1986), 1-1, 1-7.

[38] VA Richard C. Mackle, "Information Exchange Poses Enhanced Warrior Prowess", (Fairfax, VA: Armed Forces Communications and Electronics Association), SIGNAL, June 1992, 2, 17.

[39] Sessions and Jones, Interoperability, 17.

[40] Stuart H. Starr, MITRE Corporation, "Perspectives on C3 Interoperability," briefing at the Naval Postgraduate School, Monterey, CA, July 9 1990, In Interoperability: A Desert Storm Case Study, (Washington, DC: Institute for National Strategic Studies, National Defense University, Fort McNair, 1993), 17.

[41] US Army, TRADOC Pamphlet 525-5, Force XXI Operations, 3-6.

[42] Garner, "Concept Paper on Horizontal Technology Integration, (HTI)", 2.

[43] Taken from a memorandum from CPT Kyle M. McClelland, Armor Task Force Fire Support Trainer to LTC(P) Webster, Senior Armor Task Force Trainer, National Training Center, Fort Irwin, CA. Undated. CPT McClelland was the fire support point of contact for the NTC's Operations Group during the digital rotation. As such, he was responsible for observing and reporting on the Advanced Warfighting Experiment's impact on all areas of fire support. Before the experiment, he received training at the Mounted Battle Space Battle Lab, Fort Knox, KY and at the Depth and Simultaneous Attack Battle Lab, Fort Sill, OK on the various systems used.

[44] Garner, "Concept Paper on Horizontal Technology Integration, (HTI)", 2.

[45] Sessions and Jones, Interoperability, 3-4.

[46] US Army, TRADOC Pamphlet 525-5, Force XXI Operations, 3-3.

[47] Taken from briefing slides from COL Steven Boutelle, Project Manager, Field Artillery Tactical Data Systems, "Digitizing the Battlefield and Fire Support Interoperability", Presented 22 November 1993, Battle Command Battle Lab, Fort Leavenworth, KS, slide #2.

[48] US Army, TRADOC Pamphlet 525-5, Force XXI Operations, 3-5.

[49] Sessions and Jones, Interoperability, 20.

[50] US Army, Field Manual 6-20, Fire Support in the Airland Battle, (Washington, DC: May 1988), 1-2.

[51] Ibid., 1-1 to 1-7.

[52] Ibid., 3-3.

[53] Ibid., 3-3.

[54] US Army, TRADOC Integrated Battlefield Targeting Architecture Action Plan (TIBTAAP) Final Coordinating Draft, (Fort Leavenworth, KS: Combined Arms Command, May 1994), 2-84.

[55] US Army, TRADOC Pamphlet 525-5, Force XXI Operations, 2-7.

[56] LTC William N. Bransford, "Fire Support and Desert Hammer IV, The Advanced Warfighting Experiment," Field Artillery, (October 1994), 40.

[57] CPT McClelland phone interview with the author, October 1994.

[58] US Army Field Artillery School, "Interim Fire Support Automation System Information Paper," Memorandum For Command and General Staff Field Artillery Officers, July 7 1993, 1 and 2.

[59] CPT Iddins, IVIS Report, Subject: IVIS'Force Multiplying Effects, undated, 1.

[60] MAJ Gilley interview with the author, October 1994.

[61] US Army, "Maneuver Control System Information Paper," (Fort Monmouth, NJ:Program Executive Office, Command and Control Systems), 1.

[62] US Army, TRADOC Integrated Battlefield Architecture Action Plan (TIBTAAP), Final Coordinating Draft, 2-84, 2-85, 2-91 and 2-92.

[63] US Army, Battlefield Architectures, Architecture Annex to Section IV IBTA Handbook, Final Coordinating Draft, (Fort Leavenworth, KS: Combined Arms Command, Battle Command Battle Laboratory, May 1994), [--].

[64] US Army, "B2C2 Fact Sheet," undated, (Fort Leavenworth, KS: US Army Battle Command Battle Laboratory), 1.

[65] US Army, "All Source Analysis System Information Paper," (Fort Monmouth, NJ: Program Executive Office, Command and Control Systems), 1.

[66] US Army, "Army Field Artillery Tactical Data System Information Paper," (Fort Monmouth, NJ: Program Executive Office, Command and Control Systems), 1.

[67] Sessions and Jones, Interoperability, 24.

[68] Ibid., 20.

[69] US Army, Force XXI Capstone Analysis, Phase I Results, (Fort Leavenworth, KS: Training and Doctrine Command Analysis Center, July 1994), 9 and 11.

[70] Iddins, IVIS Report, 20.

[71] Ibid., 26.

[72] Ibid., 32-33.

[73] MG Wesley K. Clark, "Digitization: Key to Landpower Dominance," (Arlington, VA: Association of the United States Army), ARMY, November 1993, 30.

[74] US Army, Field Manual 6-20-30, Fire Support for Corps and Division Operations, (Washington, DC: October 1989), A-6 to A-16. FM 6-20-30 is the most specific manual when listing the Corps FSCOORD's place of duty. However, it details no specific place for the division artillery commander. It also states that "the FSCOORD cannot always be present in the supported unit CP because of his responsibilities to command the organic field artillery." The brigade FSCOORD's (the DS artillery battalion commander's) doctrinal guide, FM 6-20-40, states, "His (the FSCOORD's) duty location at any given time is where he can best execute the maneuver commander's intent for fire support." The quandary the FSCOORDs experience is a consequence of their status both as special staff officers (Fire Support Coordinators) and force field artillery commanders. A number of variables enter the FSCOORD's decision where to position himself. First, the supported maneuver commander likes to have the FSCOORD nearby to assist with the inevitable changes that occur upon execution of the oplan. The FSCOORD also must factor in the skills and capabilities of his TOC personnel.

[75] Mrs. Peggy Fratzel, Interview with the author, 7 September 1994.

[76] Dunn, Richard J. III, From Gettysburg, 16-17.

[77] Mr. Tom Douthitt, Interview with the author, 8 September 1994

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