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Fleet Battle Experiment Foxtrot Final Report

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NAVAL POSTGRADUATE SCHOOL

FLEET BATTLE EXPERIMENT FOXTROT
FINAL REPORT

Institute for Joint Warfare Analysis

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FLEET BATTLE EXPERIMENT
FOXTROT

FINAL REPORT

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FBE-F was conducted 30 Nov through 8 December 1999 in the COMFIFTHFLT (C5F) Area of Responsibility. As an overarching principal, the focus of this experiment was to gain insights that will lead to improved future combat readiness and interoperability of U.S. forces through application of future concepts, doctrine, and technologies to an existing USCINCENT CONPLAN.

This report presents the results of the analysis of this experiment.

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EXECUTIVE SUMMARY

BACKGROUND

Fleet Battle Experiments (FBE) are CNO initiated series of experiments designed for the purpose of "operationalizing" Network Centric Operations and developing its supporting concepts through the co-evolution of new doctrines, organizations, technologies and systems. The Maritime Battle Center (MBC) of the Navy Warfare Development Command (NWDC) is the CNO's agent for planning and implementing these experiments in partnership with the numbered fleets. Fleet Battle Experiment Foxtrot is the sixth in the series and was under the operational sponsorship of Commander, Fifth Fleet (COMFIFTHFLT) in Bahrain. The Naval Postgraduate School (NPS) performed the assessment of FBE-F during November and December 1999.

CONCEPTS AND EXPERIMENT APPROACH

FBE's are not laboratory experiments but are operational experiments designed to explore new concepts, technologies and processes. Operational experimentation features a high level of complexity and a small sample size. It is not possible to control variables as is case in laboratory or "hypothesis" based experiment. As a result there is rarely an opportunity for replication and the experimentation itself is unpredictable. Though they are based on concepts, operational experiments are not designed to prove or disprove supporting hypothesis but with the acquisition of knowledge to guide future decisions. In this construct "failure" is not only acceptable but often valuable and common measures of success do not apply. An experimental element that fails 80 percent of the time may demonstrate potential in the 20 percent of the time that it succeeds. The analysts challenge is to recognize when such an insight is illuminated and to capture that result for future development.

EXPERIMENT DESCRIPTION AND THEMES

FBE's are constructed to examine concepts within the context of a Critical Operational Issue (COI) specified by the fleet commander. In the FBE-F, the COI was a no-notice mining of a critical Sea Line of Communication (SLOC). COMFIFTHFLT was appointed the Commander of a Joint Task Force and charged with expeditiously reopening the SLOC in the face of a robust area denial capability. Only those assets in theater, the on station Carrier Battle Group (CVBG), Mine Clearance forces and limited joint forces (US Army ATACMS and Attack Aviation) and coalition forces (HMS Exeter) were available.

The operational "engine" for FBE Foxtrot execution centered on the complex requirements for the draft doctrine, "Joint Maritime Access Control (JMAC)". Today access operations are based on sequential phases in which enemy air defenses are suppressed, air superiority gained, maritime supremacy established and only then do mine clearance operations commence. This is effective but time consuming. JMAC is based on a simultaneous, parallel, multi-mission, combined arms operations to penetrate, engage and dominate an area denial threat. In the FBE Foxtrot scenario, where rapid reopening of the SLOC was critical, JMAC focused on parallel or simultaneous mine clearance and force protection. Mine clearance commenced prior to the establishment of theater wide superiority or supremacy through a dynamic, combined arms approach to protecting mine clearance forces.

FBE Foxtrot required the CJTF not only to conduct an aggressive undersea warfare campaign but also to neutralize or destroy a robust area denial threat and to prepare for the possibility of retaliation with weapons of mass destruction. JMAC therefore, rested on Undersea Warfare (including anti-submarine and mine warfare), Joint Strike and Fires and Nuclear, Biological and Chemical defense. Key insights into these capabilities are contained below.

KEY INSIGHTS

Undersea Warfare: Mine Warfare was the centerpiece of the Fleet Battle Experiment Foxtrot. Once hostilities commenced the timeline to reopen the SLOC was largely determined by the time required to clear the deployed mines. The mine clearance forces were the operational center of gravity and other joint forces existed largely to protect them. Key USW observations included:

- In Stride Mine Clearance Operations: Integrating mine clearance requires the creation of a temporal and spatial protective zone around mine clearance forces. Protective forces need to know the location of mine clearance forces and mine clearance forces need to know the threats, where the protective forces are located and the status of any engagements. This requires increased situational awareness on board the mine clearance forces as well as increased visibility to the remainder of the joint force. Current C4I does not support either requirement.

- USW Command and Control: The co-location of the Sea Combat Commander (SCC) and the Mine Warfare Commander (MIWC) with the Joint Forces Maritime Commander (JFMCC) was effective. The result of this collaboration was an integrated Undersea Warfare Plan, coordinated within the framework of other Naval operations. Although full exploitation of shared sensors and environmental data was not realized this collaboration should be formalized.

- Organic Mine Warfare Forces: Submarines and surface forces equipped with remote mine hunting systems constituted a force multiplier by lessening or even eliminating the requirement for defense. The command and control issues concerned with employing these multi-purpose assets efficiently require the development of supporting doctrine and effective multi-disciplinary tactics.

- MCM Protection: The vulnerability of MCM forces can be mitigated by the application of disruptive, neutralization and suppressive fires to shore based threats and the integration of asymmetric, joint forces to threats posed by surface craft. Army Attack Aviation (e.g. Apaches) appeared uniquely fitted to this role of engaging surface threats. To realize this potential many essential questions including airborne C2, ability of the Apaches to discriminate between friendly and hostile targets and crew-training questions require resolution.

- Change-Detect Mine Location: The comparison of current bottom mapping with archived data to locate deviations or "deltas" decreased the number of mine like objects requiring investigation and effectively reduced the mine clearance timeline. This technique should be instituted immediately.

Joint Strike and Fires: The protection of mine clearance forces required a flexible and highly responsive fires organization capable of integrating surface/subsurface fires (e.g. ERGM, LASM, TTLAM and US Army ATACMS) and TACAIR. During FBE Foxtrot where the preponderance of fires available came from Navy forces, a Joint Fires Element (JFE) of the CJTF staff controlled both deliberate and tactically responsive fires. The JFE demonstrated potential to accomplish these missions and appeared particularly fitted to controlling Navy fires during initial penetration and transition when the preponderance of fires were maritime based. Key fires observations included:

- Digital Fires Network: Access to a common operational picture (COP) and a common rule set is essential for Network Centric Operations (NCO). Although the system utilized during FBE Foxtrot demonstrated some shortfalls in displaying the COP, the common understanding of the operational environment (not only what and where but why events were occurring) was an essential element to the success of the operation.

- Time Critical Targeting: The expected flexibility of the TCT architecture was not demonstrated and target generation devolved into a mechanical process largely divorced from latency concerns. Median engagement time from detection to engagement was 75 minutes and almost no targets were engaged within the specified dwell time. Critically, however, some targets were detected and engaged in under 15 minutes. This illuminated the potential of networked processing and the Digital Fires Network (DFN) if technical and procedural roadblocks can be identified and overcome.

- Target Detection and Mensuration: The ability to deliver precision GPS guided munitions was not matched by the ability to generate the precision targets. During FBE Foxtrot only 53 percent of the TCTs were engaged and over half of those were not engaged due to a deficiency of data, time or resources. Optimization of the considerable programmed fires capabilities will necessitate a more robust detection capability (sensor network) and resolution of the mensuration bottleneck.

- Sensor Management: Effective sensor management is critical to generation of precision targets and battle damage assessment (BDA). The JFE must have the authority to task sensors. It must also include the organization and operational techniques to manage limited sensors and to prioritize between time critical targeting, BDA and other Intelligence, Surveillance and Reconnaissance (ISR) requirements. During FBE Foxtrot this was not demonstrated.

- Attack Guidance Matrix: The "digitalization" of a Commander's intent in the Attack Guidance Matrix is a critical element of operationalizing Network Centric Operations. During FBE Foxtrot the Joint Target Coordination Board (JTCB) attempted to translate strategy into this prioritized, digital engagement format. Although of problematic effectiveness due to inadequately understood strategy and lack of familiarity with the elements of the matrix ("what's under the hood"), this illuminated both the problems and potential of a digital commander's intent.

- Effects Based Operations (EBO): The integration of EBO was not effective largely due to a lack of common understanding of EBO, a common language and failure to adequately define the requirements for detailed, continuous commander's guidance. Organizationally future JFEs must include a feedback loop, a method of evaluating actions or potential actions effects (particularly those directed at reason and belief) and a construct to employ non-kinetic effects.

- Doctrine and Training: To optimize the fires capabilities and organization employed during FBE Foxtrot requires digitalization, automation and flattened C2. This will require a reassessment of the concepts of authority and responsibility as they apply to application of both lethal and non-lethal effects. New tactics, techniques and procedures (TTP) as well as supporting doctrine and training are required to operationalize network centric effects based operations.

Nuclear, Biological and Chemical (NBC) Defense: During FBE Foxtrot the land based CJTF was particularly vulnerable to NBC attack delivered by either theater weapons (i.e. TBM) or by terrorists. Integration of NBC defense was therefore a high priority of the CJTF who established a NBC cell that constituted a center of excellence for the staff. Key observations included:

- Mission Predominance: The encompassing nature of NBC Defense and the extensive requirements that this would have placed on the CJTF could overwhelm the warfighting capability of the staff. Though partially masked by experiment artificiality, the experiment illuminated the extent of the demands of maintaining a coalition, ensuring host nation support, evacuation of US nationals and the burden of conducting operations in an NBC environment.

1.0 INTRODUCTION

1.1 FOXTROT OVERVIEW

FBE-F was conducted 30 Nov through 8 December 1999 in the COMFIFTHFLT (C5F) Area of Responsibility (AOR). As an overarching principal, the focus of this experiment was to gain insights that will lead to improved future combat readiness and interoperability of U.S. forces through application of future concepts, doctrine, and technologies to an existing USCINCENT CONPLAN. Specifically, FBE-F focused on defining future warfighting capabilities required to conduct SLOC/ASLOC access mission requirements within the expected future context of this AOR. Future requirements include domains of C2, technological, doctrine/TTP and organizational relationships. FBE-F extended maritime dominance to a littoral environment. Conceptually the hypothesis is that new warfighting concepts (doctrine, TTP and organizational) supported by technology advances, permit the Navy to enter and remain in the littorals indefinitely. This is accomplished by combining maritime forces with Joint Forces to provide intelligence, fires, Command and Control, logistics support, and protection of forces afloat and ashore. Technology multipliers in FBE-F explored maritime dominance enabled by an improved common operational picture (COP). Improvements to the COP included improved access and processing of target information in support of responses to Time Critical Targets (TCTs), enhanced situational awareness (SA) of the undersea waterspace of interest to MIW and ASW forces and SA of force protection against air, coastal missile, artillery and asymmetric attacks. Insight was also gained by redefining boundaries of operational warfare commanders and their co-location with the Joint Force Maritime Component Commander (JFMCC) and Surface Component Commander (SCC) onboard a flagship.

The operational "engine" for FBE Foxtrot execution centered on the complex requirements for Joint Maritime Access and Control (JMAC) in the Arabian Gulf. JMAC defines a capability for joint forces to conduct synchronous (vice serial) operations, using concurrent warfare concepts in ASW and MIW, coordinating joint assets in a maritime operation and enhancing multi-mission tasking. Central to all of these roles is the capability of the Joint Task Force (JTF) to respond to immediate threats and conduct synchronized operations, while simultaneously employing capabilities of a Joint Fires Element (JFE).

Data observers/analysts were responsible for coordinating the collection of data across multiple experiment themes (i.e. MIW, ASW, JFE, NBC, IO). The data collection team combined subject matter expertise with observations to capture immediate insights surfaced within the dynamic experiment environment. These insights included implications for organizing in a variety of various command conformations and some aspects of human factors involved in decision making. Each data collector provided a brief of daily impressions that were used to develop a general assessment for each experiment focal area.

Analysis in this complex experiment had many requirements for data collection. First was the requirement for data to be used in future study. Secondly observers noted events and data which were important to expanding notions of parallel operations within each of the primary experiment themes that had been defined as specific experimental questions. Thirdly, there were unintended consequences, or innovations that were unexpected but occurred as the experiment progressed. Collateral data, such as logs, communications and contextual material necessary to telling the "story" of FBE Foxtrot were also collected.

1.2 EXPERIMENT THEME

Joint Maritime Access Control (JMAC) was the central theme behind Fleet Battle Experiment Foxtrot. JMAC is that activity which assures Friendly Force access to littoral areas by neutralizing, destroying, temporarily degrading, or avoiding enemy maritime access denial systems and/or forces by any means.

The objective of JMAC is to enable joint military operations in the littoral which might otherwise be delayed, denied, or limited in effectiveness, or subjected to an unacceptable level of Friendly Force losses because of enemy maritime access denial. Access Assurance includes all

Challenging Chokepoint Denial Threats

methods that prevent or inhibit the enemy maritime access denial systems from accomplishing their mission. It includes methods that destroy, degrade, neutralize, or avoid enemy systems. The choice of operations method to apply in each situation is determined by enemy system characteristics and vulnerability.

The JMAC scenario developed for this experiment included an enemy closure of a critical maritime strait in order to prevent logistics shipping from getting through to support engaged land forces. In this situation, the critical operational issue was rapid opening of the strait to meet force objectives, and to sustain it open for sufficient duration to permit unimpeded transit of commercial and military shipping in support of the campaign. In order to achieve JMAC objectives, synchonized operations across various warfighting areas (i.e. MIW, ASW, Fires) were initiated. The experiment C4I architecture was configured to provide each Warfare

Commander with the Common Operational Picture (COP) required to maintain complete situational awareness of the battle-space as the events materialized. The ultimate objective was to reduce the timeline required to re-open the strait by having the individual warfare commanders take advantage of the COP thus allowing each to understand the battle space and proceed with the mission in their respective focus area in parallel fashion rather than with a more traditional sequential Concept of Operations (CONOP). Although the concept of conducting parallel vice sequential operations was the primary goal of the developed scenario, observations clearly illustrated, particularly in the MIW focus area, the vulnerability of this netted architecture and the significant impact it has when all assets do not have access to the COP. However, although the difficulty in maintaining robust, network centric connectivity degraded the situational awareness of certain MIW assets, a clearer definition of requirements needed to support organic MIW was examined and should result in a better understanding for future parallel operation experimentation.

1.3 EXPERIMENT PROCESS

Fleet Battle Experiments result from a negotiation between the Navy Warfare Development Center (NWDC) (which has engaged in a process of concept development), the Maritime Battle Center (planning and execution of the experiment), Fleet Commanders (as the Warfighter and owner of unique theater challenges), high-level innovators engaged in developing the 21st century Navy, and technology developers and program managers (contract stakeholders). This is the short list. In actuality, there are many other people and organizations involved. All of these parties have some role in the development of the experiment, through the planning process and development of concepts. As with any complex plan, there are many compromises to the actual final experiment plan and its execution.

Capturing experiment data and results is similarly complex, both in concept, planning and execution. In planning, analysts have to become familiar with the dynamic conceptual terrain of the experiment. As an added challenge, it is necessary that as concepts are developed and coupled to experimentation, that there exist some correspondence between the intent of the experiment, the concept being considered in planning the experiment, and data collected in the conduct of the experiment. In general, this has meant that concepts have had to be re-defined as a set of questions, and that these derived questions have had to be retranslated to those elements of data which would suffice to expand "knowledge" about the question and therefore the concept being considered.

For this reason, it is important that data collectors understand the "conceptual terrain" of their respective observation areas, and the related questions. Data collection instruments (observation sheets, questionnaires, etc.) for each area are focused in this way.

Besides this concept-question-data instrument process, there are other very important data requirements. First, that the questions posed be refined through the experiment. That is, based on the conduct and results of the experiment, that questions surfaced as a result are captured for further exploration. Second, the role of innovation must not be neglected as a source of data. The data capture plan is a proposal about what might be important, based on what has been defined as relevant questions, and may be observed in what is thought to be the probable set of activities in the experiment. It is certainly possible that there will be a completely different set of activities, or "unexpected results," and these are often the most relevant and important results of an experiment. Data collectors and observers must be sensitive to these occurrences, noting them with as much explanation as possible.

As the experiment progresses and data continue to pile up, there is a general tendency to define the experiment in terms of the data, instead of the data in terms of the experiment. The intent of the FBE experiment process is ultimately to understand the "story" of what occurred in the experiment, in both a complex and a general way, and to use what is learned to further refine the concepts being considered as new FBEs are being planned.

1.4 SYSTEMS METHODOLOGIES AND ANALYSIS

Analysis tests solutions. It doesn't create them. The mindset should be that strategists hypothesize better strategies, tacticians conceive better tactics, and engineers dream of better hardware; after which we analysts test the hypothesis that the strategy, tactic, or hardware is (in the appropriate sense) better. In operations research it's not "Let's analyze it so we understand it", but "Let's understand it so we can analyze it." Wayne Hughes, NPS.

"What we observe is not nature itself, but nature exposed to our method of questioning." Werner Heisenberg.

"According to the systems view, the essential properties of a (complex system) are properties of the whole, which none of the parts have. They arise from the interactions and relationships among the parts. These properties are destroyed when the system is dissected, either physically or theoretically, into isolated elements....The properties of the parts are not intrinsic properties, but can be understood only within the context of the larger whole

"Systems thinking is "contextual," which is the opposite of analytical thinking. Analysis means taking something apart in order to understand it; systems thinking means putting it into the context of the larger whole." Fritjof Capra

Analytic efforts have had four evolutionary steps. First, counting things in order to keep track of numbers of occurrences within any one category. Second, relationship between different categories of entities described by simple statistics (e.g., averages). Third, a relationship between numbers of things in different categories when uncertainty is involved (probability) and finally (present-day) efforts to understand relationship of different categories of things, in a dynamic environment. The first three steps are largely numerical and reductive, however the final one is either quantitative or qualitative.

Understanding a particular technology within a system usually means taking a measurement of something that the technology is supposed to do (cause and effect) and comparing that measurement against some standard of performance. This is generally a quantitative measurement, which makes sense, given its specific focus. However, when multiple technologies are combined in a "system," which may also include those "carbon-based technology units" (people), distinctions about the portion of which any one of those technologies contribute to the system become blurred and complex. This complexity increases further in a dynamic environment in which these relationships shift as the environment itself changes.

In complex experiments there is generally a continuum of data requirements related to differing objectives. For the technology manager with a specific program in the experiment, there may be a focused data requirement that is not concerned with relationships to other technologies. Concepts testing however, will likely include multiple technologies and systems. It is generally more difficult to make a single point data observation which adequately represents the system, although some performance may be inferred by a numerical measurement. For example, if the time to respond to a time critical target exceeds the dwell time of the target, this number represents a particular occurrence of system failure, yet tells the observer and analyst very little about "why." In fact, both are important. The first to inform the observer of a potential problem within the system, and the latter to tell the "story" of the system in a way that is relevant to the research question being asked.

Analysis in the complex experiment also has a number of dimensions within a continuum. First, there is the collection of data for further study. In the process of data collection observers will note things which appear to be important with regard to the questions which are the basis for the experiment. A certain amount of inductive analysis takes place as the observer makes associations with what is happening. Secondly, apart from those data that are relevant within the context of known questions, there are occurrences which are not related to a question set, but which are nevertheless important. Innovations that are unexpected, but occur as the result of the dynamic within the experiment must also be noted. A third dimension includes collateral data, such as logs, communications and contextual material that one would want to have to tell the "story" about what happened in a complete and relevant manner.

1.5 WHY LITTORAL? FBE IMPLICATIONS

One reason to be prepared for opposed littoral operations is that the regional CINC's often request deterrent littoral operations that may become opposed on very short notice. Recent FBE's Echo and Foxtrot have focused on littoral operations of this nature and demonstrated the payoff of littoral presence.

The scenario for FBE- Foxtrot was derived from a Fifth Fleet CONPLAN of strong interest to CENTCOM. Vice Admiral Moore, who acted as the CJTF for FBE-F, stated in a briefing prepared for an upcoming Navy Flag conference that there were strategic, operational and tactical reasons to maintain littoral access within the Gulf.

Strategically, it may become necessary on short notice to maintain the flow of oil through the Gulf despite threats of closure including actual mining. The ROE may prevent a remote, retaliatory strike against alleged perpetrators but allow mine clearance and neutralization of immediate threats to the mine-clearance force, which must operate close-in, not from a stand-off distance. FBE-Foxtrot involved such operations which were judged at least partially successful against current threats.

Operationally, he stated that the forces in place in the Gulf must enable early entry of additional joining forces including those of other services. The short deadline of world demand for oil does not allow retreat from the Gulf and subsequent re-entry. Maintaining operational forces in the Gulf reassures allies and enables locally validated information on the precise location of threats, which might be lost, if a retreat from the Gulf was necessary. FBE-Foxtrot mine warfare operations took advantage of this concept.

Tactically, remaining in the Gulf allows the use of short-range sensors and quick weapon response if necessary. FBE-F tested parallel anti-submarine and mine warfare operations that required shallow-water search, coordination and prosecution.

COMFIFTHFLT stated that the number one critical enabler against the FBE-Foxtrot threat was maintaining regional access. The Navy is investing heavily in maintaining access to the Gulf through build-up of bases within the Gulf. Use of these bases requires success against littoral threats.

FBE-Echo also showed the payoff of littoral presence, even in the face of active threats. Although Echo was not a specific real-world scenario like Foxtrot, it demonstrated the application of naval forces against asymmetric threats while in a threatened but friendly port. The presence of US Navy units in the port and Marines on the ground were key to success against the asymmetric threats. The Navy's ability to stay in port and respond to threats without causing collateral damage was essential to mission success and could be needed to maintain global willingness to host our ships and forces.

As an example from FBE-Echo, the tactical UAV-like surveillance was particularly useful in tracking the mobile WMD threat when combined with intelligence preparation of the battlefield and real-time integration. Safe prosecution of the truck-based WMD threat was additionally dependent on reachback to expertise the Navy accessed.

To tie together several aspects of this question, IJWA is exploring the application of an existing model called Battlespace / Information War (BAT/IW) which has been built by two NPS faculty modelers. BAT/IW is a simple, low-resolution but easy to use model of littoral operations which highlights aggregate sensor capability including imperfect detection and mis-identification with two-sided, aggregate platform and weapon interactions. The model can reflect relative capabilities in information gathering and execution timelines in the servicing of Red targets and Blue platforms at risk.

The early efforts to exercise BAT/IW are focused on the question of operating a carrier inside the Gulf versus standoff in the Arabian Sea. The difference in dimensions of these two operations shows up in BAT/IW as higher sortie rates and more time over target for the Gulf location. Offsetting these advantages are the necessity of higher fraction of defensive missiles in the VLS tubes of escorts versus land attack weapons and the necessity of maintaining a larger fraction of the deck in defensive air operations. Although the data for the comparison is only a rough estimate at this time, some interesting non-linear behavior is showing up. It is planned to more closely match the data to the FBE- Foxtrot scenario and experience in the near future. In the longer term it may be possible to evaluate the impact of the capabilities of new technologies with BAT/IW.

An additional and parallel aspect to this question is to examine space-borne operations as they will be related to the Navy-After-Next. Space-based systems are often argued within the context of redefining naval roles in littoral operations. Evolutions in technical capability will continue to produce improvements in space-based systems. But space systems must operate within well-known laws of physics. These limit, to a greater extent than with naval forces in the littoral, the operational potential (nor will all potential capabilities be fielded).

Orbital mechanics, for example, dictate roughly 90 minute revisit times, decay rates, sensor fields of view, fuel on orbit requirements, power requirements etc. These limitations are likely to outweigh the potential for use of space-borne assets as a replacement for naval in-shore and littoral presence. For example it is unlikely that the mines in the Strait of Hormuz per the FBE Foxtrot scenario could be detected and inactivated from space. Similarly the moving Time Critical Targets could not be detected, identified tracked and attacked within their short dwell times with space assets alone. For moving TCT, a staring capability such as the locally-cued and directed UAV in Echo and Foxtrot was effective and can not be matched from space. Although such analysis is judgemental and based on current known capabilities, comparison with CNAN-defined future naval forces may yield the same result.

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2.0 EXPERIMENT INITIATIVES DESCRIPTIONS AND RESULTS

This section describes the initiatives/concepts for FBE-F, lists specific questions that were addressed, and the results. The questions describe the areas for which information was desired. The results that were obtained do not have a one-to-one correspondence to the questions, rather they address the question areas.

2.1 JOINT FIRES ELEMENT (JFE) CONCEPT

2.1.1 JFE Objectives

FBE Foxtrot was based largely on a principle of centralized processing to support concurrent and in-stride operations by joint warfare commanders and their specific forces. A Joint Strike and Joint Fires Element were central components of this structure and a demonstration of a set of *capabilities* necessary to the conduct of Joint Maritime Access and Control (JMAC) described in this report.

Capabilities defined in this portion of FBE Foxtrot were hierarchical. These capabilities could be decomposed into a capability to conduct deliberate planning in support of an Integrated Tasking Order (ITO) by coordinating a Joint Forces Air Component Commander (JFACC) with component requirements (USN, USA, USAF) and Joint Warfare Commanders such as the Joint Forces Maritime Component Commander (JFMCC) and the Joint Forces Land Component Commander (JFLCC), each of which had their own internal processing capability to define their deliberate targeting needs. At a similar level, a capability to conduct specific targeting missions against Time Critical Targets required a separate capability, but one highly coupled to the "processing engine" of deliberate strike.

Specific Joint Fires initiatives are stated in the FBE F Experiment Plan. A portion of these include:

- Define system and organization requirements for conduct of Time Critical Targeting.
- Explore capability of Enhanced TLAM operations.
- Explore use of Army Tactical Missile System (ATACMS) to support JMAC and Joint Fires.
- Examine construction and implementation of a Digital Fires Network in the Arabian Gulf (AG).

Additional initiatives that were specific for the Joint Fires Element:

- Define requirements that enable a Joint Fires Element to work directly for the JTF, emphasizing Naval Surface Fires Support (NSFS) to prosecute deliberate (ITO) strike and TCT's.
- Produce aimpoints of requisite quality for JFE prosecution from sensor events.
- Determine system and processing requirements to localize, identify and prosecute TCT's.
- Explore requirements for establishing a Joint Fires Network as part of the Digital Fires Network.
- Improve capabilities to coordinate and synchronize TCT and deliberate targeting processes between the JFE and the Joint Strike cell.

- Experiment with simulations of future weapons systems and munitions by providing excursions within the battle problem.

Assumptions made in execution of operations were that information would be resident in theater and not available through reachback (with exception of MIW *change detect* experiment), that real theater sensors and weapons (2005) would be used, and that many of the events would be simulation driven.

2.1.2 JFE Questions of Interest

- Did the JFE perform TCT sensing, target pairing and mission assessment within the TCT "dwell time?"
- Did the JFE concept enhance performance of parallel operations necessary to Joint Maritime Access Control?
- Does JFE enhance concurrent ASW and MIW operations, as well as multi-mission tasking (e.g., organic ASW/MIW)?
- How does a JFE organization impact coordination of Joint Assets for maritime operations?
- What results are indicated between the deliberate ITO planning processes and conduct of dynamic TCT missions?
- Is the JFE organizationally sensitive to system conflict and degradation? Is the JFE capable of self-organization in a time-sensitive environment?
- Was requisite information available to decision makers at LAWS to make timely and reasonable decisions?
- What impact did GISRS-M have on the sensor management related to reduction in TCT decision making time?
- How was information made available to higher authority as required?
- What feedback mechanisms were employed throughout the JFE system?
- Were changes to the TLAM process (MDS 4.X) useful in improving TLAM responsiveness?

2.1.3 JFE Analysis Results

2.1.3.1 Fires and JFE System

Joint Fires (Strike) and the JFE (referred to here as JFE unless specifying one from the other) can be described in system terms. The system was constructed as an organization of entities: a Joint Forces Air Component Commander (JFACC) with responsibility for conducting and coordinating deliberate planning against targets assigned in the Integrated Tasking Order (ITO); structures such as the Effects Coordinating Board (ECB) to determine the requirements for effects to be attained as the campaign continued; a Joint Targeting Control Board (JTCB), a collective of sensors that together represented a sensing component (tactical, theater and national sensor feeds); an evaluation and directing component (Intelligence, Surveillance and Reconnaissance desks); a mensurating system to create targeting aim points at a level of resolution required by precision guided munitions (PTW+ workstation); a weapons tracking and assignment entity, Land Attack Warfare System (LAWS); and the Joint Continuous Strike

Environment (JCSE), an ACTD designed to analyze the status and priority of time critical targets across the battlespace. JCSE also recommends weapon-target pairings with a speed and robustness that greatly outperforms current manual and stovepipe processes for engaging time sensitive surface targets.

As a second system description, data and processes connected Strike/JFE components (system entities). Mission requirements for S/JFE differed between phases, but also overlapped as the scenario developed. As these requirements shifted there were significant consequences for the organization processes involved.

Phase 1: In the Deterrence phase the S/JFE organizational role was to receive a Joint Prioritized Integrated Target List (JIPTL) that had been constructed in a collaborative process through a Joint Targeting Coordination Board (JTCB) and reprocess this Excel formatted information as weapons assigned to targets. This processing was conducted specifically at the JFE level, in a sub-element of the JFE, the JFE Strategy Cell (STRAT Cell). Here the initial weapon-target-pairing would take place, with "effects" considered, in order to make Effects-Based Orders to joint warfare commanders. The result of this process was that the Joint Maritime Component Commander (JMCC) and Joint Forces Land Component Commander (JFLCC) would use these directives to produce a coordinated Master Surface Fires Plan, and the JFACC would use the same data to produce a Master Air Attack Plan. Both master plans were then used to create an Integrated Tasking Order (ITO) which would coordinate deliberate Fires missions of all warfare commanders. Mission planning included weapons expected in this theater in 2005 included the Joint Direct Attack Munition (JDAM), Joint Stand Off Weapon (JSOW), Extended Range Gun Munition (ERGM), Land Attack Standard Missile (LASM), Tomahawk Land Attack Missile (TLAM) and its Tactical variant (TTLAM), the Army Tactical Missile System (ATACMS), HARM Block V and the Standoff Land Attack Missile-Extended Range (SLAM-ER).

Phase 2: The ITO developed deliberate planning described in Phase 1 (beginning with ITO A, and continuing in sequence to ITO E through the time frame of the experiment) began execution in concert with the parallel operations of Joint Maritime Assured Access and Control (JMAC). Organizational roles JFACC, S/JFE and warfare commanders increased in complexity as execution of ITO (Alpha) also required monitoring performance of execution while simultaneously planning ITO (Bravo) and conduct planning preparatory to operations in support of JMAC's mission to secure and open the Straits of Hormuz (SOH). Roles were distributed so that JFACC was responsible for coordinating USAF and USN tactical air missions, JFMCC coordinated precision guided munitions (ERGM, LASM and TTLAM) and the JFLCC was responsible for ATACMS (the JFLCC conducted its responsibilities from the Deep Operations Command Center (DOCC) in Kuwait). Other process responsibilities of S/JFE in this phase included the buildup of a digital fires network concurrent with and adapted to changes in operations such that the execution of Strike/Fires could be flexed across all platforms and warfare components. An enhanced TLAM process, coordinated via a digital voice network was also employed in this phase, with TLAM inventory reports being fed back to the Strike Cell. Although airspace deconfliction is an obvious concern as aircraft and long-range precision weapons are deployed together through common airspace against ITO targets, real-time airspace deconfliction was not employed in the experiment. Instead, pre-planned strike missions were deconflicted through message traffic.

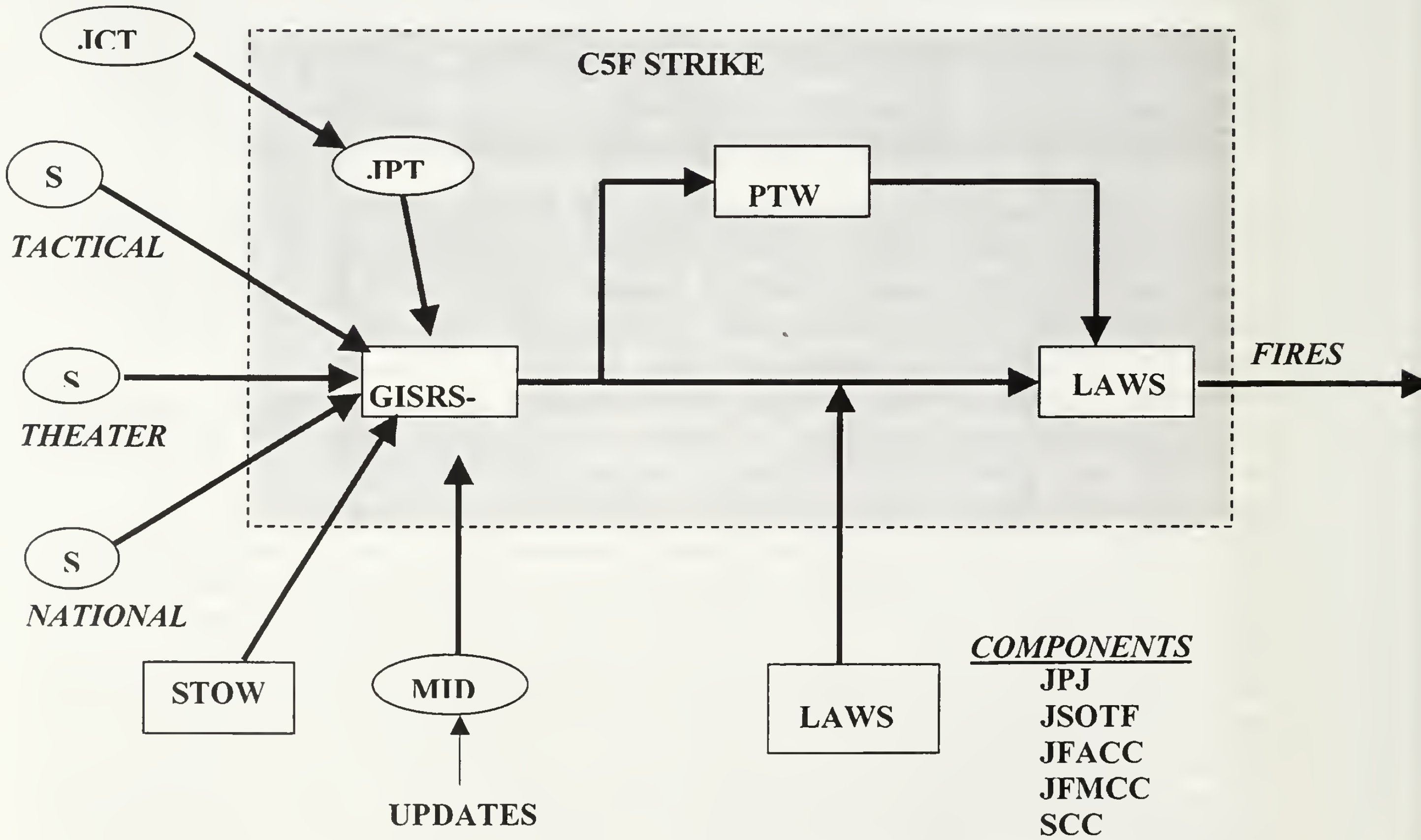
Phase 3: Phase 2 was a transition to offensive operations, which were then conducted in Phase 3 (the last 3 days of the experiment). System demands on S/JFE organization structure, processes and data flows increased to maximum levels of complexity. Concurrent with ITO planning which was still ongoing in the deliberate and sequential process, warfare commanders were conducting mine-hunting and clearing operations (MIW), ASW, special operations with Joint Special Operations forces and response to Time Critical Targets through processes within JFE.

In this phase a variety of organization relationships, command and control, ongoing deliberate planning, parallel operations by warfare commanders, targeting effects based upon CJTF guidance and adaptability in a time critical target environment were all combined in order to observe system reactions and adaptive capability. These interactions were of particular interest in the JFE, in the TCT rich environment.

2.1.3.2 JFE System Description

The following are short component descriptions with regard to how data were collected, processed and distributed within the JFE (Operations) system. Figure 2-1 provides a simplified block diagram of the key JFE components:

Figure 2-1: JFE Simplified Block Diagram



Sensor Grid: combined tactical (UAV, TARPS CD, LANTIRN, AIP P-3, SOF, SIGINT), theater (e.g., U-2 EO/SAR, RC-135 SIGINT and AWACS) and national (TENCAP) sensor inputs to GISRS-M. These feeds included imagery files of varying resolution and size.

FBE-Foxtrot tested centralized management of sensors and sensor information. Sensors are a crucial component in the effort to rapidly prosecute time critical targets, and to achieve and maintain situational awareness. Success may depend on having coordinated management of organic sensors and of the information from organic and inorganic sensors, and tactical input to inorganic sensor management.

This portion of the experiment was designed to test tactical sensor capabilities, centralized management of those sensors, fusing information from tactical sensors and national assets, rapid information processing, distributing results for fires decisions, and ensuring assessment of fires decisions for conformity with commander's intent. Central to the approach is the visibility of ISR to Operations and the ability to accomplish dynamic ISR change based on operations execution.

FBE-F tested an ISR anchor desk within a Joint Fires Effects Cell, received information from tactical and national sensors, and passed target information to a fires decision system in the Fires Cell. The ISR Desk was supported by the GISRS-M system. Fires decisions were supported by PTW+ for developing target coordinates and LAWS for weapon-target pairing. These three systems were components of the "sensor grid", "information grid", and "decision grid", respectively. The tactical sensors used were TARPS-CD, P-3 sensor suite, and simulated UAV.

- GISRS-M; where a sensed event was noted and became a nominated target, or "target-nom." This was both a technological and a human interaction with sensor feeds. Three ISR desks were manned. Operators at each desk made decisions to name any potential sensed event as a target nomination. This data was conveyed over the Global Intelligence, Surveillance and Reconnaissance (Maritime) system (GISRS-M) constructed as a sub-initiative for this experiment.
- Modernized Intelligence Data-Base (MIDB) provided a portion of electronic comparison for nomination processes and for target mensuration.
- Target Prioritization List contributed the results of an effects-based targeting process in the Effects Coordination Board (ECB) to the ISR desks.
- Attack Guidance Matrix defined system Target Location Error (TLE) requirements for nominated targets prior to being paired with a weapon system in LAWS.
- Precision Targeting Workstation (PTW+) was the point at which mensuration of nominated targets (TCT's) was conducted. Nominated targets were compared to MIDB and Attack Guidance Matrix for determination of target image and aimpoint quality prior to being pushed to LAWS. If the nomination did not meet system requirements an operator would then use PTW+ tools to make comparisons to the various C5F and Strike Intelligence libraries for further imagery support. The product of this effort was a mensurated target with aimpoint quality that could be used in pairing a weapon system to the nominated target in LAWS.
- Land Attack Warfare System (LAWS) performed final weapon to target pairing (WTP) of mensurated or otherwise validated nominated targets. At this point the nominated

targets were considered to be targets for fire missions. LAWS output produced a WTP, fire mission and inventory of weapons as they were used (engagement grid).

- Joint Continuous Strike Environment (JCSE), an ACTD (?) was provided similar information as LAWS, in a parallel feed. The output of JCSE was not used for further system processing (i.e., no fire missions were produced from JCSE processing).

2.1.3.3 JFE System Inputs

- Synthetic Theater of War (STOW) provided simulated targets, weapon systems, sensor inputs of sensed targets, and force movements (geo-translation of potential conflict areas, MIW and ASW operations areas) to GISRS-M (and then to LAWS). (Did GCCS-M play any role here?).
- Integrated Tasking Order (ITO); was produced through a long-range planning process and fed into LAWS after JFMCC, JFACC review.
- Effects Management process produced the Target Prioritization list described above, as part of the ITO planning process.

2.1.3.4 Integrated Tasking Order Process

- Joint Fires Element as a process module within the Fires concept
  a. JFE as a system of entities and processes
  b. Sensors
  c. GISRS-M
  d. Mensuration and targeting processes (PTW+)
  e. LAWS
  f. Effects-based targeting in the JFE
  g. Common Operational Picture in the JFE
  h. Organizational processes and relationships to the CJTF, Fires Cell and effects targeting organizational components (ECB, JTCB).

<u>2.1.4 Time Critical Targeting (TCT) Processing:</u>

A parallel, distributed processing system was envisioned (FBE Foxtrot EXPLAN, C.3.10.3 and C. APP 3. TAB A).

2.1.4.1 Configuration Issues

Three ISR stations were planned to receive all of the ISR sources (including live and simulated). Processing system performance depended upon the capability of the system to receive sensor inputs and add them to the comparisons performed at the next level of the system by LAWS and PTW+. An optimal ratio of system components to sensor feed in this integrated systems architecture should limit queuing conflicts so that no TCT is left unserviced due to "bunching up" of target nominations.

Originally three (3) PTW+ units were to be part of the JFE, however only one was employed in the experiment. The result was a backlog of sensor target nominations at PTW+.

Analysis of optimal technology mix should be the focus of additional experimentation. In general, in the context of this experiment it seems that the required ratio for system performance within TCT dwell times should have been on the order of one ISR desk forwarding target nominations to one PTW+. This one to one relationship does not necessarily imply the same ratio with respect to LAWS.

Queuing of sensor feeds at ISR desks is ambiguous from experiment data. This relationship will depend upon the numbers and type of sensors, target distribution and type per unit area and C3 organization supporting sensor management.

2.1.4.2 TCT Processing Issues Related to JFE System Components

- Imagery-based targeting from tactical reconnaissance assets (TARPS-CD, LANTIRN, TARPS-DI, P-3 AIP) requires a standardized imagery format.
- Imagery resolution is a critical variable to system performance. Resolution which does not meet system parameters (in this case the Attack Guidance Matrix) required for direct weapon target pairing in LAWS (or JCSE) requires further processing by PTW+. Nearly refined images require less processing here than those needing extensive mensuration.
- PTW+ can reduce mensuration timelines. However, in addition to low imagery resolution, timelines may be adversely impacted by low correlation to Intelligence Products Library (IPL) data, or by limited access to IPL. Limited access is typically related to inadequate data storage immediately accessible to the PTW+ operator.
- Related to the comment above, the Modernized Integrated Database (MIDB) may not contain necessary data to construct TCT aimpoints. At issue here are the variable rates at which the MIDB may be refreshed at different locations.
- LAWS specific processing issues:
  1. Capabilities related to messaging include a requirement for the operator to keep the "incoming log" open at all times for added situational awareness, and to maintain the display of a broadcast message while also activating other windows.
  2. A protocol needs to be developed so that multiple LAWS nodes can provide mensurated target information for further processing in PTW+. In this FBE there was ambiguity when one
  3. LAWS unit (e.g., aboard the CV) would need to push a target nomination to the LAWS station in the JFE.
  4. There were instances in which BDA reported over GSIRS-M were designated as random
  5. Targets in LAWS: There needs to be a distinction between BDA reports and potential targets, which should also include a means to couple the BDA to a specific LAWS target.

2.4.1.3 Summary of TLAM Enhancements and Impact

LAWS was modified to support in FBE-F the management of TLAM engagements. The principal characteristics of that capability include the following:

1. TLAM Mission Manager. The Mission Coordination: TLAM list displays, in a single line for each mission, the status of all TLAM, TTLAM and LASM missions prosecuted, or in the process of prosecution, by all platforms. Double clicking a mission in this display provided the detailed mission data. Using the add function the LAWS operator can enter the data for creation of a new mission in the TLAM Mission manager. A mission can also be created in LAWS by importing an Indigo or LSP message

2. TLAM routes. A request for a TLAM route is automatically generated and transmitted to the LPMP with the Mission Planning request tool. LAWS accepts and stores the returned route information.

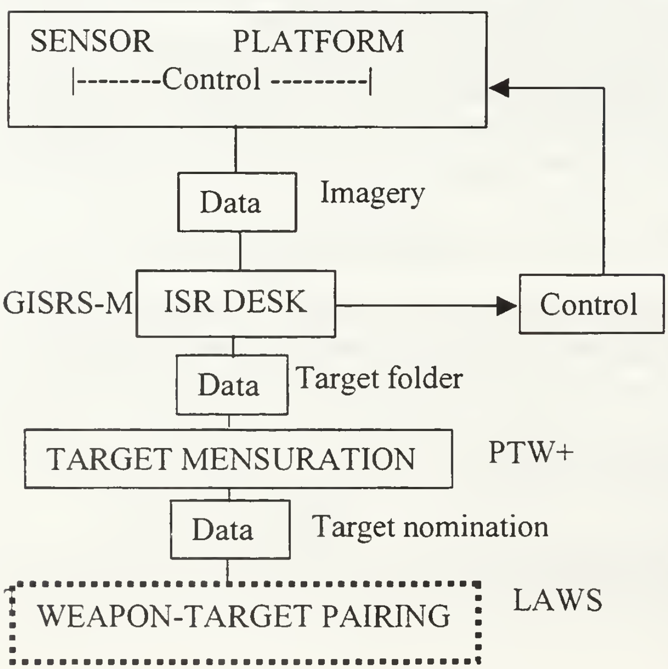
3. Fire Commands. LAWS can generate an Indigo message.

4. Inventory Status. The weapons inventory menu provided several ways of looking at the weapons inventory of all the platforms in the experiment. In particular, the Ships option in the weapons inventory menu provides a pictorial display of the status of each VLS cell on a platform.

5. Inventory Update. LAWS, on receipt of a TIR or Indigo Firing Report message automatically updated VLS cell inventories.

2.1.5 Sensor Management in the JFE Process

The following figure shows the components of what we refer to as the "sensor system", (or "sensor grid") which includes sensors, sensor information, sensor management, and fused sensor information. LAWS, which is outside of this system is also shown because it is the recipient of target nomination data. Reference can be made to the JFE cell diagram to see the position of this system within the JFE. We do not show all of the individual components of the sensor system, rather agglomerate into function blocks for efficiency of results presentation.



A sensor is mounted on a platform. The platform "pilot" may be able to Control the sensor.

Data sent from the platform can Contain status communications.

ISR desk control of sensors is via a platform controller

LAWS is not part of the sensor syst

Principal Sensor System Results

These principal results are syntheses of the system component results that follow. They refer to performance of the system within the JFE rather than performance of system components. They are divided into areas of interest.

2.1.5.1 JFE Sensing of Targets within the TCT's Dwell Time

The ISR anchor desk provided an important new capability for local collection management, making it possible to deal with TCTs more expeditiously. The Attack Guidance Matrix (AGM) was a useful tool but it needs to be modified to make it a collection management and execution aid. The desk allowed parallel sensor, target location and identification, and weapon target-pairing processes. The result of having the JFE as an overarching capability was a more rapid process than is normally obtained by sending less processed information to component commanders.

The JFE concept improves dynamic response to emerging threats, such as TCTs, through centralized management of assets. The time scales of information available to this function need to be modified to match the pace of its operation. Examples are a dynamic target list rather than an AGM, an ITO and Modernized Information Data Base (MIDB) that are refreshed in time-step response with the tactical situation.

The JFE needs a complete tactical picture in order to perform its function. This may be beyond what would normally be provided by a COP. For example, JFE needs projected tracks of sensors. It also needs cradle-to-grave information about threats, including those which haven't been adequately mensurated nor designated as targets, and the results of BDA.

Doctrinal changes, such as the inclusion of the J2 and J3 watches in the JFE and improved interoperability should be explored. This would allow real-time fusion with sensor information. Real-world operations precluded the assignment of the intelligence staff for Foxtrot. Possibly as a result, responsibility for collection planning was not clear.

2.15.2 JFE Coordination of Joint Assets, Interactions with ITO planning and dynamic TCT

Because it can be a focal point, considerable attention to ISR desk manning, responsibilities, TTPs, etc. are needed. A possible methodology is a sensor plan developed in parallel with the ITO followed by ISR desk managing by exception.

TTPs are needed for sensor control that is responsive to the dynamic tactical situation. It is unclear how control of sensors should change in a self-synchronized manner as tactical requirements change. Note that in Global-99 control/management of ISR was relocated twice during the course of the game.

The ISR desk needs to treat tactical sensors as organic assets. In order to do this it needs access to the same platform information that is available to the JFACC and needs real-time coordination of those platform's assignments. Two-way communication between the UAV sensor controller and the ISR desk reduced the nomination time-lines, implying an increase in efficiency of TCT prosecution.

Easy to use, real-time communications are needed for the JFE to perform its function. As examples: Efficient communication paths (verbal, e-mail) between the ISR desk and the mensuration operators was an essential part of the process. Voice over IP was an effective method to communicate with UAV operators and vector UAVs to areas of concern.

Additional doctrinal development is needed to identify the reinforcing roles of all search and prosecution participants.

UAV pictures and location data aided targeting but command relationships and control doctrine need to be defined.

2.1.5.3 ISR Desk Management, Processes, and the TCT prosecution time

The ISR desk appears to decrease the time-line for that portion of the system from sensor to target nominations. For example, interaction between the ISR anchor desk and UAV control enabled tactical control of the sensor grid within a 10-min threshold (from LAWS data and interviews).

Experience gained during Foxtrot operations allowed the GISRS-M operators to build target information folders that could be more efficiently mensurated.

There were bottlenecks at various points in the process, e.g. GISRS transmission via smtp taking 30sec to 10min or three GISRS workstations overwhelming the PTW+ station. This indicates that extending this configuration to handle a full tactical area will require careful examination of information loads at the choke points. Balancing the number of GISRS-M, PTW+, and LAWS terminals and improving their interoperability is required to eliminate bottlenecks especially if the sensor/information process becomes more efficient.

As an ISR desk becomes overloaded, areas of sensor exploitation could be cued in communications between the ISR desk and remote exploitation sites.

Passing of target images from F-14 TARPS-CD pods to GISRS-M is a promising innovation for finding targets. This process was severely handicapped by poor experiment connectivity (does not diminish potential capability).

2.1.5.4 Quality of Sensor Information

The full system does not provide sufficient information to do an adequate assessment of TLE, which is necessary for improved targeting. This degree of centralized processing requires more information about the sensors and platforms than is normally provided. Real-time telemetry of this information needs to be provided with imagery. Fusing sensor data can require inclusion of this information.

"None of the sensors provided a TLE adequate within the ROE to shoot on. They all had to go through the PTW+ for precision targeting. This resulted in a stovepipe process—a serial one if the target was coming from sensors." (GISRS-M lead)

Target mensuration is greatly aided by multiple resolution imaging. However, passing full images for all possible targets overloads the system. A decision process is needed that restricts the amounts of information passed to the fires cell. Several actions could aid this situation:

- Pass hyperlink references to images rather than the images.
- Resolve ambiguity and duplication at the ISR desk before passing nominations.
- Use the Attack Guidance Matrix and forward nominations based on priority.

None of the sensors provided a targeting quality TLE, which required all imagery to go through mensuration before weapon assignment. To a large extent this was the result of simulation. Simulated images were pre-built in the STOW and injected into the JFE decision process later. These digital target images were of lower quality than would be expected from "live" images from "real" systems. Lining each image into a mensuration processing queue resulted in a highly serialized process, with possible bottlenecking and a slowdown of the TCT process. Improved information from the STOW sensors could result in an improved process by which some targets are of sufficient targeting quality to bypass portions of the mensuration process, resulting in more rapid prosecution of TCTs.

2.1.5.5 Sensor and Platform Capabilities

In FBE Echo near real time information was combined from JSTARS, UAV, Links 11 and 16, and LAWS. Fusion and an enhanced capability to conduct Full Dimension Protection as a result illustrated the power of Network Centric Operations (NCO). FBE Foxtrot furthered understanding of this capability however, there are also doctrinal and semantic deficiencies.

Sensor managers on platforms and UAV controllers need to observe sensor output in order to obtain quality information. They also need to be in communication with the ISR desk so that real-time coordination between sensor data and information requirements can be accomplished.

Mobile targets require additional sensors including an organic MTI/SAR capability.

Attention is needed with regard to image type, quality, and an accompanying information package that are required for this system to efficiently nominate targets. For example, P-3 imagery needs to have longer dwell times in order to be useful. Passing images through a chain of workstations for processing can degrade them to the point where mensuration is not possible

Need an airborne sensor with higher resolution for increased stand-off capability.

Mobile targets require additional sensors, including organic MTI/SAR capability.

Sensors for the asymmetric threats such as swimmers, jet skis, and rubber boats have not yet been developed beyond the human eye and ear, each of which is limited by darkness, high winds and waves, etc. The Air Force C130U has special capabilities for detection of humans that could potentially be added to the network. Further doctrinal development and connectivity is required.

2.1.5.6 System Component Results

The following results refer to specific components of the sensor system. They are:

- Sensor Information
- Sensor Control by the Platform
- Sensor Data (both data content and transmission pipeline)
- ISR Desk
- ISR Desk Control of Sensors
- Target Folder Data (both data content and transmission pipeline)
- Target Mensuration
- Target Nomination Data (both data content and transmission pipeline)

In addition to results that apply to specific system components there are results that refer to supporting information. They are:

- GISRS-M Supporting Reference Material
- PTW+ Supporting Reference Material
- COP Issues

2.1.5.7 Sensor Information

<u>TARPS-CD specific results:</u>

- System performed well, with some shortfalls.
- Additional rapid tactical reconnaissance is needed. TARPS can provide tactically important time critical information on initial strike Bomb Impact Analysis and on movement of forces.
- Include EO, IR, and Radar in the TARPS pod. TARPS-CD contains only one sensor whereas the wet film version contains 3.
- Need increased resolution for higher over-flight and an increase in stand-off distances.
- Enhanced capability of sensors should include reliable automatic target recognition.
- Important characteristics to incorporate as capabilities:
  Ability for pilot to remain heads-out
  Feedback for camera operation
  Reliable operation during tactical maneuvering
  Ability to reset the camera after transient faults
- Significant capability improvements are:
  Increased coverage of the CD version
  Earth stabilization
  Sensor maintains performance during dynamic maneuvers
  Feedback of camera operation and image capture to the operator
- Specific recommendations to improve TARPS-CD capabilities are:

1. Allow the capability to exchange the CD-261 for an IR or combined EO/IR camera for night reconnaissance.
2. Investigate multiple sensors by replacing the forward TV camera with a better sensor for imagery collection.
3. Provide a better antenna (perhaps directional) and improve the location for better range and reliability.
4. Decrease the delay between turning on the camera and image capture.
5. Allow more operator adjustment for exposure.
6. Provide the software for a file of imagery history for graphical depiction (preferably for use with PFPS).
7. Incorporate a solid state recorder system.
8. Increase memory for thumbnail analysis on the waterfall display.
9. Provide software for stitching of thumbnails.
10. Provide software for annotating images.
11. Provide training for base station users and a technical representative for troubleshooting.
12. Provide a technical representative for camera maintenance.

2.1.5.8 Sensor Control by the Platform

Exposure adjustment should be made from imagery seen in the cockpit rather than terrain type, and a wide range of shutter speeds rather than a single stop adjustment would be an improvement.

The platform pilot needs a heads-up sensor display to enable controlling sensors while executing flight maneuvers.

2.1.5.9 Sensor Data

TARPS-CD wideband data link inoperative, data conveyed by physical transfer of digital tape.

High quality TARPS-CD data received at C5F. >1 hour latency due to data recovery, image screening on JFK (NAVIS ground station) and SIPRNET transmission.
UAVs/P-3/TARPS must provide telemetry data stream (coordinate, TLE)

Tactical imagery needs to include a North arrow and exploitation support data.

Need better location for the omni-directional antenna for F-14 TARPS. A directional antenna in the nose could be used for long distance transmission.

Provide a graphical depiction of the aircraft flight path on the imagery as a photo interpretation aid.

The Common Data Link connectivity, as a self-contained, real-time imagery system does not meet expectations. Burst transmission of thumbnails through other established links could provide some capability up to 300 miles.

Next generation sensor telemetry could include sensor pointing and location accuracy to yield target location error.

Target Location Error is necessary for TCT, thus the ISR anchor desk must have the capability to compute it from sensor data.

Target location error must be included in real-time video sources.

F-14 LANTIRN acquired and imaged live targets and disseminated via FTI. In every case, received images at ISR were of too low quality for target ID.

P-3 video provided sufficient resolution for target recognition.

P-3 video could not be used for TCT nomination because of dwell/direction and location. 15-30 sec of stabilized video needed for PTW+ mensuration, on the average only about 5 sec was available.

P-3 video contained no telemetry nor location info to provide even rough localization of targets.

Send the imagery to other strike or C2 aircraft. Would need to include the N arrow, coordinate, and a distance scale.
Send a continuous stream of images to intelligence centers to analyze real time.

Use JSTARS GMTI information as a means of cueing the TCT process. Fusion is a problem. Passing GMTI data as tracks followed by SAR NITF images could eliminate this problem.

2.1.5.10 ISR Desk

Need automatic, continually displayed, target quality in GISRS.

GISRS should bundle multiple target view images.

Bundled images: permit the operator to choose the best image for targeting.

Need reverse playback capability for photo interpretation.

One operator can simultaneously monitor two streams of streaming video, but can only work a single feed for nominating TCTs.

Locate an 8x8 video switch with the ISR anchor lead for expeditious changes from sensor-to-sensor and workstation-to-workstation.

Real-time ISR assets resolved uncorrelated ELINT contacts through a display-centric fusion process. The Attack Guidance Matrix was used to fly UAVs to TCT/ high payoff activity areas in response to uncorrelated contact reports, resulting in a large number of successful cross-cued TCT prosecutions.

A TTP is needed for direct coordination with reachback exploitation sites.

Direct, automatic distribution of newly collected imagery from framing sensors to ISR situational awareness displays is a proven concept for TCT ISR support.

Proven concept for TCT ISR support: Direct parsing and display of footprints associated with newly collected imagery from framing sensors to ISR situational awareness displays works. NITF images with 4-corner coordinates were parsed and an icon displayed the latest collection event on the ISR Situational Awareness display.

ISR sensors can capture multiple targets on a single frame or chip. Need a way to connect individual aimpoints with the original TCT nomination and tracking from cradle to grave.

Summary of functional requirements/capabilities used/identified for the ISR anchor desk to support the TCT process:

1. Directed exploitation/analysis support:
   Capability for designating and automatically disseminating ISR TCT nominations to ISR analysis nodes for additional time critical exploitation/analysis support.

2. TCT target nomination interface providing the capability for nominating targets directly from each of the following data/information sources:
   Video
   COP
   Voice reports
   MIDB/reference data (cued by other sources)
   NRT SIGINT
   GMTI

3. Attack Guidance Matrix/Sensor tie-up table.

4. Dynamic Target List/LAWS mission status tracking panel

5. Real-time collection steering support

6. ISR rout plan formulation/display/monitoring

7. On-line MIDB data query is based on geographic coordinates of the ISR situation awareness window.

2.1.5.11 ISR Desk Control of Sensors

Need ability to talk to the aircraft sensor operator

ISR management needs to cue/direct time sensitive exploitation of tactical imagery when bandwidth precludes forwarding raw imagery.

Need coms so TCT ISR can cue areas of exploitation emphasis at decentralized exploitation nodes. (a TTP)

Two-way coms between with the UAV sensor controller resulted in decreasing the time to nominate TCTs and increased the number identified and prosecuted.

ISR anchor needs for control of the sensors for TCT

- Sensor telemetry must include position and pointing.
- Need the same information as a ground control station.
- tactical control of real-time sensing from UAVs should be a TTP
- Can provide warning to pilots of potential danger with respect to target sites.

Sensor TTPs cannot be generalized but must be specifically tailored to the capabilities of individual sensor platforms.

Voice Comms are a tremendous facilitator for TCT when sensor control and TCT cell are not co-located. IVOX adequate at times, infuriating at others. Collaborative Virtual Workspace during JEFX was considerably more reliable and useful.

2.1.5.12 Target Folder Data

Target nomination package transmission too slow, now 2-10min.

Moderate to poor quality/resolution imagery data: GISRS digitization, then frame grabbing, then bitmapping, can render imagery unusable.

Reference imagery included with target nominations from GISRS to PTW+ is a necessary component and needs improvement.

GISRS to PTW+ nominations sometimes included multiple aimpoints.

It would be better to disseminate hyperlink references to an image rather than the images.

GISRS transmitted to 4 different smtp mail hosts, with a wait time of 30 sec to 10 min. This bogged down the nomination process.

ATI.ATR target nomination needs to handle multiple coordinates and multiple pictures, a folder.

2.1.5.13 Target Mensuration

Precision mensuration not accomplished in near-real-time at C5F due to operator and workstation workload conflicts, and due to integration difficulties with the TIGER software application on the JTW.

PTW+ was not fed with national imagery. Necessitating estimation of target location.

More PTWs needed for this size operation.

Need a quality double-check on the mensuration process.

Single PTW+ client workstation insufficient for a targeting cell. Nominations from 3 GISRS workstations overwhelms it.

TCT nominations should remain local until ambiguity is resolved and check with other nodes for duplicate nominations

Visual Target Aids attached to ATLARs: were of extremely poor quality, occasionally missing (thus no mensuration possible), and must be annotated to eliminate errors.

2.1.5.14 Target Nomination Data

LAWS and other operational systems need to be able to process and retrieve ISR analyst narrative comments.

Manual typing of ATLARs produces errors, and transmission via Eudora e-mail resulted in 2-3 increase in transmission time. Need self-populating interface.

2.1.5.15 GISRS-M Supporting Reference Material

Collection Manager should link to ITO to determine green status for collection plan.

Need a Sensor Guidance Matrix providing ROE for matching ISR info to a TCT.

Collection Management Planning Template was needed for the host command.
Tracks vs Targets: Use the Attack Guidance Matrix for screening TCT nominations to reduce overload of the operations system.

2.1.5.16 PTW+ Supporting Reference Material

Classify targets according to the location accuracy needed for the weapon type to be used against them.

Digital Point Precision Database (DPPDB) and NTM need to be collected and loaded on PTW+. DPPDB age and image resolution were significant detractors from PTW+ performance.

NTM imagery to PTW+ must be in primary formats, not IDEX exploited and without full exploitation support data.

Imagery Product Library difficulties.

2.1.5.17 Sensor Related Common Operational Picture (COP) Issues

Incorporate means for generating and displaying ISR collection routes in the ISR situational awareness display.

Immediately pass track reports to operational nodes for "see and avoid" while TCT nomination is ongoing.

ISR needs to know from Operations the status of TCT nominations as a driver to collection/processing refinement.

System could allow analysis and use of imagery by other forces prior to aircraft return to the carrier.

At all stages of the targeting process, there should be available a target management/status function that shows priorities, target flows, and situational awareness.

Specific experiment ISR sensors should input data into the Experiment COP via TCP/IP gateway.

Need 100mb ethernet minimum for build/distribute COP.

Need non-actionable targets in the COP.

The ISR desk needs a real-time COP containing the following to support the TCT process:

- Video from UAV and P-3
- Tactical Data Link information on friendly/hostile force locations
- NITF imagery from tactical, theater, national sources
- TCT nominations
- Uncorrelated near real-time SIGINT information
- JSTARS (APY-6)/GMTI track information

2.2 MINE WARFARE (MIW) CONCEPT

In order to assist the JFMCC and MIWC in executing their mission, FBE-F attempted to highlight the effect of future capabilities and gain some insight into a mix makeup of organic and dedicated MCM forces in the 2005 timeframe. The foundation of the experiment was the tactical data link exchange between experimental mine countermeasures tactical systems (mainly through simulations), legacy mine countermeasures systems, and a command and control network to tie the two together. The need for a high degree of situational awareness for units operating in a dynamic environment makes this a necessary requirement. Through networking, display and management systems the following operational capabilities were evaluated:

- Tactical data link capabilities to support timely exchange of MCM tactical information between the on-scene tactical commanders and assigned MCM forces.
- Automated MCM planning, evaluation and execution decisions support tools and automated information management and reporting capabilities interfaced with host platform core C4ISR capabilities.
- Automated capabilities to develop, maintain and display a common MCM tactical picture, with the capability to integrate it with the rest of the maritime picture into the CJTF display. The MCM picture includes mine and mine-like contact locations, mine threat and danger areas, gaps in potentially mined areas, Q-routes, breakthrough and clearance status, and the location and status of MCM forces.

2.2.1 MIW Questions of Interest

<u>Organizational</u>

- How did the JFMCC/SCC/MIWC interface with each other and other warfare commanders for the tactical control of platforms with organic MCM capabilities?
- How did having organic MCM capabilities affect the Battle Group Commander's response in multiple threat situations and conflicting mission requirements?
- In a multi-threat situation, was the SCC, with the MCM mission assigned, able to effectively direct MCM forces, including organic MCM assets, clearly and with no ambiguity as to intent?
- To what extent did Warfare Commanders cooperate with the MIWC to support MIW mission when conflicting mission tasking requirements were present?

<u>Architecture</u>

- Do automated MCM planning, evaluation, and execution decision support tools provided sufficient support for Distributed Collaborative Planning (DCP) for the MIWC?
- Was the MEDAL/GCCS-M connectivity sufficiently robust to provide a near real-time Common Tactical Picture (CTP) between the MCM units and the SCC/JFMCC?
- Did the CTP provide sufficient situational awareness for the SCC to make knowledgeable tactical decisions based on mine threats depicted on the shared CTP?
- Was the MCM force able to maintain communications connectivity?
- How well did an integrated LINK/GCCS-M CTP support protection of MCM assets?

Environmental

- What was the impact of having in-situ environmental data on the concurrent MIW/ASW mission?
- Was NAVOCEANO SIPRNET connectivity sufficient to support expeditious transfer of environmental and bottom topography data exchange?
- Was the NAVOCEANO reach-back and quick turn-around of real-time data into data base support products tactically useful for forward-deployed MIW/ASW units?

2.2.2 MIW Analysis Results

2.2.2.1 Parallel Operation Implications

FBE-F indicates that the MCM force must be able to conduct operations in parallel within the JFMCC campaign to gain efficient control of the seas.

Unencumbered maneuver, particularly in an environment of mining in the Straits of Hormuz (SOH), cannot be achieved until the risk of mines is reduced.

Early exploration operations to find out where the mines are and where they are not is valuable input to parallel operation decision making sequence and should effect a timeline reduction in some capacity.

The emphasis on opening a Q-route and providing a path of communication for ships and merchants falls short of providing unencumbered maneuver in the waters surrounding the Q-route (i.e. surface ships can not conduct ASW operations from inside a Q-route).

Therefore, an aggressive assessment of the enemy's intent with regard to mining coupled with a continuous ability to assess the movement of submarines and surface ships is critical to knowing where the mines could be or equally important, where the mines are not.
In essence, for future MCM capable forces to sufficiently effect a timeline reduction, a counter-mine campaign strategy (pre-penetration phase) should be a process that begins early when indicators warrant.

It should be noted that this preliminary MIW penetration phase should also embody parallel operations. For example, submarine forces could contribute to an enhanced penetration capability by conducting concurrent organic MIW, ASW, and SOF missions during the pre-penetration phase.

Hence, it is important for the MIWC and SCC to cultivate a relationship and share relevant information at the Warfighter commander level so that each maintains the appropriate situational awareness.

An effective C^2 process between warfare commanders similar to the structure exercised during FBE-F is important for information exchange and cross-pollination of the two disciplines. Although a common operational picture should be tailored to each commanders need, in a decentralized environment, it would be beneficial during parallel operations, for the SCC to access the MIW picture and for the MIWC to access the ASW/USW picture so that each is cognizant of the complete battlespace.

2.2.2.2 Organizational Relationships

FBE-F provided an opportunity for analysts to evaluate the organizational influences on the developing JMAC scenario.

Although co-locating the MIWC with the JFMCC and Sea Component Commander (SCC) on the same platform is contrary to network centric operations, centralizing the decision making process did provide opportunities to observe the interaction at various staff levels across this continuum. Close interaction between these key decision-makers was important and productive for parallel MIW/ASW operations.

Without robust distributed collaborative planning tools, decentralizing the decision-making is a difficult task.

In the organizational structure implemented for the experiment, the MIWC was positioned to identify requirements and advise the JFMCC on the critical MIW related local battle space issues. MIW is a time consuming warfare area, especially early in the conflict. Hence, the MCM force in JMAC must be able to conduct operations in parallel with the JFMCC campaign plan to gain control of the seas. It is important that the MIWC help focus JFMCC attention to the various phases of this critical operation.

Of equal importance throughout the developing scenario was the role of the SCC, who was primarily focussed on situational analysis and providing the JFMCC with information required for ASW/USW decision making.

The organizational structure during this experiment created a dynamic that encouraged a continuous interaction between the MIWC and SCC that proved to be quite beneficial. With both working as subordinate warfare commanders to the JFMCC, the speed of command in resolving support and supporting requirements was achieved.

A common operational picture (COP) plus the effective C^2 process established between the MIWC and SCC staff's enhanced the relationship of the two organizations.

Also, situating both MIW and SCC staff watch-standers in close proximity enhanced the utility of the common situational awareness and provided an environment for dynamic information sharing.

In addition, during the experiment, it was apparent that the GCCS based MEDAL and LAWS components utilized to display the COP have the potential of offering unique warfare management tools to each warfare commander yet still provide a common situational awareness understanding required by each during parallel operations.

2.2.2.3 MIW Force Protection in the JMAC Scenario

Force protection is fundamental to mounting an MCM campaign in parallel operations with other enemy suppression efforts.

The low density/high demand of MCM assets early in the JMAC conflict significantly raises the value of each MCM tool.

Given that unencumbered maneuver is denied to the CRUDES MCM force protection package due to the threat of mines, surveillance and armed response between the threat and the MCM asset is essential if moving vulnerable MCM forces beyond the reach of CRUDES was required during FBE-F.

Data indicates that armed helicopters (i.e. Apaches) offer such an avenue of protection for surface assets early in the conflict and essentially permit MCM exploratory operations to be undertaken throughout the Q-route area with reduced risk to the maritime asset.

Also, submarines appeared uniquely versatile and effective in supporting simultaneous ASW and MIW missions by reducing the requirement for defense against enemy surface and subsurface threats.

Cross-service sharing of force protection assets for MCM operations is a force multiplier that offers maritime assets typically tasked with this force protection role an opportunity to conduct other parallel tasking during mine sweeping efforts.

Additionally, a maturation of tactics for the employment of organic sensors will be required to optimize exploratory coverage and limit risk during this phase. After the location presence of mines is determined, maneuver area for force protection can be expanded and the reliance on armed helicopters will diminish. At that point, CRUDES assets can fully assume force protection as the Q-route is opened and MCM effort focuses on expanding the maneuver area.

2.2.2.4 Environmental Implications for MIW Operations

FBE-F indicated that the primary requirement for MIW forces is an almost real-time environmental database from which tactical planning decisions can be made as well as precise sensor performance predictions for a specific unit.

The primary means of transfer and display of tactical oceanographic aids was through SIPRNET and MEDAL, and the products that were required include in-situ Bathymetric data, Bottom Characteristics Database, Surface Sediment Type database, Currents, Master Contact Database, Acoustic Imagery Mosaics, and Mine Warfare Pilot Information.

Although the experiment C4I architecture could not support the reach-back network for the MCM unit during the FBE, the effort did provide a clearer definition of the types and size requirements needed for shared databases required to support MIW. It was evident that a robust and redundant communications network architecture is essential for reach-back capability.

2.3 ANTI-SUBMARINE WARFARE (ASW) CONCEPT

FBE-F was used as a building block for developing a Distributed Collaborative Planning (DCP) CONOPS between the MOCC, AIP P-3, and surface ships. FBE-F explored the applications of DCP methodology to ASW search plans in support of coordinated multi-sensor ASW operations against submarine threats in the littorals. The experiment examined methods of sharing a Common Tactical Picture (CTP) among all of the ASW forces, with the CTP including:

a common view of acoustic predictions based on high fidelity models,
databases, and
in-situ environmental measurements.

This effort was conducted in conjunction with SHAREM 131 and Arabian Mace.

During the experiment, the Sea Combat Commander (SCC) in conjunction with the ASW module performed the following:

(1) Prepared plans to conduct parallel ASW and MIW
(2) Developed a Network centric approach to ASW
(3) Developed CTP aids
(4) Conducted distributive collaborative area ASW planning
(5) Examined underwater engagement zone (UEZ)

FBE-F focused on developing a search plan methodology with the goal of developing and maintaining a force vice platform optimized search plan using DCP tools to provide the best utilization of available ASW resources to achieve campaign mission objectives. Characterization of DCP includes:

- Force vice platform level forces
- Shared operational situational awareness
- Synergistic employment of ASW force sensors
- In-situ measured and reach-back access to area environmental information
- Balanced processing and bandwidth
- Dispersed organizational structure

Exploration of CONOPS to develop and maintain a multi-sensor, coordinated ASW search plan using DCP to optimize area search under rapidly changing environmental and tactical conditions was also a primary ASW focus during the experiment.

In addition, examining the use of advanced fusion techniques, shared high fidelity models and associated environmental data bases, and networked communications to increase situational awareness of the undersea battlespace were focal points of data collection efforts.

2.3.1 ASW Questions of Interest

- Did the force optimized search plan developed via the Distributed Collaborative Planning (DCP) methodology yield a higher probability of detection (Pd) compared to the aggregated Pd of the independently developed platform search plans?
- Did the force optimized search plan developed via DCP methodology provide a greater

sensor coverage for the volume of interest significantly minimizing or eliminating gaps that an adversary submarine could exploit?

- Did in-situ environmental data allow the SCC to develop and maintain a more accurate search plan (sensor lineup), and provide a greater confidence in implementation of the same plan developed with historical environmental data?
- Did the evaluation of time-series in-situ environmental data yield insight that permitted the SCC to further optimize the force integrated search plan to increase the Pd of the adversary submarine?
- Did Concurrent MIW and ASW operations reduce the time that would have been required if sequential operations had been conducted?
- Did Concurrent MIW and ASW operations subject the mine sweep assets to any higher ASW threat than sequential operations?

2.3.2 ASW Analysis Results

2.3.2.1 Parallel ASW and MIW Operations

Parallel ASW and MIW operations conducted to improve mission execution timelines, proved feasible compared to traditional serial operations.

During FBE-F, collocation of the SCC and MIWC was important to the development of parallel operation plans for the JFMCC. The lack of a robust and redundant communications infrastructure would have significantly impacted this relationship if the Commanders were at geographically separate locations.

The dynamic working relationship between the SCC and MIWC during FBE-F enhanced both Commanders intimate knowledge of the operations area (environment and bathymetry), and intimate knowledge of adversary submarine operations/tactics. These were significant factors in measuring the force protection requirements during parallel operations planning.

It is important to mention that accounting and planning for the priority of SCC and MIWC force protection requirements at the JTF level is critical to the success of parallel operations are to become feasible. Without the appropriate priority, operations will default to serial.

Netted sensor effects that allow the SCC and MIWC a robust understanding of the battlespace at the beginning stages of planning is essential to force protection planning for parallel operations.

Appropriate Joint planning Tools that allow the Commanders to understand all resources available to evaluate all force protection options is important.

2.3.2.2 Distributed Collaborative ASW Search Planning (DCP)

The experiment objective to examine ASW collaborative sessions between the SCC, USS John Young, PATRON Bahrain, and an in flight AIP P-3 was not achieved to the level of robustness desired. Principal factors contributing to this included communications degradation, and experiment execution shortfalls.

Although the experiment did not identify the methodology to yield a higher probability of detection (Pd) compared to the aggregated Pd of the independently developed platform search plans, limited collaboration between nodes still generated findings that are important to understanding the maturing DCP methodology concept.

It is critical that a DCP methodology or process with appropriate TTP's fit within a disciplined planning/battle rhythm scheme.

The SCC's ability to display a near real-time COP, with in-situ sensor performance data from each ASW node is essential.

The ability to display a force search plan and have supporting computational data that identifies the advantages and disadvantages of the plan implementation is important. This allows an understanding that helps optimize the search plan to eliminate the potential gaps or holes that an adversary submarine could exploit.

The near real-time ASW COP also becomes essential for parallel operations planning, particularly for force protection planning aspects.

2.3.2.3 In-Situ Environmental Data

The ability of collaborative ASW nodes to pass ASW sensor performance predictions based on in-situ environmental data to the SCC was important to the development and maintenance of a force level search plan.

In addition, the sharing of in-situ environmental data was a critical contribution to the SCC in maintaining a netted sensor effect situational awareness that supported parallel operations planning with the MIWC and JFMCC.

Although up-to-date environmental data may not always have a significant advantage over historical data, small differences may be useful and should be exploited. Therefore, a frequent updating of the in-situ environmental data should be an integrated part of Distributed Collaborative Planning (DCP) and the operations that follow.

2.4 NUCLEAR, BIOLOGICAL, CHEMICAL (NBC) DEFENSE CONCEPT

Several countries in and around the Central Area of Responsibility (AOR) are aggressively increasing their chemical and biological warfare capabilities. The threat of employment of weapons of mass destruction (WMD) by non-state actors is also increasing. Recognizing this threat, USCINCCENT has set WMD defense near the top of his Integrated Priority List *[USCINCCENT FY01-05 Integrated Priority List (IPL) (U)]* , and selected Task 6.2.8, "Establish NBC Defense", as one of 17 Joint Mission Essential Tasks from the Universal Joint Task List. USCINCCENT has also set WMD defense as a cornerstone of his Cooperative Defense Initiative with friendly AOR countries *[USCINCCENT MACDILL AFB 131336Z AUG 99].*

A recent Government Accounting Office report *[GAO/C-NSIAD-97-9, (U) Chemical and Biological Defense]* highlighted deficiencies in chem/bio defense preparations in the Central AOR. CJCS has established WMD/NBC defense training as the #1 Issue for Immediate Action *[CJCSI 3500.02B, JOINT TRAINING MASTER PLAN 2000 FOR THE ARMED FORCES OF THE UNITED STATES].* In response to those deficiencies and priorities, COMFIFTHFLT has initiated an aggressive program to equip, train, and exercise US naval forces in theater for chem/bio defense. A recently completed exercise highlighted the following Joint Uniform Lesson Learned:
TTPs (Tactics, Techniques, and Procedures) are needed to document the mission, organization, and operations of the Joint Force Commander's NBC Battle Management Center across the spectrum of crisis and conflict. *[Exercise Neon Falcon 99 Joint Uniform Lessons Learned]*

NBC Defense experiments in FBE-F directly addressed the warfighting priorities that are referenced above.

2.4.1 Experiment Objectives and Analysis Questions

NBC defense experiments addressed five major objectives.

- Command and Control for NBC Defense: establish and equip an NBC Defense Battle Management Cell at COMFIFTHFLT Headquarters. The role of the cell is to provide the Force Commander (COMUSNAVCENT, COMFIFTHFLT, CJTF, other) with Command and Control capability for the broad scope of NBC defense plans and operations, across the scope of conflict (peace through theater war), locally and across the Force Commander's Area of Responsibility. The cell was intended to provide the following functions:
    - Readiness and Vulnerability Assessments
    - Oversight of Disaster Preparedness Planning
    - Tactical Control of Assigned NBC Defense Forces, including sensors, local units, and units responding to contingencies
    - NBC event warning and reporting
    - Management of initial NBC event response
    - Coordination of intra-theater support
  - Develop Standard Operating Procedures for major NBC Battle Management Cell functions.
  - Conduct operational experiments to assess and improve the NBC Cell's structure and procedures.

- Install a Collective Protection System for the Joint Operations Center building at COMUSNAVCENT headquarters.
- Equip and train Explosive Ordnance (EOD) Mobile Unit Eight Detachment Bahrain with additional NBC defense capability, and experiment with that capability.

The key questions for analysis of the NBC experiments were:

- Was the NBC Defense Battle Management Cell appropriately equipped and manned to maintain a coherent tactical picture of force-wide NBC defense, including disposition of NBC defense forces, readiness, supply issues, current status of NBC events, and event warning and reporting? Was this NBC defense tactical picture accurate and shareable?
- How effective were NBC Cell interfaces to key communities, such as Naval Support Activity, Force Medical, US Navy ships, Meteorology and Oceanography, and Joint and Coalition commands?
- Is the Collective Protection System installation worthwhile?
- Was EOD NBC defense training worthwhile? Was new EOD equipment well integrated into EOD response operations?

With the establishment of a Joint Task Force structure for the Arabian Mace Exercise, collocated at COMUSNAVCENT Headquarters, another key question emerged during the experiment:

- What was the impact of the NBC Cell at the CJTF level?

2.4.2 Experiment Setup

This section briefly describes the capabilities established for the NBC defense experiments.

- NBC Defense Battle Management Cell. The NBC Cell was established in COMUSNAVCENT N5 spaces in the Joint Operations Center building. The layout of the Cell is shown in Figure 1. The cell includes the following equipment:

    - Eight SIPRNet workstations with basic software load including Office software, Joint Warning and Reporting Network software, Command and Control PC software for display of maritime tactical picture, and message processing software
    - Two NIPRNet workstations
    - Four laptop PCs, SIPRNet capable, for expeditionary use and Cell expansion
    - Two wall-mount color large screen displays and video switching system for all SIPRNet workstations
    - Portal Shield (biological agent networked detection system) Command Post Computer
    - Two Defense Red Switch Network phones and two separate speakers, enabling secure voice communications on multiple satellite communications circuits
    - Motorola hand-held radios, compatible with Naval Support Activity trunked radio system, for common secure voice communications between NBC Cell and field NBC units in Bahrain
    - Motorola base station radio, also compatible with NSA trunked system, for off-site base (such as bed down site) or for extending range of hand-held radios on Bahrain

- o INMARSAT Mini-M systems for common voice circuit between NBC Cell and NBC defense units deployed off Bahrain
- o STU-III voice and fax
- o Motorola SVX 9600 secure telephone, with fax machine, for secure voice and data communications with coalition partners

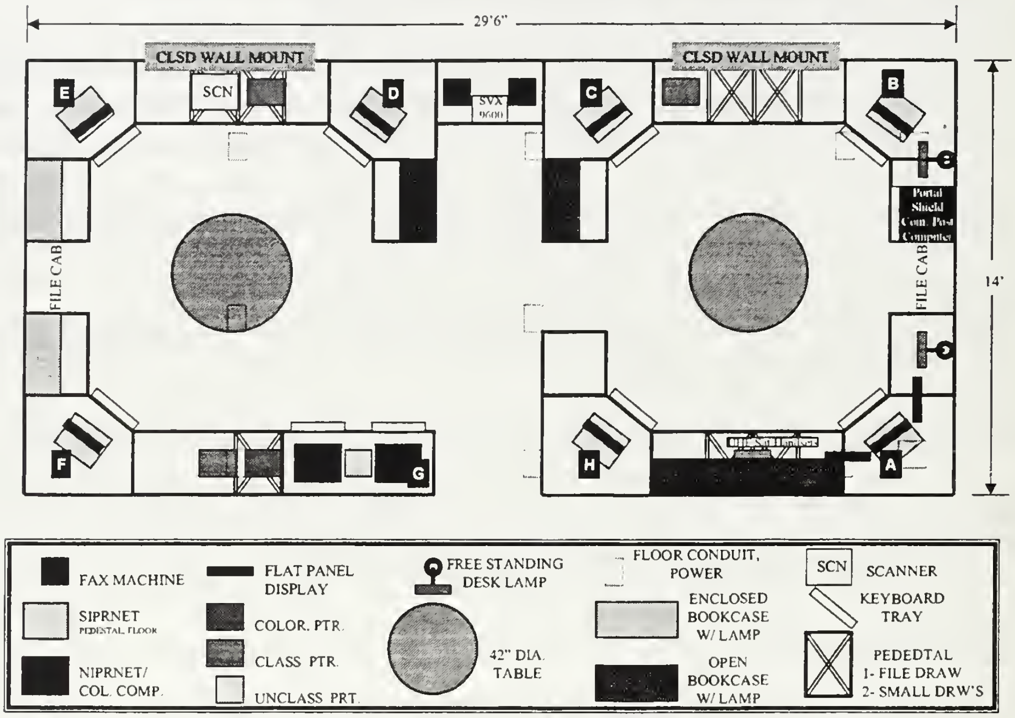


Figure 1. NBC Cell Layout in Joint Operations Center

NBC Cell functions require significant communications requirements. The communications requirements, and equipment used to meet the requirements, are summarized in Figure 2.

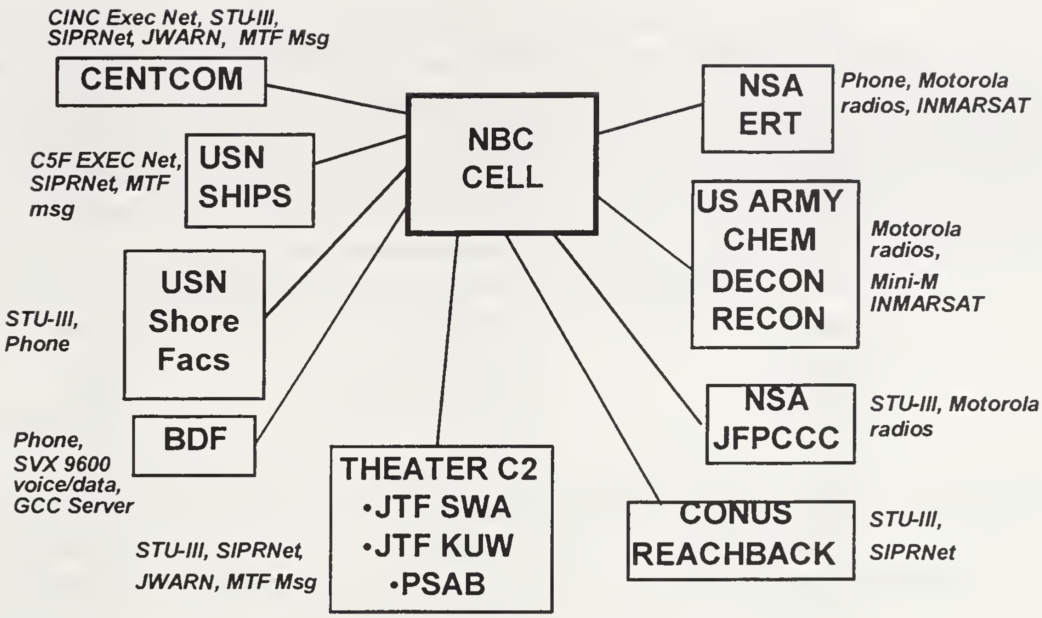


Figure 2. NBC Cell Communications.

The most critical component of the NBC Cell is the personnel. For FBE-F, service experts were invited to man cell positions. The manning for FBE-F is summarized in the table below. Descriptions of the roles and responsibilities for the NBC Cell positions are given the the DRAFT NBC Cell Standard Operating Procedures produced for FBE-F.

Table 1. NBC Defense Cell Manning in FBE-F

Personnel	Role	Source
USMC O5	NBC Cell Chief	I MEF
USMC NCO	Cell Communications	I MEF
USMC CWO5	JWARN Operator	CMLS CL
USN O4	Navy Ashore Ops	C5F
USN O4	Navy Afloat Ops	C5F
US Army O4	Army LNO	18 AB Corps
SOC O4	CA/CM*	SOCCENT
US Army O4	Medical	USAMRIID
Intel	NBC Cell, Intel Liaison	ONI
Portal Shield	PS operator	JPO/BD
USN O6 and O3	Cell Surge	USNR
Coalition LNO	NBC Cell, BDF sim LNO	C5F

* CA/CM: Civil Affairs, Consequence Management, SOCCENT LNO

- Standard Operating Procedures. DRAFT NBC Battle Management Cell Standard Operating Procedures were provided at the start of the experiment. The DRAFT SOP included a description of the Cell's missions, duties and responsibilities of cell members, command/control/communications descriptions, information management guidelines, NBC warning and reporting procedures, and procedures for response to shore-based alarms, with focus on the Portal Shield sensor network for biological agent detection. Cell members were encouraged to use the initial DRAFT SOP as a starting point, then edit the SOP during the experiment.
- Collective Protection System. A Collective Protection System (CPS) provides a shelter which excludes airborne contaminants, where personnel may perform mission critical tasks without the encumbrance of individual chem/bio protective equipment. For FBE-F, the COMUSNAVCENT Joint Operations Center (JOC) was retrofitted with a modified shipboard CPS. This system maintains slight positive pressure in the JOC (relative to outside) by providing a continuous flow of filtered supply air with slightly higher

pressure than that in the JOC. The supply air is filtered with the same chemical/biological/radiological filter sets used with all US Navy CPS configurations.

- EOD Capabilities. For FBE-F, personnel from EOD Training and Evaluation Unit Two conducted approximately 40 hours of classroom and hands-on training in NBC defense for the local EOD Mobile Unit Eight in Bahrain. Response to possible NBC events is a new mission area for the EOD unit, recently authorized by COMUSNAVCENT 141630Z OCT 99 'Expanded Capabilities in Response to WMD Incidents'. EODMU EIGHT was provided with new radiological and chemical detection equipment, and tactics/techniques/procedures for incorporating that equipment into their operations.

2.4.3 Data Collection

Key points:

- ➢ dedicated observer/analysts at key locations during NBC-specific events, with focus on timelines and procedures
- ➢ daily de-brief of cell personnel, with focus on internal procedures and external interactions

2.4.4 Analysis Results/Summary

Key points:

- ➢ Basic objectives achieved:
    - o Cell established and equipped, C4I tools functioned as planned
    - o SOPs developed and revised, still some gaps in specific procedures
    - o EOD training and TTP development very successful, with smooth integration into effective WMD response
    - o CPS installation successful, very highly praised by COMUSNAVCENT staff and Government Accounting Office assessment team; need to focus on more effective building airlock, and on decontamination procedures at building entrance
- ➢ Although not well planned (experiment focused on NBC Cell processes vs interactions with higher authority), there was opportunity to experiment with NBC Cell interactions with a CJTF staff – the Arabian Mace staff. Cell was clearly a powerful and useful center of excellence for the CJTF staff, but was not well integrated into JTF processes. NBC Cell should have had larger role in more JTF staff functions, given a scenario such as the FBE-F scenario. This should be a subject of further experimentation.
    - o NBC Cell was able to plug into key JTF areas – J2, J3, Strike, Medical – as the scenario warranted
    - o NBC Cell functioned much like a warfare commander – took in sensor data, fused it with expertise, and allocated multi-mission assets. Suggests that the NBC Cell should report directly to the CJTF. For Arabian Mace purposes, NBC Cell reported to J3, but this did not work well due to the unfamiliar nature of NBC issues. Instead, direct NBC Cell interactions with CJTF proved extremely beneficial in Arabian Mace, although the opportunities were few in relation to the scenario.

- The NBC Cell proved to be effective at its primary functions. C4I capability and Cell staff composition were very good. However, the Cell relied heavily on key experts that may not be available for extended contingencies. In particular, there is a lack of Navy expertise, which resulted on heavy reliance on Joint assets in the Cell.
- Cell not able to execute some functions end-to-end:
  - Warning and Reporting: internal Cell procedures worked out in detail and well exercised. However, due to exercise constraints, external voice reporting, base alarm, and pager alarm was not authorized. In addition, message reporting was required to be routed through J3, which added unnecessary delay to the reporting cycle.
  - Response to Portal Shield biological detection: reliability of Portal Shield sensor network was not sufficient; first use of in-theater confirmation laboratory (Theater Medical Surveillance Team) – TMST not yet fully operational; sample packaging and evacuation to CONUS reference lab (USAMRIID) not attempted. All should be subjects of further experimentation.
- Ship event identified training and equipment deficiencies. In particular, ships are sensor poor, and communications (warning and reporting) procedures need to be clarified.
- Summary: Joint participants indicated that this was a "watershed event for the US Navy". Take-aways for COMUSNAVCENT – NBC Cell equipment, SOPs, CPS, and EOD capabilities – materially increase capability to conduct NBC defense management at COMUSNAVCENT, across spectrum of plans and operations. Should take next steps in NBC Defense Battle Management:
  - better integration into JTF organization
  - interfaces with Consequence Management, Interagency roles (especially State Department), emphasis on operational/strategic impact of NBC events, casualty management, force structure considerations

3.0 FBE-F ORGANIZATIONAL CHANGE

Organization design: Over the course of FBE's it has been learned that by bringing decision makers, operators and staffs together with sufficient C2, planning tools and situational awareness through a COP, organizations that are adaptive may evolve. Organizational experimentation is therefore a large dimension of the overall experiment. Much of what is understood from FBE experimentation is not explicit, but the result of interactions between participants, processes and technology. Organization change in general includes many dimensions, and understanding relationships between them.

What follows in this section are highlights from observations, interviews and analyses, arranged by principle experiment organization areas. The intent is to surface many different areas of interest. Some of the commentary is related to experimentation in general, which is of interest to future experimentation. For many of the participants it was difficult to separate experimentation from capabilities. In other words, much of what was critiqued by participants was related to the design and execution of the experiment, which was difficult to separate from larger issues of *capabilities* implied in the experiment. It is at the level of *capabilities* expressed or implied in these organization interactions that analyses hopes to understand what was most important from the experimentation process.

Organization structure: Commander, Joint Task Force (CJTF) (COMUSNAVCENT, C5F) was OCE for the experiment operations. Experiment control was exercised by Maritime Battle Center, in conjunction with a C5F exercise, ARABIAN MACE. Directly under the CJTF were the Joint Forces Maritime Component Commander (JFMCC) (principally naval forces, including an ASWC and MIWC), a Joint Forces Land Component Commander (JFLCC) (principally U.S. Army ground, ATACM, MLRS and Army Aviation units) and a Joint Forces Air Component Commander (JFACC).

3.1 JFMCC

General: The Joint Forces Maritime Component Commander was aboard the CV. Of the three joint warfare commanders, the JFMCC held the largest responsibility and the preponderance of forces. Although tactical air (TACAIR) was coordinated through the JFACC, the assets were part of the forces reporting directly to the JFMCC. In addition, the Surface Component Commander (SCC), Anti-submarine Warfare Commander (ASWC) and the Mine Warfare Commander (MIWC) were collocated and coordinated planning directly with the JFMCC. Multiple roles and responsibilities that merged joint warfighting with largely naval JMAC operations required additional organization design to couple JFMCC to deliberate strike planning and production of an Integrated Task Order (ITO), effects-based targeting as part of Strike operations, and to TCT processes.

Note: Underlined headings are part of general coding which relates to a larger database effort as part of an overall Knowledge Management (KM) system.

Organization relationship: The role of the Guidance, Apportionment and Targeting (GAT) ashore was to coordinate JFMCC efforts with the JFE, represent the JFMCC at the ECB and the JTCB and in all other domains. A liaison officer from JFMCC was assigned. Difficulty arose from a lack of direct interaction between the LNO and the modeling and simulation which were part of the battle space that required coordination.

Organization relationship/authority: (GAT) set up ashore did not overcome a command and planning barrier which resulted from concerns by the JFE that although they were working with the GAT, in actuality they were speaking to the JFMCC. In other words, the GAT ashore carried the weight of the JFMCC. This was potentially a good situation except in the condition in which the GAT was not adequately linked to the JFMCC's intentions and concerns. There is evidence that this was the case early in the experiment, but that the situation improved as the experiment and connectivity continued.

C2/organization relationship/synchronization: Improved connectivity was noted between days 3 and 4, producing a potential for JFMCC/JFE coordination which shifted perceived responsibility of the JFMCC GAT ashore directly to the JFMCC. This resulted in a very close coupling between JFMCC and his warfare commanders, and the planning and execution planning cycle being conducted ashore in the JFE/Fires cell. This is evidence of synchronization, and of organizational learning. This also highlights that the GAT role need not be institutionalized throughout the life of the operation, but be phased in and out of the ops as the organizations involved develop the competencies to engage strategic and tactical problems in a distributed environment.

Organization relationship/synchronization: "We (JFMCC) think our contribution was very important to understanding interactions between deliberate planning and dynamic TCT operations. We think we had a much better understanding of how to do it, and that overall our planning execution synchronized the operation to actually fit very well within the JFE organization. We had good coordination with the JFACC and we think we delivered a much stronger assessment of the JFE product to the CJTF."

Organization change/adaptation: Organizational change about day 5 in which functions of JFE ashore were reversed, becoming a GAT cell afloat in which the JFMCC would become strike lead.

Synchronization: Coordination effort between planning, battle rhythm, and execution enabled a unity of effort at the JFMCC level. "When the JFMCC came to the table with the other components and the CJTF at the morning (VTC) meeting, the staff already had prepared for higher authority what JFMCC had planned, what the status of operations in the last 24 hours was, and the proposed scheme of maneuver for the next 24 to 48 hours. With improvements in the COP what developed was our own method for interacting with the staffs, watch captains and the infrastructure ashore. The tight decision loop could be a model for what the CJTF will expect out of future battle groups in successive CPX's and experiments."

Organization relationship/design: A problem was noted with regard to continuity of requirements and missions that would have coupled JFE and JFMCC: an LNO from JFMCC was not included in the JFE strategy cell. "We really didn't have a JFMCC interface or insight into the kind of direction we wanted to go (which was) sort of a main effort for the JTF." This caused the Strategy cell to "extrapolate" and to bridge their interpretation of commander's intent with

JFMCC operations. Result was a discontinuity between CJTF intent, strategic planning within the JFE Strategy cell and operational planning by the JFMCC. End to end chain of intent to targeting was therefore not possible.

Insight/Recommendation: One concept that emerged was the possibility of a "Joint Force Fires Commander" (JFFC) based on preponderance of forces, operationalized by a JFE/ECB. In FBE F scenario this would have been the JFMCC, supporting the CJTF and supported by the JFACC. This was tried in the last two days of the experiment and worked well. In this case the GAT would be collocated with the JFMCC and strike planning would continue either ashore or afloat as the situation dictated. This is especially important at the beginning of the campaign, in which there are large numbers of TTLAM/TLAM followed by ERGM/LASM and TACAIR. If this is phase 1, then continuing with a second phase may include redistributing responsibility for GAT and ECB along with a JFE, all still working for a JFFC. In a third phase, which is synchronized with the parallel operations necessary to the conflict, JFFC may become the JFACC, with JFMCC supporting and the associated JFE/ECB becoming part of this staff. In the littorals (and JMAC type missions), this is the likely case scenario. Handoff between JFMCC/JFE and JFACC is analogous to the CATF to CLF handoff in an amphibious operation. JFACC is an established Joint doctrine, and this notion fits within that notion, but also establishes a Navy role for a JFE-like function when first on scene as part of a land or littoral campaign.

3.2 JFACC

As a result, the experiment JFACC was stood up with the minimum personnel and capability necessary to keep the experiment moving. Additional requirements for integration of JFACC functionality into the effects-targeting process added another dimension to JFACC organization capability. JFACC processing capability was necessary to developing the Master Air Attack Plan (MAAP), and integrating the Master Surface Fires Plan and Master Land Attack Plan, which were constructed by the other components and integrated by the JFACC. This validated a JFACC-like capability, necessary to building coordinated and synchronized fires plans for targets assigned in the ITO by components and warfare commanders. In a Navy littoral scenario in which the Navy is responsible for access, this capability will be necessary. As demonstrated in FBE F however, the capability can be met by a much smaller organization than the fully manned JFACC. As access is accomplished and greater number of joint forces arrive in theater to support infrastructure building, the role of the JFMCC-centric JFACC capability would move easily to the fully functioning JFACC.

Organization design/doctrine: Another consequence of the scaled-back JFACC is that a GAT (Guidance, Apportionment and Targeting cell) for JFACC was found to be useful. A similar organizational capability is also necessary for Naval Surface Fires mission processing. During the final two days of the experiment a GAT-like capability, which included some JFE function was set at the JFMCC. This essentially provided JFMCC authority to employ direct support aircraft in his AOR for prosecution of tactical operational time critical targets.

Organization relations: Commentary made (reiterated many times) that the relationships between JFACC, GAT and ECB were blurred. Participants did not understand the difference between these organizations, and most felt that what they were doing was equivalent to the same activities they had previously done in other organizations that simply were called different names.

Organization design: Several participants in FBE Foxtrot noted the need for a "Guidance, Apportionment and Targeting (GAT)' Cell to support the use of Naval Fires by the Joint Fires Element (JFE). It is believed that the functions performed by such a cell would allow the JFE to complete the detailed assignment of targets to naval fires in a shorter time and more confidence in their integration with other fires for joint effectiveness.

Historically a GAT cell is a shortcut means of providing / interpreting the joint commanders intentions, apportioning resources to efforts and generating a target list. Doctrinally these are each lengthy processes that are performed according to joint doctrine through a Joint target Coordination Board and the ATO generation process. There is no GAT cell in joint doctrine but one did perform very important planning and monitoring functions in the Gulf War.

Naturally the same guidance, apportionment and target development processes that are appropriate for predominately aviation- delivered munitions (which have traditionally included both Naval aviation sorties and Tomahawk strikes) may be appropriate for Naval fires of other types such as ERGM, LASM etc. During Foxtrot the JFACC cell performed some of these functions for aviation sorties and generated an ATO. They may have been referred to by some as the GAT cell at times. The term may also have been applied to the JFE itself by some participants, particularly when the JFE was moved in part to the USS Kennedy, but others remained in Bahrain. There was no GAT cell formally.

These circumstances alone could explain the perceived "need for a GAT", but is likely that in addition it is also due to the focus of Foxtrot on pursuit of Time Critical Targets (TCTs) by Naval forces, primarily non-aviation. Therefore, there is currently no doctrinal methos for dealing with TCTs. Since, in examples as the Gulf War, TCTs were dealt with primarily by the assignment of SCUD CAP aircraft that would loiter in an area waiting for targets to appear, the activity was largely handled on an exception basis by the JFACC. Because Foxtrot focused on the nonaviation resources to respond to TCTs, it is not surprising that there was a paerception of the need for a cell (or set of processes) that would enxure that the JFEs actions to pursue TCTs are in accordance with the commander's guidance, do not conflict with other uses of the Naval resources, and strike an appropriate, not simply a feasible, set of targets, i.e. the GAT processes. For example, it would be desirable to have an authority to approve the assignments by the LAWS operators of weapons to targets (or at least someone at a higher level to discuss the issues that might be involved in a timely manner). A GAT cell, if it existed and had doctrinally defined functions and authority, could provide such support. The guidance, apportionment and targeting processes have traditionally focused on pre-planned operations and the ATO. When TCTs become important and the ATO is impacted, there is no current approved doctrine for how this is to be handled. In fact the Joint doctrine status board reports that the development of Tactics, Techniques and Procedures (TTP) for Time Sensitive Targets is being separated from the draft publication JP 3-60 Doctrine for Joint Targeting as JP 3-60.1 JTTP for TST.

Therefore there is no doctrinal method for dealing with TCTs currrently. Since in the past, such as the Gulf War, TCTs were dealt with primarily by the assignment of SCUD CAP aircraft that would loiter in an area waiting for targets to appear, the activity was largely handled on an exception basis by the JFACC. Because Foxtrot focused on the non-aviation resources to respond to TCTs, it is not surprising that there was a perception of the need for a cell (or set of processes) that would insure that the JFEs actions to pursue TCTs are in accordance with the commanders guidance, do not conflict with other uses of the Naval resources, and strike an appropriate, not simply a feasible set of targets, i.e. the GAT processes. It would be desirable to have an authority to approve LAWS operators assignments of weapons to targets (or at least someone to discuss the issues that might be involved at a higher level in a timely manner). A GAT cell with doctrinally defined functions and authority could provide such support.

Lacking a doctrinal GAT, what coordination point would be appropriate for the JFE? For a JFE primarily concerned with TCTs, it would make sense for it to coordinate with the JFACC TCT cell if it is in existence. This would deconflic duplication of attacks. If a JFACC has not been established or is internal to the JFMCC, coordination of the JFE becomes trivial unless extensive USMC, US Army or Special forces are involved and or exposed to the fires pursuing the TCTs. Lacking a JFACC and with extensive participation of the other Services, it might be advisable for the JFMCC to establish a cell for allocating Service efforts and coordinating / authorizing attacks on specific TCTs. It might be confusing to call this a GAT, but it could be so named.

3.3 JFLCC

The Joint Forces Land Component Commander included primarily U.S. Army forces stationed in the immediate AOR, which would be available in the 2003 time frame of the experiment. JFLCC was set in Kuwait, and used the Army's Deep Operations Coordination Cell (DOCC) as the primary means for integrating and coordinating operations, synchronizing with other joint warfare commanders and the CJTF.

"What we were trying to do is integrate Army capabilities into the digital fires network that we set up among ships, from headquarters here, and try to prosecute missions using Army land-based assets in a mostly Naval environment."

Organization structure/joint: The DOCC is doctrinally rigid, and operates on a prescribed set of inputs to their processes, and produces a set of specified products. Language is very important to the operators and planners in these processes, and there were ambiguities in the language used to plan and coordinate between other warfare commanders and the DOCC. One observer noted the distinction between USN "nightly intentions" intentions type of direction, contrasted to the expectation for more direct and dynamic Commander's Intent. The result was some ambiguity about the CJTF's intentions at the DOCC level.

Organization/feedback: Feedback from Army missions was difficult to inject back into JFE/JFACC planning. An example of this was the attack guidance matrix. "The attack guidance as a device was there, but there were problems: One, constructing it, and two, it was difficult to use because the process to disseminate information was not mature. Elements within the AGM were fed back piecemeal through their LNO (liaison officer) so that the strike cell could go ahead and do what they needed to do." (this comment is specific to production of an attack guidance matrix to be used in prosecuting land-based targets).

Organization/C2: One intention of the organization structure in this experiment was to "flatten" C2 and roles. There was some impact of this structure, as evidenced in the comment; "we (JFLCC) did some things you normally don't see. Most of it was in simulation. But, normally you don't see elements within the JFMCC reaching through and coordinating fires with the Army guys. The network allowed them (commanders) to flatten the command structure. Of course, we weren't firing missions without the approval of the JFE, especially time-critical missions. But, we were using a very flat command and control system to effect coordination between elements. In that, it worked quite well."

Another indication of this was the coordination of Army Apache helicopters in a MIW defense role.

3.4 EFFECTS COORDINATION BOARD

This section describes ECB relationship to the experiment, considers future weapons systems within a maritime battle management context, how to use the ECB in the conduct of Effects Based Warfare, and how to stand up a JFE and ECB as part of a Navy-centric CJTF. The numbers in parentheses refer to individuals comments, which are logged at NPS.

ECB is really a GAT (35) "I've been on every ECB for the last three years in the real world. It is called the Strategic GAT cell at JFACC, and that's exactly what we do."
According to this officer the mission of the GAT was subsumed within the ECB, but when the long range weapons such as TLAM and TTLAM, LASM and ERGM were also employed, then the role of ECB as GAT became more apparent even though it may not have been called by this name. Interesting to note that the TLAM was characterized as a precision Air-to Ground weapon under this definition.

Guidance (36) was a problem in Desert Fox, and is reiterated as a problem in the experiment. Effects based targeting is highly coupled to understanding evolving commander's intent.

Intelligence/Feedback (37) Although still a problem, commander's intent was somewhat better than Desert Fox. Another area of concern in the experiment was a lack of realistic intelligence that would normally be a part of the decision making process for prioritizing targets. This is an understood artificiality in the experiment (expected), however, this also points out the association between GAT/ECB and intelligence providers. This coupling is another kind of feedback.

LASM/ERGM/TTLAM relationship (38) "We have a lot of Tomahawk Knowledge here. Also, to use the other weapons you have to get closer." Reason for the high early usage of TLAM/TTLAM. "They (planners and targeters) don't have a lot of true knowledge of what LASM and ERGM can do."

Parallel ops in Strike (39) Point about paralleling strike ops means that some sequential events also have to take place. For example, use of 300 TTLAM the first few hours of the attack to suppress enemy SAM sites and associated C3, followed by the B-2's, B-1's, B-52's, F-18's, F-15's etc. that are in parallel at that point with the ERGM and LASM which can now get in close enough to be used. According to these respondents, there was very little of this thinking occurring in the Strike process.

Parallel ops and tools/ feedback/SA (40) "We (ECB) had no idea where anybody was, or how they were operating or what they were doing, unless we walked into the JOC and took a picture." This comment is also about the need for feedback with regard to the tactical picture and effects. Judgement by this observer was that SA was low in the ECB. Characterized as "nonexistent" by another observer. Only potential for SA was via two laptops that were part of SIPRNET LAN. Other than electronic connectivity, SA was obtained directly through the morning brief. (41)

Feedback (42) Lack of BDA to ECB made it difficult for the ECB to understand contributions of planning to effects.

Organizational relations (43) Opinion (reiterated many times) that the relationships between JFACC, GAT and ECB were blurred. Participants did not understand the difference between these organizations, and most felt that what they were doing was equivalent to the same activities they had previously done in other organizations that simply were called different names.

Organizational ambiguity (45) Question around who does the function of "current operations." Usually a "current operations" planning cell, however this function may be required to reside inside of ECB or other JFE structure. "It was schizophrenia that we had to deal with, asking continually 'is that Current Ops or is that us?' Because Current Ops does, indeed, need to involve themselves in the effects phase."

Relationship to definition of Effects (46) Information to the ECB came from the Strategic Plans organization. Example might be "hit mobile TELS because we want to neutralize a chemical weapons threat." Planners in the ECB had difficulty making a distinction between this mission as an "effect" and as an "objective." The distinction was important to the ECB because if the "effect" was to limit the chemical weapons threat, then the ECB's role may have actually been better served by having them plan missions to maximize the effect, e.g., destruction of chemical weapons storage facilities. The requirement for an effect would have to be understood within the context of commander's intent, which would support this mission unless the CJTF's intent was to limit the scope of the conflict by not being overly aggressive. In this case there is a relationship between limiting effects and accepting additional risk, i.e., intercepting TEL's or other potential WMD carrying weapon system.

BDA (47) "Did we achieve the effects we desired? We don't know. All we did was fix some more targets and keep going."

Organizational (48) ECB was essentially "a modified GAT." (49) attitude of participants was that the responsibility for targeting should not be maintained in the ECB, but reside in the J-2 staff organization.

Organization coordination (49) Coordination of target sets occurred between the ECB and J-3 "to ensure that our target set matched the CINC's intentions." Argument here is that this function remain with the J-2 because intelligence manages and coordinates ISR functions, which can include targeting impacts such as human shields etc. (50)

Experiment objectives were ambiguous (51) "there's always room for improvement in doing it (targeting), but essentially what they tried to stand up here is not anything new or different." (perspective of USAF officer trained as part of JFACC staff). Problem was also related to the design of the experiment in that other structures were necessary to test the organizational design intended. An example of this would have been the results of intel analysis collection management dissemination or target folder development made available to decision making processes in the experiment organizations like the JFE or ECB. What was provided were targets as place holders (usually from the simulation), however there was no real intel supporting these target sets, while many RFIs were initiated to produce the information that should have been included. But, realistically, it would have been very difficult to recreate JIC functions for the experiment without actually having a JIC to do this. The outcome for all of this was an apparent mismatch of organizations and data which would normally have had a real part within a data-flow system to support the integration of functions represented in the JFE/ECB/JTCB and so forth. This is an important consideration in the development of experiment design. That is, the amount and kind of data that supports the process functions that are being experimented with needs to be planned for, even if canned.

CINC intentions (52) There may be a distinction between JTF intentions and CINC intentions, depending on the theater. In CENTCOM it will usually be the CINC who will establish intentions, although this is not the way the experiment was conducted. There may need to be a process of adjudicating CINC and CJTF intentions.

Effects Based Operations (24) The Effects problem in the experiment was associated with a similar problem in GLOBAL 99 wargame. Difficulty was experienced with constructing an operational definition which could be synchronized with an organizational design. "The JPG would hand me something and say 'here is an effect,' to which I said, 'this in not an effect. This is a task or something.' I think we need to come up with a common definition of what an effect is and put that out to everyone so we can march in the same direction." (25) Negotiations of meanings took a lot of effort in the course of the experiment, and some meanings were never completely constructed to an operational level. Negotiated meanings was important to the experiment, and was at the root of an organizational event at day 3 in the experiment in which the experiment was put on hold. What most people thought of as training, or "bringing participants up to speed," was really a mechanism of creating common understanding around the meanings of concepts and processes unique to the experiment and which were meant to set the experiment apart from "the normal way of doing things." Getting at what was unique for the experiment was important to the participants and experiment planners, including the notion that all participants be part of the common experiment experience, or "claim to be a part of the same experiment," and share a common understanding of experiment terms as well as a common understanding of processes within experiment areas (e.g., JFE). (26)

3.5 JFE

JFE; org. relations: (6) Relationship of the JFE to coordination of joint assets: First 2 days of the experiment the POV from JFMCC was that their function was one of response and observation. After the second day this perception shifted to one of a proactive planning role to develop parallel operations with MIW, ASW, Fires and Strike. Success in this role created a tendency for the JFMCC to seek a wider dynamic role using afloat assets. (7)

Comms. (8) Improved connectivity was noted between days 3 and 4, producing a potential for JFMCC/JFE coordination which shifted perceived responsibility of the JFMCC GAT ashore directly to the JFMCC itself. This resulted in a very close coupling between JFMCC and his warfare commanders, and the planning and execution planning cycle being conducted ashore in the JFE/Fires cell. This is evidence of synchronization, and of organizational learning. This also highlights that the GAT role need not be institutionalized throughout the life of the operation, but be phased in and out of the ops as the organizations involved develop the competencies to engage strategic and tactical problems in a distributed environment.

Org. change: (12) Organizational change about day 5. The functions of JFE ashore could be reversed; to become a GAT cell afloat in which the JFMCC would become strike lead.

System relationships/ dialogue competence/ commander's intent/ feedback system/ formal relations v. informal practice (15) Ops officer CCDG-5/ JFE Strategy Cell Chief. Description of process: Joint Planning Group provide "guidance" to JFE Strategy. JFE Strategy processed (using "numbers") guidance into set of tasks, including a list of "6 priorities" as part of this process (?). Further processing by JFE Strategy to turn tasks into target sets. Also possible to construct target sets that would need to be developed into tasks. Processes and products aligned "to meet CJTF intent." List of targets, vetted against priorities would then be passed to the Effects Coordination Board (17, 18). System feedback in the form of dialogue between Strategy Cell Chief and the ECB Cell Chief, with little to no direct coordination with the JPG. There was a formal relationship to the JPG, and Strategy Cell was represented at formal meetings, however a dialogue was not engaged.

(16) Problem noted with regard to continuity of requirements and missions that would have coupled JFE and JFMCC: an LNO from JFMCC was not included in the JFE strategy cell. "We really didn't have a JFMCC interface or insight into the kind of direction we wanted to go (which was) sort of a main effort for the JTF." In the words of the Strategy Cell lead, this caused the Strategy cell to "extrapolate" and to bridge their interpretation of commander's intent with JFMCC operations. Result was a discontinuity between CJTF intent, strategic planning within the JFE Strategy cell and operational planning by the JFMCC. End to end chain of intent to targeting was therefore not possible.

(17) Dynamic Commander's intent had very little impact on JFE Strategy processes. "The original guidance we received was pretty much the same guidance we stayed with throughout."

Organizational relationships (18) "I think probably the weakest link (in the system) was between us and the JPG. In retrospect we needed one of their guys with us and vice versa." Perceptions of the JFE Strategy cell's job description changed as the experiment progressed. "I think we became more of a future ops cell instead of a strategy cell. I think the JPG should be looked at as the place where future ops are developed in line with strategy." In other words, lack of feedback and clear roles contributed to a sense of ambiguity about the system role for the JFE Strategy cell. This could be rectified by trading LNO's between JFE and JPG, and by developing a competent dialogue around the system requirements of both organization components.

BDA (47) "Did we achieve the effects we desired? We don't know. All we did was fix some more targets and keep going."

Role perceptions (22) Other members of the JFE Strategy cell (US Army) did not understand differences between JFE and Army's Deep Operations Control Center (?) (DOCC). This furthered sense of role ambiguity and has implications for employment of JFE as part of a joint operation—synchronization at the level of JFE and Army doctrine, for instance.

Impact of the technology (23) Technologies did not have a big impact on the way that Strategy performed its perceived role. Only difference in this person's view, from what the normal process would be and the one used in the experiment was that instead of the results of processes going to the JFCC (Joint Fires Center), they went to the Effects Coordination Board.

Organization problem (27) The JFE Strategy cell was developing Fires missions based on a "Fires CONOPS" which are not "doctrine." Planning for Fires missions was separated from the information that was being generated about the fires missions that would normally have been required to do the missions. "The JPG was planning one thing and then the JFE Strategy cell was over here. (also) "we were handed some guidance, some bullets (from the JPG?), but we didn't know what the underlying intentions were." (28)

TTP Requirement (29) Although the experiment was stopped for an afternoon in order to conduct group training of participants, the training provided an overview of what the objectives were, but did not explain what was being done to attain those objectives.

System feedback (30) Strategy is essentially a futures exercise. Projections are made about the status of the operation in the future and some predictive model is used to make a forecast, which can then be used to modify strategy. These tools were not available in the experiment, so from this interviewee's perspective, strategy could not be effectively "played." In other words, feedback was not available for Strategy to conduct modifications. In addition, decision making was similarly described in the ECB as "swag-ing it."

Organizational relationships (31) Only way for the Strategy cell to make information based assessments was to bring in the (C5F?) Intel officer, and "he would tell us in his opinion what he thinks our effects would have been on them based on how they typically employed themselves and defend themselves." "If we had a different guy we would have gotten a different opinion." Lack of feedback was observed to impact the information processes in the JFE. The ATO cycle did not run for sufficient time so that there could be feedback from the previous iteration.

Organizational coupling through LNO's (32) The recommendation here is that to be effective the ECB, JFE and JTCB all need to trade senior level LNO's. A problem with this however is that the concept that all of the LNOs will sit around a table and apportion their resources to each other is “apportionment by altruism.” However, as this officer pointed out, “they (his commander) don’t send me to give things away, they send me to get things.” (33)

Air space control authority and weapon-target pairing need to be coupled. In the experiment this coordination was done at the JFACC-component level with the JFE because they were all collocated. If the JFE is not collocated with the JFACC, after the effects-based order goes to the components to construct their master plans, and consolidation occurs in the ITO, then this assumed coordination with JFE needs to be formalized in a feedback process between them. This feedback will be necessary for synchronization.

(C2) (1) Early in the experiment (first few days) there was poor connectivity and situational awareness of what was happening with the JFE ashore from the point of view of JFMCC and personnel embarked on the carrier.

JFE organization relationships/ feedback (19) Strategy cell was more responsive to CJTF intentions than JPG direction. CJTF intentions were more direct, with little change, and because of the lack of clear direction with the JPG, it was natural for the Strategy cell to fall back on the most consistent and useful direction, effectively cutting out the JPG from the tacit system relationships. This is a discontinuity in the JFE system. “We knew the direction the commander wanted to go in, so that’s what we based our assumptions on.” “Combat assessment and those kinds of things didn’t play in this at all, either.” In other words, without BDA as feedback, or without JPG guidance, the only way for JFE Strategy to conduct its role was to use static CJTF guidance. From the Strategy cell point of view, therefore, the only part of the experiment that was experimental was the employment of a variety of weapons types that would not ordinarily be part of their decision making process.

3.6 ASWC AND MIWC COLOCATION WITH JFMCC

The MIWC and the ASWC were co-located with the JFMCC on board the carrier. Interview data and analysis of parallel operations conducted between the MIW and ASW forces engaged in the problem of clearing the straits and providing access indicate that there was higher than usual (as defined by participants) synergy, coordination, cooperation and effectiveness of maritime and joint forces that might be at least partly credited to enhanced collaboration.

“Collaboration is a meta-capability that lies at the heart of new forms of competitive advantage in industries experiencing the disintegration of traditional industry boundaries and simultaneous demands to act in both centralized and decentralized ways.” (Liedtka, Academy of Management Executive, 1996 Vol 10 no. 2) Although this quote comes from the business environment, the case can certainly be made that the role of information and requirements to push “operational and tactical” decision making to lower levels is relevant there as it is in the military. In a network-centric environment the potential for collaborative interaction increases, and the notion of adaptive centralized and decentralized activities which co-evolve within a battle space problem is self-evident.

"The art of building and sustaining collaborative relationships is a fundamental prerequisite for competitive success…" (ibid.) This is especially true in the dynamic battlespace environment.

Success at achieving collaboration is not guaranteed by technology. In FBE Echo the ASW Distributed Collaborative Planning (DCP) tools employed were sophisticated and capable. Connectivity between nodes was good. Data from this experiment revealed that the difficulties experienced in conduct of the ASW planning problem were related to organizational issues and protocols about the use of DCP tools. For example, use of DCP tools in a hierarchical environment tends to flatten hierarchical roles which can lead to ambiguity with regard to chain of command and opcon in general. Although this is an intended result of network-centric capabilities, without organization-wide understanding of a role for collaboration, dynamic-collaboration may not be achieved. This was the case in FBE Echo.

Close coordination between the MIWC and the ASWC (and their coordination with the SCC and JFMCC) was successful in FBE Foxtrot. Two warfare commanders meeting together and experiencing the same information at the same time in a communal environment allowed them to engage in collaborative roles which are understood in face to face communications. These communications are sets of routines and protocols in which the two warfare commanders have a great deal of competence. While it certainly could have been otherwise, collaboration between MIW and ASW, towards a common goal, and with overlapping resources was highly successful and produced a decrease in the mine-clearance timeline.

This does not point to a requirement for co-location, as much as it indicates a need for further understanding of collaboration and tools for collaboration. From the point of view of the MIWC, "(In spite of) the best connectivity in the world, when you can't go face-to-face, you miss a lot. Whereas, when you are co-located you are "connected" simply because you are there. An issue that may be reasonably trivial standing alone tends to be resolved before it becomes a bigger issue." Users of DCP technology often assume that the technology itself is a mimic of human interaction and includes the complexities of human collaboration. Evidence however, indicates that besides the technical capability, connectivity and necessity to engage in problem solving, there is a specific competence to collaborative practice not necessarily emergent in current doctrine, technology or practice.

This collaborative or "dialogic" competence is evident in successful face to face collaboration, but just as it is possible for participants in collaborative practice to have low dialogic or collaborative competence in face to face interaction, it is certainly likewise possible to demonstrate this in a network centric environment.

In short, what has been demonstrated to date in past FBEs and reinforced in FBE Foxtrot is that collaborative roles are *increasingly* important in a network-centric and distributed environment. Technologies to engage in collaborative practice exist and are improving. These need to include a capability for users to tailor information to their specific needs, while also having access to a shared picture that may include multiple domains. Hence, a common data structure that may be tailored at each node is called for. Besides the technologies which provide a *potential* for collaboration, greater understanding of the elements to *competency* in collaborative practice is necessary.

4.0 Implications of Organizing for Effects-Based Operations

Fleet Battle Experiment Foxtrot included an Effects Coordination Board (ECB) as part of the Joint Fires Element (JFE). In general, the purpose of this organization was to provide a means by which Commander's Intent for attaining force objectives could be included in the development of an Integrated Tasking Order (ITO), and in prosecution of time-critical-targets (TCT). Executing the JFE concept highlighted some difficulties with regard to notions of "effects" in general, which should be explored further.

4.1 HIGHLIGHTS FROM FBE-F

1) Definition of Target Guidance Matrix was not linked to dynamics of the battle problem. In other words, effects at the weapon-target pairing level were not necessarily reflective of an "effects" vetting process.

2) Effects coordination was very difficult without adequate and timely feedback from previous tactical events.

3) Integrating consequences of effects into a larger operational and strategic view of shaping the battle-space was not understood at nearly all levels of the JFE and associated organizations.

4) JFE did however provide organizational structures that were a "first cut" at deepening an understanding of the means by which "effects-based" processes might be employed.

The statements above are not offered as evidence that effects-based planning failed in FBE Foxtrot. In fact there were successes. The point here is that the experiment highlighted some wider deficiencies in the notion of "effects" as a basis for organizing forces and advancing a campaign.

4.2 CONCEPTUAL DIFFICULTIES

First, there is a semantic difficulty. This arises from what becomes a circularity of distinctions in defining the class of "effect" apart from that of "objective." The distinction is an important one, but is also one made more difficult by including different perspective levels. In other words, what might be called an "objective" at one operational level (e.g., the CJTF) may also become an "effect" within a more strategic view. One person's effect therefore can be another's objective.

The semantic difficulty arises from another problem—lack of a commonly understood means to make the distinction from a non-contradictory definition of "effect."

A second difficulty arises from the impact of coordinating differences in first, second, third and so forth, levels of effect. Similar to "branches and sequels," planning based on effects cannot be limited to describing first-order effects, but also secondary, tertiary and so forth. Coordination of *potential* relations between these different levels of effect may include notions of complexity far beyond current doctrine and organization structures.

A third conceptual notion that is not yet integrated into Effects-Based Operations (EBO) is that of its control functionality. A principle of control theory is that a "regulator" or system of regulators must have the same or greater degrees of control as the system being regulated.

One must think of EBO as a control system, where fundamental principles show us that, for proper control, you must have the correct time constants and degrees of freedom/control. For EBO this means that you need to design the system so that sensing, information, decisions, and the expected reactions you will be monitoring are all matched in time, space, and organizationally. In addition, you have to build in the required feedback loops (and the TTPs to go with them) so that the system can actually be responsive, producing what some people like to refer to as a self-synchronizing organization. If the response time for a portion of the organization is out of sync with the rest, or with what is required, or if required feedback/response is missing, EBO cannot be effective. It takes a significant amount of thought, effort, and testing to produce a dynamic organization of the type needed.

4.3 IMPLICATIONS

1) FBE Foxtrot explored processes related to the tactical level of "effects-based targeting." An organization was defined to operationalize this concept. Effects at an *operational* and *strategic* level will likewise require congruent organization (synchronicity of actions).

2) Sensor management of battle-space and national assets in FBE Foxtrot did not include adequate real-time BDA, essential to associating effects between tactical and operational levels. Inclusion of this system element will require additional asset management control by the JFE, and likely increase the number of sensors and associated C4I.

3) A Coordinated and shared Situational Awareness (or Common Operational Picture) must be integrated into effects-based processes.

4) The battle-space must be understood as a complex and dynamic system. In order to implement EBO it will be necessary for "planning" to identify expected/desired primary and secondary effects. We cannot at this time reliably identify tertiary and higher order effects. Both levels of effects should be presented and promulgated in a document such as the ITO as guidance for an effects control board. Such planning guidance should also include directed flexibility, such as "if this effect is accomplished then that change in operations is implied," which is really a sophisticated prioritization scheme that is effects based (note that the decision to think of producing such planning guidance gets us beyond the semantic discussion of what we mean by the effects; it will be defined as needed for a specific operation).

4.4 THE ROAD AHEAD

The first requirement for moving forward in this concept is to devise a coherent and logically consistent set of system elements that together define "effects" within context of tactical, operational and strategic operations.

A <u>second</u> requirement is to define organizational and doctrinal implications.

The <u>third</u> requirement is to include the two requirements above in plannning future war-games and FBEs.

A <u>fourth</u> requirement exists; to determine what tools are necessary that will allow notions of "effects" to be implemented in the dynamic battle-space.

When EBO is discussed it is most often in the context of Blue goals and operations We have made the point above that one has to be clear about the level of the effects, strategic, operational, tactical, or some combination. It is important to recognize that a parallel consideration has to take place concerning Red intent; what are their strategic, operational, and tactical goals. Attention also needs to be paid to matching Blue and Red levels of intent/effects.

Consider the following example. If Red intent is to achieve the strategic effect of disrupting the support of our coalition partners, a near term operational goal could be to deny Straits access for 14 days. They could reason, probably correctly, that a disruption of that length of time would put tremendous pressure on the coalition. Our operational goal could be to clear the Strait in 10 days and one or more effects could be associated with it. But, what is our strategic goal in countering the Red strategic goal? Clearly, it is to preserve the coalition and to preserve our influence in the area. One of the effects associated with this is certainly to restore the flow of oil. There are others. The point is, that if one is to properly consider action/counter action, goals and effects considered have to be at the same level if one is to properly assess capabilities and consequences.

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5.0 C4I ARCHITECTURE

5.1 FBE-F OBSERVATIONS AND ISSUES

One definition of the Naval C4ISR Architecture is that it is the network providing the infrastructure on which Network-Centric Operations (NCO) are conducted. The NWDC Capstone Concept for NCO is taken as the defining document here. According to it, NCO has the objective to "enable the Navy after Next to decisively win in the littoral and on the high seas". NCO " derives power from the robust, rapid networking of well-informed, geographically dispersed warfighters to create a precise, agile style of maneuver warfare and overpowering tempo…to sustain access and decisively impact events ashore". The Naval C4ISR Architecture supports command and information relationships that allow NCO of the Navy and Marine Corps and related Joint elements.

The FBE's are testable excursions from today's Navy, so it is not surprising that NCO can not fully be executed in the FBE. But FBE has shown significant steps toward NCO. Future implications and implementations have become clearer through the FBE process. Architectural issues and deficiencies have become obvious in the FBE's. The architectural deficiencies include:

- Doctrinal (no command/information relationship specified but found needed),
- Interoperability (relationship implied but not feasible),
- Connectivity /capacity /timeliness (relationship enabled partially, slowly etc)
- Semantic (relationship implemented but not understood)
- Noise level (relationship implemented but overwhelmed by competing inputs)

Some of the architectural deficiencies in FBE Foxtrot are mentioned below. Unfortunately training deficiencies may mask, or falsely indicate, deficiencies of an architectural nature. Some of the deficiencies below may only indicate lack of training in the existing architecture or its experimental extensions, which only once again indicates the crucial role of training in NCO.

5.2 C4I DEFICIENCIES:

In FBE Foxtrot, although many new concepts were investigated, architectural deficiencies were found in areas of parallel mine and ASW warfare, integration of operations with collection management, targeting across weapons types, and NBC efforts.

- In FBE Foxtrot the timeline for clearance of straits was to be reduced through synchronous antisubmarine and mine warfare. C4ISR deficiencies were minimized by the co-location of the MIWC and the SCC. There are severe bandwidth capacity constraints in reaching the mine warfare ships, which prevent the COP from being distributed to them. The COP which, as a work-around was distributed via GCCS because of SIPRNET problems, was, not surprisingly, judged unable to support synchronous operations because of time latency and accuracy deficiencies.
- US Army Apache helicopters were successfully vectored to support mine warfare ships by the SCC. Doctrinal and IFF deficiencies should be addressed.

- The ARCENT Deep Operations Coordination Center (DOCC) was remotely integrated into the fires effort and fired simulated ATACMS missions but additional doctrinal, interoperability, connectivity and semantic deficiencies were identified.
- Special Forces units were involved in mission planning but their full utility was encumbered by doctrinal and information deficiencies.
- Effects-Based Operations (EBO) in FBE Foxtrot were hindered by lack of simulated feedback that could have been provided by simulated ELINT and SIGINT that might have quickly indicated the relative success of fire missions. The role of the Effects Coordination Board and the location of its functions changed during the experiment, perhaps indicating a need for additional doctrinal development.
- The concept of an Attack Guidance Matrix (AGM), borrowed from the US Army, was explored to aid in EBO and in reducing the timeline for TCT. This is a promising concept but depends upon accurate capability to estimate target location error and system response time as well as a stable assessment of target priorities . Additional testing and doctrinal development is needed as well as Joint interoperability. TCT suffered from lack of visibility by all participants into the status of Blue response since a sample showed that only about half of TCT designated targets were attacked.
- The concept of a Joint Fires Element (JFE) was perhaps the most promising innovation in Foxtrot. It consisted of a sensor grid (ISR cell with feeds from national , theatre and organic sensors) supported by a GISRS-M terminal, an information grid (targeting cell with MIDB target data base) supported by a PTW+ terminal and an engagement grid (fires coordinator) supported by a network of LAWS terminals. In particular GISRS-M provided an important new capability for local collection management that makes it possible to deal with Time Critical Targets (TCT) much more expeditiously when combined with LAWS and the PTW+. Connectivity to the UAV controller was particularly important in tracking of moving TCT. The AGM was useful to the GISRS-M operators but adaptation to a collection planning and execution aid is desired. Doctrinal changes such as the integration of the J-2 and J-3 watches and improved interoperability should be explored. Balancing the number of PTW+, LAWS and GISRS-M terminals and improving their interoperability is required to eliminate bottlenecks when they are not co-located as they were in Foxtrot.
- Mobile targets require additional sensors including an organic MTI/SAR capability. Real-world operations limited the assignment of the intelligence staff in Foxtrot. Possibly as a result, responsibility for collection planning was not clear.
- Passing of target images from F-14 TARPS-CD pods to GISRS-M is a promising concept for finding targets that was severely handicapped by poor connectivity. RPTS for passing images to the cockpit is also promising but defeated in Foxtrot because of connectivity. P-3 images need to have a longer dwell time on the target as well as location information incorporated with the imagery. Image quality was sometimes degraded in passing through the chain of workstations.
- Simulated NBC events were handled in FBE-Foxtrot. The GAO observers felt that NBC was well integrated into the exercise and were impressed with the Collective Protection System. Reachback was demonstrated. A doctrinal difference between the Services and additional interoperability needs work.
- In ASW, Distributed Collaborative Planning (DCP) was accomplished but it was found to be difficult and time-consuming and required a strong leader, preferably on an ASW

platform. Much was accomplished by UHF voice rather than high bandwidth means. Improved fusion and connectivity is still needed.

5.3 COMMON OPERATIONAL PICTURE (COP)

The participants in FBE Foxtrot strongly stated that the Common Operational Picture (COP) supplied to them in Foxtrot was not adequate to support targeting of land attack missions. This raises three related analytical questions of consequence:

- Was the COP in Foxtrot unusually poor?
- Does the COP ever contain adequate information to support targeting?
- Should the COP be enhanced or should other means provide targeting quality info?

It is asserted here that although the COP was unusually poor in Foxtrot because of restricted equipment availability and displaced geometry. On the other hand the COP is a joint situational awareness tool and will never be adequate for total support of targeting. Target information is applicable to small subset of the objects that are relevant to situational understanding and targeting has a much higher quality of information with regard to accuracy of location, latency etc. A special set of targeting folders and/or a targeting net is necessary to support targeting and is dependent on the sensor and weapon combination being employed. Targeting support and authorization are likely to remain the responsibility of joint level commands for some sensor ñ weapon combinations with other combinations necessary to unit survival being localized and tightly integrated. Finally the COP can be of use in supporting targeting with information concerning the situation surrounding the target, which may be difficult to put in the target folder or on the targeting net. These issues are addresses below.

Many participants in the JFE expressed strong feelings that the COP did not provide adequate information support for targeting of TCTs. Most of them seemed to be concerned with latency and incompleteness and inaccuracy of the picture. Others have suggested that the COP (or at least the Land Attack TCT COP if it were to exist) should have additional information that it does not now have such as:

1. Sensor data: sensor location, target location error, footprint and pointing data
2. Full TADIL information and track history for each target
3. Imagery: video from UAV with telemetry info and NITF images
4. Related near-real time SIGINT and possibly COMINT, MASINT
5. GMTI track (JSTARS) info and position location info (tags) concerning targets.

Finally some conceptions of a targeting-oriented COP include the addition of information concerning the firing status of friendly units, some representation of the priority of the targets and even confirmation of authority to fire.

Although all of the above information would be useful in a Joint Fires Element, clearly these requirements go far beyond the current capability of the COP. The COP is first of all a situational awareness tool. As such it must cover a broad area such as a theatre and is literally a picture in order to enhance comprehension. It therefore has a limited level of detail and less than instantaneous latency. It is a joint and often a coalition service that must be available to those with only Secret clearance or often even less. Historically at sea it is closely related to the tactical air picture with all tracks of ships and aircraft: friendly, neutral, unknown and hostile/potentially hostile. Because of the cognitive objective of the COP, it is usually screened by a human operator for clean-up of dual tracks and the categories listed in the previous sentence which are based on many inputs for identification. Often only this operator (FOTC) is allowed to add tracks, change categories, see highly classified inputs etc. The COP as seen today is simply not a targeting tool. Targeting requires additional tools as such as target folders, sensor links and targeting nets. To ask the COP to perform these functions is to overload it and restrict its dissemination.

During FBE Foxtrot the COP was severely limited by the real operational situation which did not allow direct connection to the tactical link pictures. In addition the MIREM and SHAREM exercises were positioned at a distance from the areas of interest to Foxtrot so that a virtual displacement of locations was necessary for the Foxtrot scenario which made correlation to actual locations difficult. As a workaround the LAWS was able to display an extraction/modification of the GCCS-M picture. It is well known that the GCCS picture (although defined by some to be the COP) has notoriously bad latencies and often does not contain all traffic: air, surface and sub-surface but only selected units of high interest. Moreover there was some differences between the LAWS COP aboard the Kennedy and the one in Bahrain because LAWS had different servers and these were not totally synchronized. Thus the COP used in Foxtrot was not even a particularly good situational awareness picture.

However even the best COP will not adequately provide all the information necessary for targeting. Situational awareness concerns thousands of objects, some of which may be conjectural but important. Targeting focuses on a much smaller number of objects but in much more detail. As an operational level, situational awareness tool the COP simply can not be expected to have the focus, latency and dissemination for targeting. Targeting requires extremely short latencies (at least for some targets) , very accurate location and firm identification of just those objects that may be considered for attack.

It has sometimes been suggested that a Common Tactical Picture (CTP) might be developed that is the tactical equivalent of the COP but more inclusive of localized targeting information and with short latencies. For AAW this would describe some aspects of the Cooperative Engagement Concept (CEC), for example. However compared to the Land Attack picture, CEC has certain advantages of a localized geometry with small number of objects with relatively good identification (IFF), small number of participants on the net, precision sensors (SPY phased-array radars) and very high bandwidth line-of-sight communications. An equivalent CTP for land attack is simply not technically feasible or affordable because of the higher number of objects, larger distances, diverse sensors and lack of bandwidth. It is not likely that a COP or even a CTP will soon be able to provide all the information required by land attack targeting.

The COP or perhaps eventually a CTP can provide important background information for targeting. Because of its wider perspective, the COP can enable additional identification information (launch area of a missile for example). It can provide an understanding of the location and status of friendly units which might provide targeting quality information or fires or BDA, the potential for fratricide and collateral damage, downwind fall-out casualties etc. Before engagement the COP can provide significant help in collection management prioritization and interpretation for IPB. It can serve as a way to pass important sectorization decisions and serve as one basis for collaborative planning.

If the COP can not practically provide all necessary targeting information, how can the information needs of targeting be met? A combination of IPB and dynamic targeting folders, direct sensor- weapon threads and perhaps some specific targeting nets is likely to be crafted for specific land attack scenarios rather than a general purpose broadcast of all targeting information. The reasons for this, in general, is that the targeting information is specialized by type of weapon and is often restricted in its releasability / dissemination both for classification and simply because of geographical relevance and sensitivity. Moreover the authorization for attack of some potential targets and use of some of the weapons is likely to be reserved to specific levels of command which may desire to limit visibility into their operations, for security and other considerations.

The information to support TCT targeting and weapon assignment depends upon the combination of target type and weapon type that are being paired. Although having all the information necessary for targeting (all types of weapons might facilitate the most efficient pairing of weapons and targets) for TCT, it is much more important to be able to quickly make a feasible pairing with the information in hand than to wait for all information on which to base an optimal choice.

Two target types that are most relevant to TCT are either moving (or relocatable) versus fixed. Fixed targets can have an electronic target folder prepared in advance that contains all of the required location and mensuration, collateral damage and other limitations concerning ROE. All that is required in real time is the time-critical status of the target and the location of friendly or neutral units. A COP could provide this (if it could be injected with minimum latency) in addition to the target folder. For moving targets the task is much lengthier because the interpretation, location, identification and mensuration must be established and the assessment of collateral damage and ROE must be performed after the detection of the target. This information is not possible to file ahead of time so an electronic target folder must be built before the target can be authorized for attack (some portions could be done in parallel). Moreover there may be a long period between when the first sensor is alerted and the actual detection of a potential target since Automatic Target Recognition (ATR) is still relatively ineffective. Therefore moving or relocatable targets are quite difficult to target within the usual TCT thresholds of between 5 minutes and a few hours, almost regardless of the weapon being used.

From the sensor standpoint, often TCT sensor provides some kind of imagery: video from a UAV, national SAR or EO imagery. This generally allows rapid identification and reasonably accurate location but may require mensuration. Other times the TCT sensor is only an IR launch warning or SIGINT event or HUMINT / MASINT report. It is anticipated that JSTARS like capabilities will provide TCT over land and that distributed ground / water sensors will also provide detection (and identification in some cases). Generally a fusion of this information or correlation with imagery is necessary before the target location and identification will reach acceptable completeness for attack.

From the weapon and weapon platform standpoint, the usual response to a TCT is to vector an aircraft already in the area to make final identification and destroy / suppress the target with whatever armament is on board. This requires almost no information beyond an approximate location and description (some information about defensive activities in the area would also be desirable). On the other hand if the weapon at hand is a missile that can not be controlled once it is launched (Tomahawk or ATACMS) then very precise information regarding location and identification must be available. Gunfire support may fall somewhere in between in information required. The 16 sensor-weapon threads planned for Foxtrot show in detail the information required for each pairing. It should be possible to identify the expected time for these 16 evolutions for comparison against the TCT thresholds. Inspection of the LAWS data from Foxtrot reveals that no missions were performed within the specified time window and that very few missions were executed within the usual TCT thresholds. In addition only about half of the TCTs had missions generated.

In the case of a moving or relocatable TCT with short thresholds, the only hope for successful execution is that an imaging sensor is under the control of (or in direct support of with very good connectivity) the JFE fires planners (LAWS in Foxtrot). In Foxtrot a simulated UAV was available to the GISRS-M operators and the UAV sensor display was available locally. It was therefore possible to locate, with some degree of accuracy, and to identify the TCT. Because LAWS had sporadic information on status of friendly firers, it could begin to assess firing options while the target was being mensurated and a reasonably rapid firing assignment that was likely to be feasible could be made. Authorization of higher levels was not necessary in Foxtrot simulations and firers were supposed to report back via LAWS when performing the simulated execution. Thus the firing loop could conceivably be closed in a reasonably short period. In effect the Video from the UAV plus its controls became a targeting net supporting LAWS.

Targeting nets for TCT, in order to provide identification and short latency, will need to have imagery support directly from the sensors and a close degree of sensor platform control of the sensor. They must also have very tight connection to fires. But for effects-based prioritization, re-tasking of strike platforms and deconfliction, the targeting net must include a node with broad understanding of the current status of the operations and with authority not only to direct fires but to re-task platforms that are performing lower priority missions. This must be a fairly powerful node with quick access to responsible command levels. It must be supported by a good COP as well as the much more restricted targeting net(s) and have extensive intelligence support from national sources probably through a Joint Intelligence Center. In a large-scale joint or coalition operation this node will have to have be at the JTF level and have the commanders personal blessing because of the necessity of intervening in on-going missions in order to respond to TCT as well as high priority for intelligence collection and sensor management.

One of the demands for responsive intelligence collection and interpretation is that for any type of TCT target and weapon it is important that BDA be obtained in order to decide when to stop firing. Because TCT are so important, re-strike will be necessary until confirmation that the desired effect on the target has been reached. The planning of BDA should occur with every fire mission pairing. Otherwise it is likely that the BDA will be delayed to provide useful information for restrike decisions and many weapons will be wasted.

6.0 JOINT MARITIME ACCESS CONTROL (JMAC)

Section 1.2 introduced Joint Maritime Access Control (JMAC) as the central theme behind Fleet Battle Experiment Foxtrot. This section provides a broad overview of JMAC and notes specific areas of applicability to FBE Foxtrot. The section also discusses the relationship of various aspects of the experiment such as Time Critical Targeting, Fires, and parallel operations to JMAC.

6.1 JMAC OVERVIEW

Joint Maritime Access Control (JMAC) is that activity which assures Friendly Force access to littoral areas by neutralizing, destroying, temporarily degrading, or avoiding enemy maritime access denial systems and/or forces by any means.

The objective of JMAC is to enable joint military operations in the littoral which might otherwise be delayed, denied, or limited in effectiveness, or subjected to an unacceptable level of Friendly Force losses because of enemy maritime access denial.

6.1.1 Enemy Maritime Access Denial Objectives

JMAC recognizes why an enemy might seek to use a strategy of maritime access denial. From the viewpoint of Friendly Force operations, there are three key objectives of enemy maritime access denial:

- Maritime Chokepoint Denial
- Coastal Objective Denial
- Offshore Operating Area Denial

Maritime Chokepoint Denial by an enemy is the denial of Friendly Forces use of a sea-line-of-communication (SLOC) adjacent to coastal areas under enemy control to prevent transit of Friendly Naval Forces and/or prevent sealift of Friendly Land and Air Forces, heavy equipment and supplies. Examples of areas where an enemy might use a strategy of Maritime Chokepoint Denial include the Strait of Hormuz or the Strait of Malacca.

Coastal Objective Denial by an enemy is an element of enemy defense of critically important coastal locations from attack by Friendly Forces. The enemy's purpose is to enable continued use of the coastal area by Enemy Forces, and to deny Friendly Forces the opportunity to land ground forces and land-based air forces, and their equipment and supplies either through a developed port, or through an Amphibious Objective Area or Landing Zone. Historical examples of coastal objectives include Normandy in World War II and Inchon in the Korean War (where Friendly Forces prevailed); and Wonson in the Korean War and Kuwait City in the Gulf War (where enemy maritime access denial was successful).

Offshore Operating Area Denial by an enemy includes the use of land-based weapon systems and naval forces in the littoral to deny Friendly Forces use of maritime operating areas adjacent to coastal areas under enemy control. The enemy's purpose is to deny or inhibit Friendly Force use of Aircraft Carrier Operating Areas (CVOAs), offshore areas from which to stage

Operational Maneuver From the Sea (OMFTS), or offshore areas used by Friendly Combat Logistics Force ships. Examples could include the Gulf of Oman in SW Asia, the Yellow Sea in the Korean War, or Yankee Station in the Vietnam War.

Maritime Chokepoint Denial was examined in Fleet Battle Experiment Foxtrot. The other aspects of Enemy Maritime Access Denial are areas for further JMAC exploration, discussed in section 3.3.

6.1.2 Enemy Maritime Access Denial Systems Characteristics

Effective tactics, techniques and procedures for JMAC must recognize how an enemy maritime access denial capability may be put together. The characteristics of enemy systems used for maritime access denial include:

- System Density: Dense (e.g., DPRK)
  Sparse (e.g., Falklands)
- System Extent: Area of coverage (e.g., entire coastline or selected points)
- System Mobility: Fixed (e.g., Hardened Shore Battery)
  Mobile (e.g., Mobile Cruise Missile Launcher)
- System Activity Reactive (awaits target arrival)
  Proactive (seeks targets)
- Detectability: Hidden or stealthy (e.g., mines, submarines, coastal artillery in caves, etc.)
  Exposed (e.g., surface ships, aircraft, open coastal defense sites, etc.)
- Independence / Networking: Autonomous (e.g., submarines) through Integrated (e.g., IADS)
- Layers / Overlap: Defense-in-depth (e.g., interspersed submarines and mined areas)
  Mutual support (e.g., minefields covered by cruise missiles)

For illustration, we next discuss three of the more important characteristics.

Layering/Overlapping is the characteristic of enemy maritime access denial systems that creates the greatest challenge for Friendly Forces. One aspect of layering may be called defense-in-depth. An example is layers of submarine operating areas and minefields. They could be arranged such that mines would inhibit anti-submarine operations at the same time that submarines are inhibiting mine countermeasure operations. An aspect of overlap could also yield mutual support for enemy maritime access denial systems. An example could be minefields in a maritime chokepoint covered by concealed cruise missile or artillery sites along the coast. They could be arranged such that enemy maritime minefields can remain hidden because of threat to mine countermeasure operations from coastal cruise missiles or artillery. The coastal cruise missile and artillery systems can also remain hidden because they do not need to be exposed unless they have targets (ships) to shoot at; and the ships are deterred from entering the chokepoint by the presence of mines.

Detectability of enemy maritime access denial systems is a basic characteristic that can be a fundamental aspect of systems effectiveness in the access denial mission, and be a determining factor in the approach Friendly Forces must use in JMAC. Detectability ranges from exposed or open systems, to hidden or stealthy systems. Some enemy systems are normally exposed. Examples include combatant surface ships, patrol boats, conventional aircraft, and fixed maritime access denial installations. Some enemy systems are deployed in a manner designed to increase their effectiveness by decreasing their detectability. Some maritime access denial installations may take advantage of natural terrain features in the littoral environment for cover and concealment, such as dense vegetation or rugged mountainous terrain. Some concealed coastal systems may expose themselves when they are employed, such as by moving into the open before firing, but others may remain hidden, such as coastal artillery in caves. Some enemy systems are fundamentally designed to be hidden or stealthy. A good example of enemy maritime access denial systems designed to be hidden are mines. An example of a system designed with inherent stealth is the submarine.

Independence or Networking of enemy systems is the degree to which enemy systems operate independently or together. It is the third characteristic of enemy maritime access denial systems that is important in determining the best JMAC approach. Some enemy systems are autonomous, such as mines or submarines. Once deployed, they do not necessarily rely on external sensors or centralized command and control to accomplish their mission. Other enemy systems are fully integrated, such as ground-controlled fighter aircraft. They are designed to rely on a network of external sensors and command and control.

Enemy maritime access denial systems are not just the weapons, but also the sensors that detect opposing forces in the vicinity of coastal installations, harbors and shorelines, maritime chokepoints, and offshore operating areas. These sensors may include radar, sonar, electronic intelligence, imaging, etc.

6.1.3 Enemy Maritime Access Denial Worst Case

The worst case for the United States and Friendly Forces is a well-designed enemy maritime access denial system of systems that effectively requires a protracted length of time and/or a high level of friendly force attrition to overcome. Ways to play into the hands of the enemy maritime access denial strategists, and possibly allow the enemy to achieve its strategic goal would be to confront the maritime access denial by an extreme trade-off between time and friendly force attrition.

The first extreme, intended to minimize friendly force attrition, might be called sequential operations. In sequential operations Friendly Forces might first conduct a long-range air campaign focused on attrition of enemy air, air defense, and key ground targets, followed by engagement and attrition of enemy surface forces, followed by a campaign against enemy submarine capability, followed by a mine-countermeasures effort. While the sequential operations approach does provide a way for friendly forces to get started against a well-designed enemy access denial system of systems, sequential operations could be strategically ineffective if it takes too long.

The other extreme, intended to minimize time, might be a brute force, broad-based engagement of all enemy access denial systems simultaneously. If the enemy maritime access denial strategy is well designed (incorporating such features as defense-in-depth, mutual support, and stealth), then a brute force approach could result in an unacceptable level of Friendly Force casualties.

The essential challenge, therefore, when faced with a well-designed enemy maritime access denial system of systems is **both** how to significantly reduce the length of time needed to achieve maritime access, **and** how to do that without incurring an unacceptably high level of friendly force attrition.

Joint Maritime Access Control doctrine, tactics, techniques, and procedures (TTP) must provide a framework to address this worst case – to reduce the length of time needed to achieve maritime access and to get started against a well-designed enemy access denial strategy without incurring unacceptably high friendly force attrition.

The time aspect of JMAC was examined in Fleet Battle Experiment Foxtrot by focusing on parallel versus sequential operations. The complementary aspect of JMAC, how to get started against a well-designed enemy access denial system of systems is an issue for further JMAC exploration, discussed in section 4.3.

6.2 JMAC FUNDAMENTALS

A classic operational approach to dealing with an enemy maritime access denial threat is sometimes called sequential operations. In sequential operations Friendly Forces might first conduct a long-range air campaign focused on attrition of enemy air, air defense, and key ground targets, followed by engagement and attrition of enemy surface forces, followed by a campaign against enemy submarine capability, followed by a mine-countermeasures effort. The advantage of a sequential operational approach is that it provides a way for Friendly Forces to get started against a challenging array of enemy access denial systems, and limits the exposure of the Friendly Force to the enemy systems at their strongest point. The disadvantage of a sequential operational approach is that it could be strategically ineffective if it takes too long.

A new approach to Joint Maritime Access Control is to use alternative tactics to achieve the advantages otherwise offered by sequential operations, namely a way to start and a way to limit Friendly Force attrition, but avoid the disadvantages by significantly shortening the timeline of pure sequential operations.

The principle of operations of Joint Maritime Access Control is simultaneous, parallel, multi-mission, combined arms operations applied to penetrate, engage, and dominate a multi-dimensional threat.

An alternative tactic that may be used in a JMAC mission is referred to as an *armed probe.* Armed Probe is most closely analogous to *armed reconnaissance* in land warfare, and has much similarity with *combat air patrol* missions of aircraft, and anti-shipping *patrol missions* of submarines.

Armed Probe - A mission with the primary purpose of locating and attacking targets of opportunity, i.e., enemy submarines, surface craft, aircraft, coastal defense and missile sites, in assigned maritime areas or along assigned sea routes, and not for the purpose of attacking specific briefed targets.

To achieve the greatest effect, armed probe missions should be simultaneous, multi-mission, combined arms operations. Armed probes would typically not be assigned to single Friendly Force platforms, but rather should be assigned as combined arms, or coordinated operations with multiple, mutually supporting capabilities. Units assigned to armed probes should be trained and equipped to conduct simultaneous, multi-threat operations. The key objective of an armed probe mission is to flush out hidden enemy positions such as submarines, hidden high-speed surface craft, hidden coastal artillery or cruise missile batteries, etc. Friendly forces assigned to armed probe missions may be able to successfully engage enemy targets at the time of initial contact. Otherwise, Friendly Forces assigned to armed probe missions may be directed to withdraw so that the flushed out target may be prosecuted by other Friendly Forces in a preplanned coordinated attack.

Initial Penetration - JMAC includes Initial Penetration, in which the key Friendly Force capabilities are stealth and survivability. As part of initial penetration, clandestine capabilities are used to enable subsequent overt combatant operations for further Joint Maritime Access Control. The operational and tactical objectives of initial penetration are the location of concealed enemy maritime access denial systems and enemy sensor negation. A recent historical example of single dimensional Initial Penetration was the use of Tomahawk cruise missiles and F-117 Stealth Fighters to precede manned aircraft strikes in Desert Storm. In a multi-dimensional JMAC scenario, examples of the types of forces that might typically be employed to conduct initial penetration are:

submarines,
stealth aircraft and cruise missiles, and
Special Operations Forces.

An example of parallel, multi-dimensional, combined arms operations during Initial Penetration might be the coordinated employment of:

Friendly Force submarine,
Special Operations Forces, and
Stealth Aircraft.

The parallel multi-mission objectives might include:

mine countermeasures,
reconnaissance and targeting,
anti-submarine warfare, and
strike.

This example is summarized in the following:

Initial Penetration Armed Probe Mission

Forces Assigned

- Submarine
- SOF
- Land attack cruise missile platform and/or stealth strike aircraft

Objectives

- Locate & attack enemy submarines
- Locate & report enemy minefields & areas free of enemy mines
- Deploy SOF to locate coastal cruise missile sites.
- Destroy by direct action or targeting for land attack missiles or stealth strike aircraft.

When combatant operations have been enabled, Armed Engagement confronts enemy maritime access denial with combatant forces aimed at achieving local air and sea superiority in the area of interest. The key characteristics of Friendly Forces applicable in armed engagement are firepower and combat engagement ability. The operational and tactical objectives of armed engagement are attrition of layers of enemy maritime access denial and the suppression of enemy shooters. Examples of force employment during Armed Engagement include:

cruisers and destroyers conducting armed reconnaissance,
strike/fighters conducting counter-air operations,
tactical aviation assets conducting SEAD and counter-air operations, and
Marine or Army assault forces employed in raids.

An example of parallel, multi-dimensional, combined arms operations during Armed Engagement might be the coordinated employment of :

Friendly Force Surface Combatants with Mine Countermeasure capabilities and mutually supporting manned aircraft conducting armed probes.

The parallel multi-mission objectives might include:

mine countermeasures,
reconnaissance and targeting,
anti-submarine warfare, and
strike.

This example is summarized in the following:

Armed Engagement Armed Probe Mission

- Forces Assigned
- Guided Missile Cruiser or Destroyer with LAMPS
- Organic Mine Countermeasure capability or paired MCM platform
- Combat Air Patrol

- Objectives
- Flush out & attack enemy submarines.
- Locate & report enemy minefields & areas free of enemy mines.
- Flush out coastal cruise missile or artillery sites. Destroy by ship or air-launched counterbattery fire, or withdraw & report for subsequent pre-planned coordinated attack.
- Flush out hidden enemy high-speed small combatants. Engage with ship weapons and CAP, or withdraw & report for subsequent pre-planned coordinated attack against base of operations.

Multi-Mission Combined Arms Operations: It is noted that the organic mine countermeasure capability may be provided by systems deployed in the surface combatant, such as a Remote Minehunting System (RMS) or airborne mine countermeasures helicopter. Alternatively, such capability may be provided by a dedicated MCM platform, surface or helo, assigned to accompany the surface combatant on the armed probe mission. In that case, the surface combatant would have the additional responsibility of defending the MCM platform. This example also illustrates simultaneous, multi-mission, combined arms operations. Parallel missions against other enemy maritime area denial systems such as air strikes against enemy airfields, submarine operating bases and other critical nodes should be assigned concurrently.

6.2.1 JMAC Sequencing and Pace of Battle

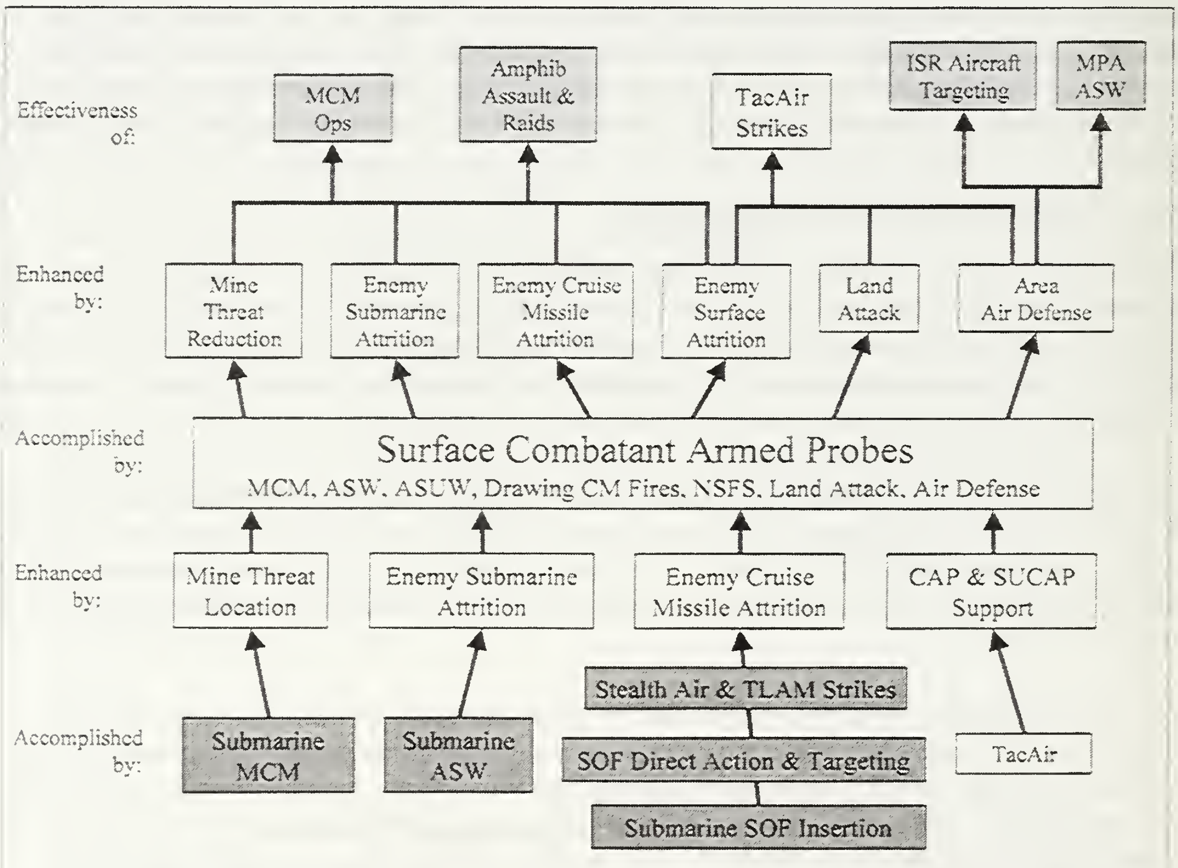
When local sea and air superiority have been attained, JMAC dominance operations continue until enemy maritime access denial systems are no longer capable of interfering with Joint Force operations. All Joint force capabilities, across the broad spectrum of military disciplines, are applicable. The operational and tactical objectives are clearance of remaining enemy maritime access denial, sea and air dominance, and total area control.

From initial penetration through dominance, Joint Maritime Access Control includes all methods that prevent or inhibit the enemy maritime access denial systems from accomplishing their mission. It includes methods that destroy, degrade, neutralize, or avoid enemy systems. The choice of method to apply in each situation is determined by enemy system characteristics and vulnerability.

An aspect of the JMAC principle of parallel multi-dimensional operations is that the rate at which enemy maritime access denial systems are overcome *snowballs,* or accelerates, through the JMAC campaign. JMAC may start relatively slowly with the most survivable of Friendly Force capabilities conducting initial penetration. In armed engagement, armed combatant forces can then achieve a higher rate of JMAC mission accomplishment due to greater numbers, a greater arsenal, and the enabling effect from initial penetration. The highest rate of JMAC mission accomplishment can be finally achieved after Friendly Forces have achieved local air and sea superiority, when the most robust surveillance and neutralization capabilities can be brought to bear to achieve sea and air dominance.

A simple example of the snowballing effect in JMAC can be seen in the case of the neutralization of enemy minefields. During initial penetration, submarines with mine reconnaissance systems can penetrate possible minefields and either locate some mines or identify areas free of mines (while conducting other initial penetration missions such as SOF insertion, ASW, or cruise missile launches). Leveraging off of the initial penetration, cruisers and destroyers can follow up while conducting armed engagement, locating and neutralizing additional enemy mines with remote minehunting systems and organic airborne mine countermeasure systems (while conducting other armed engagement missions such as ASW, engagement of enemy surface craft, or land attack). Finally, after sea and air superiority are attained, dedicated surface and air mine countermeasure forces can achieve the highest rate of enemy mine clearance.

An essential element of the principle of operations in JMAC is to achieve enhanced or synergistic effects that are the result of enabling effects of Friendly Force JMAC actions earlier, and mutual concurrent support. The following graphic provides an example of enhanced JMAC effects due to enabling effects and mutual support.



In this particular example, the graphic represents that the effectiveness of Mine Countermeasures Operations and Amphibious Assaults and Raids are enhanced by the enabling effect of mine threat reduction, enemy submarine attrition, enemy cruise missile attrition and enemy surface combatant attrition accomplished by the surface combatants. In addition, TacAir operations during armed engagement are enhanced due the attrition of enemy surface combatants that may be armed with surface to air missiles; land attack of land based enemy air defense sites, and AEGIS area air defense. The AEGIS area air defense also enhances the effectiveness of MPA other surveillance aircraft missions by providing cover for greater freedom of movement.

The graphic also represents that the JMAC effectiveness of Surface Combatant Armed Probes is enhanced by enabling effects from initial penetration. This is due to a combination of some mine threat location accomplished by submarines, some enemy submarine attrition also accomplished by friendly submarines, some enemy coastal cruise missile attrition accomplished by air and Tomahawk strikes, and SOF actions. The chart also shows the enhancement due to CAP and SUCAP mutual support during armed engagement provided by TacAir. Similar examples can be envisioned showing enabled and/or enabling effects and mutual support effects for other Friendly Forces, and suppression of other enemy maritime access denial forces and systems.

6.3 RELATIONSHIP TO FBE-F

Overcoming an enemy strategy of Maritime Chokepoint Denial was the setting for Joint Maritime Access Control examined in FBE-F. Within that setting, the time aspect of JMAC was examined by focusing on parallel versus sequential operations to significantly reduce the length of time needed to achieve maritime access. The experiment also included examination of various concepts, initiatives and critical operational issues as they relate to JMAC and contribute to the overall operational objectives.

6.3.1 Sensors

Sensor employment related to Joint Maritime Access Control ranges from pre-hostility Intelligence Preparation of the Battlespace through the warfighting JMAC campaign to continued surveillance after sea and air dominance have been achieved. Depending upon the level and strength of the enemy maritime access denial system of systems, some particular sensor packages or platforms are called for in JMAC. For example, Initial Penetration sensors may include:

- clandestinely deployed undersea sensors,
- submarines,
- unmanned undersea vehicles, and
- low observable unmanned air vehicles or aircraft.

Armed engagement sensor packages include:

- TacAir and
- surface combatant sensors.

Sensor employment considerations in JMAC also include mutual support operations such as an Aegis air defense umbrella for unarmed surveillance aircraft providing both airborne early warning for the surface combatants as well as targeting for Joint Fires.

6.3.2 JFE Relationship to Time Critical and Deliberate Targeting

An enemy maritime access denial system of systems may include many elements that would fall within the target sets of interest for Joint Fires, Time Critical and Deliberate Targeting. Fixed targets may include:

enemy command and control sites,
land-based sensor sites,
fixed coastal artillery,
cruise missile sites,
airfields,
fixed air defense sites,
logistics support for enemy naval forces, and
mine stockpiles.

Mobile and/or moveable land targets may include:

mobile coastal artillery,
mobilecruise missile units,
ballistic missile transporter erector launchers (TELs),
movable air defense and sensor sites,
coastal defense ground forces and vehicles, etc.

Joint Fires Element Concept: Some of the targets may be hardened or concealed and thus have unique susceptibility to surveillance and targeting and narrow windows of vulnerability to attack. The tactics developed to conduct time critical targeting and the Command and Control embedded in the Joint Fires Element Concept have the potential to contribute directly and uniquely to the JMAC objectives of countering the enemy maritime access denial systems. In addition to providing a means to engage much of that target set, the tactics also fit into the JMAC objective of reducing the time to achieve maritime access with parallel, multi-dimensional operations.

6.3.3 SEAD/SECD and issues of Force Protection

Suppression of Enemy Air Defense (SEAD) tactics is both an ingredient of JMAC and a model that can be extended to other dimensions of warfare and threat within the context of maritime access denial. As an ingredient of JMAC, established SEAD tactics are an enabler of strike operations against critical land-based enemy maritime access denial systems, including command and control, coastal defense sites, airfields, and logistics support. In addition, the basic ideas involved in SEAD tactics against air defense sites may be generalized to the suppression of other enemy coastal defense sites such as coastal artillery and coastal cruise missile batteries. The Initial Penetration Armed Probe Mission and Armed Engagement Armed Probe Mission examples in section 0 apply here.

6.3.4 ASW/MIW and implications for Parallel Operations

Submarines and mines are both deployed in the same environment – hidden underwater. Consequently, an enemy having both submarines and mines may establish areas that have either mines or submarines lying in wait, and thus create a layered, mutually supportive maritime access denial system of systems. This could establish conditions that dictate JMAC multi-dimensional parallel operations involving initial penetration and armed probes to deal with the enemy threat within an acceptable time frame, with an acceptable level of Friendly Force attrition.

As discussed in section 6.1.3, classic sequential operations can just take too long. Also, single dimension operations, even if conducted in parallel, could still be ineffective if the enemy system of systems is well designed (for example, if submarines threatened MCM forces or if mines restricted the maneuverability of ASW forces – not to mention enemy surface, air, and cruise missile threats). Thus, multi-dimensional, parallel operations may be called for. Three of the parallel operations listed in Section 4.2 aply to this situation:

> Initial Penetration of Friendly Force submarines conducting concurrent ASW and search with organic MCM systems.
>
> Surface Combatant Armed Probes, either with organic MCM capability or paired with MCM forces conducting concurrent ASW while probing the area of enemy maritime access denial.
>
> Parallel operations of Maritime Patrol Aircraft conducting ASW concurrently with dedicated Airborne MCM operations under the protection of local air superiority under a CAP and/or Aegis umbrella.

6.3.5 Joint Operations

JMAC relates to joint warfighting in two respects. First and foremost, it may be a critical element of a joint campaign. An example of such a situation is the case of an enemy closure of a critical maritime strait in order to prevent Friendly Force logistics shipping from getting through to support engaged land forces. In this situation, the critical operational issue would be the opening of the strait in time to meet Joint objectives, and to sustain it open for sufficient duration to permit unimpeded transit of commercial and military shipping in support of the Joint campaign.

The other joint aspect of JMAC is the potential use of multi-service assets to overcome enemy maritime access denial. An example might be the use of Army Apache attack helicopters, either land-based or ship-based, to defend Navy Mine Countermeasures platforms from attack by small high-speed surface craft. Another example is integration of Air Force surveillance aircraft into the C4ISR network supporting JMAC. Another example might be the use of Army Air Assault forces to neutralize enemy coastal artillery in caves in mountainous terrain.

6.4 FURTHER JMAC EXPLORATION REQUIREMENTS

Maritime Chokepoint Denial in a Strait of Hormuz scenario was examined in Fleet Battle Experiment Foxtrot. The other aspects of Enemy Maritime Access Denial, namely Coastal Objective Denial and Offshore Operating Area Denial are areas for further JMAC exploration. Various Western Pacific scenarios contain significantly different threat situations, timing, and force level considerations that should be factored into JMAC tactics, techniques, and procedures.

The time aspect of JMAC was examined in FBE-F by focusing on parallel versus sequential operations. The complementary aspect of JMAC, how to get started against a well-designed enemy access denial system of systems, or shear overwhelming numbers, is an issue for further JMAC exploration. The tactics of Initial Penetration parallel operations and Armed Probe parallel operations should be further developed and evaluated.

Navy leadership to experiment with Joint Maritime Access Control in FBE Foxtrot employed predominantly Navy ships and aircraft. More exploration of JMAC, including Amphibious and Marine Expeditionary Forces, as well as Army and Air Force should be conducted.

FBE Foxtrot included elements of Joint C4I. Further exploration of JMAC in the context of a large scale Joint Campaign is needed to flesh out the details of Command and Control and Planning that should be contained in Joint tactics, techniques and procedures.

APPENDIX A – FBE-F NETWORK ANALYSIS

A.1 NETWORK ANALYSIS OVERVIEW

SPAWAR Systems Center, San Diego (SSC-SD) continued in their support of the Maritime Battle Center (MBC) during Fleet Battle Experiment-Foxtrot (FBE-F), with regard to network data collection and analysis, and other issues related to Information Assurance (IA) initiatives. Detailed results of FBE-F Network Analysis effort can be obtained from SSC SD Code D80.

Actual onsite network data collection, analysis, and bandwidth management experimentation was conducted from 28 November 1999 through 8 December 1999. SSC-SD provided three network engineers at the Commander Fifth Fleet (C5F) facilities in Bahrain and one aboard USS JOHN F. KENNEDY (JFK) allowing coverage of events across multiple network subnets in addition to concurrent data collection and analysis during exercise conduct. Moreover, the use of three network engineers at the C5F facility aided in the isolation of network faults and identification of heavy network user applications during periods where network capacity was clearly being taxed.

The objectives of the network data collection and analysis effort included:

- "Discovery" of C5F and JFK LAN and WAN architecture
- Assessment of on/off ship/site bandwidth usage, with emphasis on SIPRNET, which constituted the primary shared WAN media throughout the conduct of the exercise
- Characterization of traffic content by protocol, IP addresses, and port numbers
- Identification of traffic as generated by FBE and pre-existing shipboard systems.
- Performance of bandwidth management experiments using a packet shaping tool (the "PacketShaper 2000™", by Packeteer, Inc.)
- Support of network fault isolation as requested during the exercise
- Render recommendations & lessons learned based on exercise observations
- Firewall (F/W) Investigation - Examine the Firewall (F/W) and Intrusion Detection System (IDS) policies and implementations to ensure that FBE-F reach-back requirements were not hindered.

A.2 NETWORK ANALYSIS ARCHITECTURE

The paragraphs that follow describe the network architecture as observed during FBE-F. This architecture description will focus on those locations as instrumented with network data collection tools during the course of the experiment. These included the C5F facilities at the Naval Support Activity (NSA), Bahrain and USS JOHN F. KENNEDY (JFK). For FBE-F, JFK was instrumented in order to obtain network observations from two distinct perspectives over the WAN. As the hub of activity for FBE-F, however, the C5F network at the NSA will be emphasized within this report.

The network architecture at C5F and the Indian Ocean Regional Network Operations Center (IOR NOC) consisted of a multi-tiered Wider Area Network (WAN) structure, with a number of C5F LANs attached to its router, known as the "Tier 3 Router". For internal/administrative and certain real-world applications, C5F had a separate ATM LAN subnet, which was not considered within the context of the FBE architecture. The two LANs of interest attached to the Tier 3 router included one associated with the Strike Center and another associated with the Friendly Forces Command Center (F2C2) and Joint Operations Center (JOC).

Aside from the single ATM subnet, the C5F LAN architecture, as used within FBE-F, consisted entirely of 10Base Ethernet. This actually turned out to a limiting factor on the LAN side, as numerous subsystems vied for use of this relatively narrow LAN pipe. This was verified via a network analyzer attached to the LAN segment within the JOC (which also ran to the F2C2). LAN usage was often in excess of 80%, resulting in network packet collisions and retransmissions.

The network architecture onboard JFK was typical of IT-21 installations, in that the SIPRNET router was attached to a switch, connecting it to other networked subsystems. As previously stated, the JFK was instrumented to provide observations of WAN data on either side of the WAN "cloud" as employed during FBE-F.

Other networked platforms included the USS JOHN YOUNG (DD 973), USS JOHN PAUL JONES (DDG 53), and USS DEXTROUS (MCM 13). These ships were provided a unique network architecture, using a Satellite UHF Link to downlink an aggregate 56Kbps to all three ships and also providing an uplink capability of 2.4Kbps for each platform. These platforms were not instrumented due to limits in their WAN capability..

A high-level view of the FBE-F WAN connectivity, including those platforms not instrumented for data collection, is illustrated in Figure below.

A.3 NETWORK TOPOLOGY

It is necessary to understand the network connectivity for any data collection and analysis effort. Without such an understanding, it is impossible to properly characterize the origin and general content of the traffic collected, much less any tactical/operational ramifications implied.

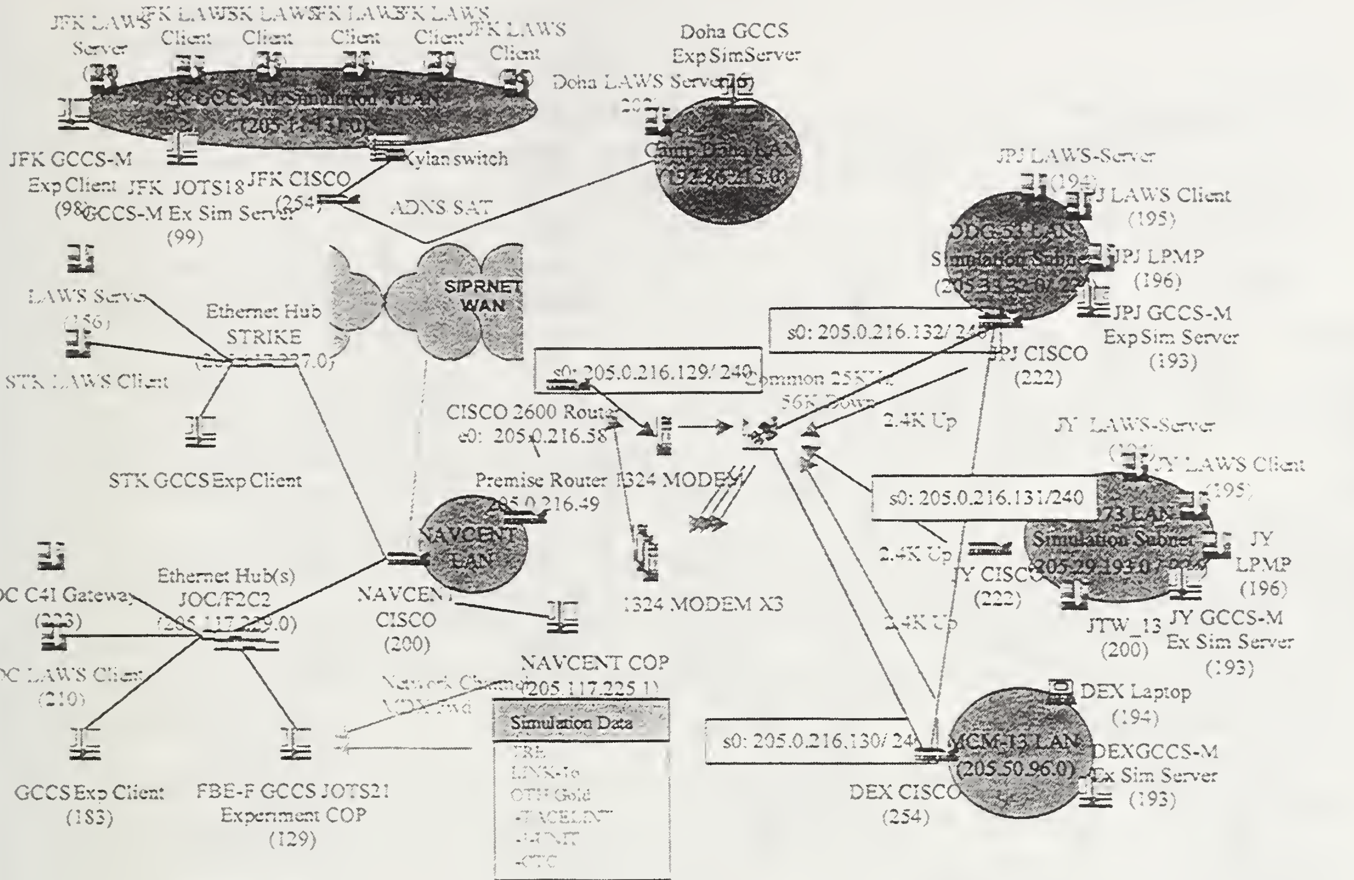


Figure A1. FBE-F High-Level WAN Architecture/Topology

Participation in the early phases of FBE-F planning by the network data collection team was vastly improved over previous such efforts. This saved perhaps as many as 4 days of network architecture discovery time during the course of this FBE. With this additional information, it was determined that yet more information was needed to thoroughly execute the network analysis and bandwidth management experiments intended for this FBE.

While participation in advance planning meetings, coupled with an advance site survey, greatly aided in the network analysis team's understanding of the network architecture/topology, additional discovery efforts were in fact required at the commencement of the experiment. This was particularly true in the determination of the actual protocols in use, IP addresses not previously identified, and ports in use. This again proved that while more data was available at the commencement of the exercise than had previously been the case, yet more information was needed prior to the commencement of subsequent FBEs.

An overview of FBE-F network connectivity, from the standpoint of the data collection effort, is depicted in figure 2, illustrating WAN connectivity between the C5F/IOR NOC facilities and JFK. Some deviations from figure 2, which was derived from the network analysis site survey conducted in October 1999, were encountered, such as moving certain analysis components to a temporary JFACC tent for the sake of efficiency.

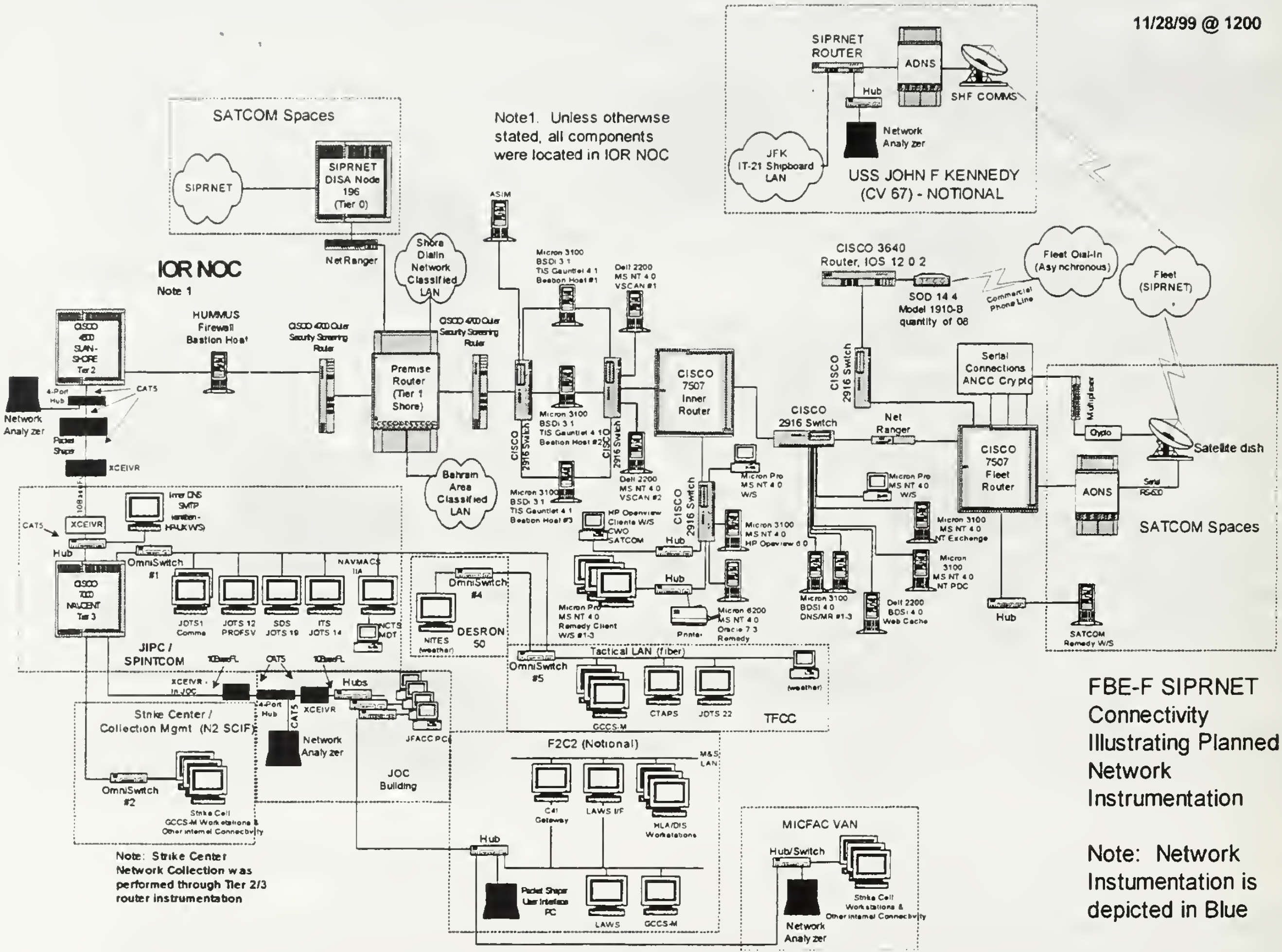


Figure 2. FBE-F Architecture/Topology Supporting Network Data Collection

A.4 NETWORK ANALYSIS CONCLUSIONS AND RECOMMENDATIONS

A number of conclusions can be drawn with associated recommendations for future application.

A.4.1 Bandwidth Management

The most significant aspect of FBE-F's network analysis / bandwidth management effort was the demonstration of the PacketShaper in its capacity as a bandwidth manager. Although this initial field demonstration of the tool was somewhat limited, it demonstrated flexibility within a complex environment by allowing network analysis personnel to select an individual protocol derived from specific subnets and then "cap" the incidence of the corresponding WAN traffic using the selected parameters.

The particular experiment selected for FBE-F was of particular relevance in that it may also directly benefit successive FBE's. Until the direct cause of excessive TCP NetBIOS traffic is isolated and addressed, the PacketShaper can provide a viable means to mitigate the occurrence of these packets on otherwise restricted WAN media (e.g., a ship's SHF or Challenge Athena installation).

While packet "shaping" was only on for approximately 1.5 exercise days, the PacketShaper itself was running, collecting statistics and establishing classes for use in subsequent policy development, 24 hours a day for the duration of FBE-F. The MS Windows NT-based network analyzers would each periodically fail at one time or another (largely due to network volume and associated processing loads), whereas the PacketShaper did not register a single failure. One qualification to this assessment is that the PacketShaper was in fact installed at a shore site, which is a somewhat less arduous environment than that as encountered in a ship's computer/communication space. However, it should also be noted that the PacketShaper successfully shipped (in its original packing box) to the C5F compound at Bahrain with no adverse impact on performance. Thus, the unit appears to be adequately "rugged", both functionally and structurally, to handle near-term FBE requirements.

The PacketShaper did in fact exhibit some unforeseen difficulties in the classification of a portion of the WAN traffic. However, the exact cause of this is presently unknown. On the surface it does not appear to be a PacketShaper design deficiency, so much as the absence of information needed to ensure proper classification of the otherwise non-classified or "default" information.

The results of the bandwidth management experiment make a compelling argument for further such experimentation with the ultimate goal of supporting network bandwidth management Comm Plans. Such plans would become the network equivalent of (or complement to) the old tactical circuit comm plans, where a limited number of dedicated RF circuits are allocated based on tactical priorities and available resources. The aggregate bandwidth for any shared WAN link could be viewed as a resource to be allocated across users, based on user priorities and requirements. Given the flexibility available in the Packet Shaper's traffic classification and policy/partition definition scheme, one can see how such a capability could be applied given a well-organized and validated network comm plan. Elements comprising such a plan would include:

- Individual user's bandwidth requirements, based on application type (e.g., streamed audio/video, file transfers, mail, etc.) and latency requirements (e.g., TCT messages versus normal administrative email).
- Individual user's priority, which could be assigned through the PacketShaper, for example, from 1-7, with 7 being the highest. In this case, lower priority traffic may only be sent if sufficient bandwidth is available after the needs of the higher priority traffic have been satisfied or if higher priority traffic is not present.
- In cases where the WAN was largely in a quiescent state (little ambient traffic), policies could be established which would allow various classes of traffic to "burst" up to the limit of the media, at least until other packets of the same or higher priority were present. In the PacketShaper, this is referred to as creating a "burstable" policy or partition, which allows for the best case performance under conditions of lower overall bandwidth usage.

Policies could be established at a unit level or even a Battle Group (BG) or component level. Such policies could be developed and validated ashore and then documented for entry at the various managed locations. While more research, experimentation, and ultimately testing is required to refine the use of the PacketShaper or other similar device to the degree where sophisticated network Comm plans can be implemented, development and implementation of early experimental plans should be considered for subsequent FBE's.

In addition to supporting network comm plan development and implementation, the PacketShaper also shows promise in the simulation of restricted WAN pipes within a laboratory environment. For example, a new experimental system could be validated to ensure conformance with its "rated bandwidth" requirement (e.g., 28 Kbps), by employing a non-burstable policy/partition at that limit and validating its operational performance. Thus one could ensure that a packet shaping policy would provide adequate support for a subsystem's mission prior to its introduction within an exercise or operational environment. Another application would be the simulation of a restricted shipboard-like WAN pipe, such as the SIPRNET segment on a typical SHF installation (e.g., 128 Kbps). Several applications could be run within a lab environment at their respective assigned "slices" of the simulated WAN pipe (defined as a partition of multiple policies) to determine the effectiveness of the comm plan within a lab environment prior to its introduction to the fleet. Such lab experiments and tests would conceivably have two effects: (1) ensuring optimal bandwidth usage across shared media as new applications are introduced and (2) providing incentive to developers to render their applications more bandwidth efficient (applications which used unacceptable levels of available bandwidth would be identified early).

A.4.2 Network Analysis & Discovery Parameters

Requests for experiment system network parameters proved quite valuable for FBE-F. Information regarding IP Addresses and Port # assignments proved particularly helpful in determining the nature of WAN and LAN traffic in the early part of FBE-F. Receipt of this information highlighted two valuable lessons:

1) Users need to continue to provide such information for future FBEs and
2) Information provided must be complete and compulsory for participation across the FBE WAN/LAN.

Moreover, that information must be accurate and maintained, if possible throughout the conduct of the FBE. In instances where such information changes, due to circumstances and/or the relatively dynamic nature of the configuration, such modifications need to be reported to the network analysis team. Failure to report modifications and/or additions results in additional investigative efforts on the part of the analysis team.

A database continues to be needed for each exercise that relates IP or MAC addresses to shipboard location and tactical system names and / or functional application, so that depiction of network elements is tactically meaningful. This would greatly aid in the ship's use of such information, which otherwise, by its very nature is rendered somewhat cryptically.

A.4.3 Network Management Tools

FBE's are conducted within a dynamic configuration/environment, where changes often occur during exercise conduct. Therefore, while early identification of experiment system network parameters will greatly promote the quality of the network as well as the analysis/bandwidth management effort, the capability to rapidly discover changes or previously unknown information is needed. This is certainly not a new observation, in that it was also highlighted in the FBE-E report.

For FBE-F, one of the portable PCs normally used as a network analyzer was employed as the PacketShaper web-browser user-interface. This was facilitated through a SIPRNET drop in the JFACC tent, which was attached to one of the unswitched FBE- F LANs. Since the PacketShaper user-interface required an IP address, this provided a unique opportunity to employ some of the network discovery tools included within the network analyzer software[1]. These proved extraordinarily useful in automatically classifying traffic addressed to nodes on the instrumented LAN (the traffic observed included packets received locally and via the WAN). This information was added to the already known list of network parameters, which allowed for rapid identification of high-bandwidth users. In fact, the availability of this capability allowed the network analysis team to respond to requests for the cause of perceived low network performance, which were usually traced to heavy activity from a small subset of nodes. This capability highlighted the need for some form of very simplified network management tools that allow for the identification of networked servers and workstations and render the type of IP Address/Port # database needed. The current Network Associates software package is adequate in this capacity, assuming its use is authorized in this less passive state, however, a network manager that handles Simple Network Management Protocol (SNMP) packets and provides an overview of the network topology and activity at a glance would be an improvement. In order to employ the network analyzers in support of network discovery, at least one per subnet should be allocated an IP address for subsequent exercises. This should be considered for all future FBE network data collection efforts.

A.4.4 DNS Servers

Various network analysis and management devices employ "Domain Name Servers", or DNS servers as they're more commonly known, to identify the host names associated with the various workstations and servers. These DNS servers essentially maintain the applicable host list, ensuring nodes can be identified by name (e.g., "c5fsvr" or "jots1"). Typically this allows a device, such as a network analyzer or SNMP manager, to interrogate all addresses maintained at a DNS server and determine the corresponding host names. In the case of FBE-F, however, multiple DNS servers were employed (as many as 3 or 4). When attempting to "auto-discover" hosts associated with the IP traffic encountered the network analyzer in the JFACC tent would periodically rename the hosts, based on their different host names within the various servers. This created confusion is was, of course, inherently inefficient. It is recommended that only a single DNS server be made available to hosts on any given subnet, thus alleviating the confusion

[1] Note: Virtually any workstation equipped with IE 3.0+ or Netscape 4.0+ would have sufficed in the capacity of a User Interface PC. A separate notebook PC was brought in, thus ensuring full-time monitoring of PacketShaper functions. The benefits described in this paragraph were merely a "by-product of opportunity".

and simplifying network setup at individual workstations. Assuming that multiple DNS servers are to be employed (as often occurs with Internet Server Providers [ISPs], thus ensuring redundancy), then the use of host names must be standardized across servers.

A.4.5 NetBIOS Traffic

NetBIOS activity across the WAN routers was high. Most of this traffic was from ports characterized as NetBIOS traceable via IP address to the LAWS servers and workstations. The two theories that apply to the cause of this traffic include the possible use of continuous COP updates and/or frequent file sharing of large files, such as imagery associated with TCT operations. While the PacketShaper proved capable of managing this bandwidth in a manner that did not adversely affect TCT operations and kept most of the WAN available for other uses, this high level of TCP NetBIOS would have created problems on platforms with lesser available bandwidth. While bandwidth management can throttle the WAN TCP NetBIOS down to acceptable levels in any environment, it is uncertain as to the impact that would be incurred in LAWS or other affiliated systems. During one brief (5 minute) period, the TCP NetBIOS traffic was throttled down to a 200 Kbps average rate with the cooperation of a LAWS user outside of the tier 2 router (considered outside of the C5F network). The workstation was located in the Special Operations Command (SOC) space. Upon applying this even greater degree of control, the LAWS user within the SOC space experienced what was described as "an unusable system", by virtue of the latency induced. In spite of this evidence, the observation of the large amounts TCP NetBIOS across the WAN was considered a first, as nothing like this had been observed during past exercises involving the LAWS. Therefore, it is highly recommended that WAN media used to transport LAWS data be instrumented in successive FBE's (starting with FBE-G) to further characterize this traffic or determine that the excessive FBE-F use as anomalous. Moreover, a cooperative effort between network analysis and LAWS representatives is highly recommended, thus ensuring a fair and balanced characterization of the problem (assuming it persists) along with a corresponding recommendation for subsequent system improvement (as required).

APPENDIX B – TIME CRITICAL TARGET-LAWS ANALYSIS

This report presents data relating to TCTs in FBE-F based on an analysis of the LAWS data collected from the LAWS server on the JFK. The primary assumption underlying this analysis is that all of the targets presented in the LAWS Mission Coordination: Fires list were TCTs. GISRS-M, which nominated about one third of the targets in the list, confirms that all their nominations were TCTs. The principal broad conclusions drawn from the analysis are listed below.

1. About half the TCT nominations were engaged.
2. Of the targets engaged, about one third were engaged with MLRS.
3. Of the targets not engaged, about half may not have been engaged as result of inadequate time, data or resources.
4. For those targets with sufficient timeline data on which to base a conclusion, almost no targets were engaged within the specified target dwell time.
5. There does not appear to be much relation between the experimentally observed sensor to engagement threads and the 16 TCT threads defined in the Fleet Battle Experiment Foxtrot Fires and Precision Engagement Roadmap.
6. The LAWS data contain many voids.

Each of these points is discussed in more detail below.

B.1 TCTs ENGAGED

The LAWS Fires mission list contained 218 targets. Of these, 14 targets (nominated by C5F LAWS and JPJ LAWS) were deleted because the target description contained the word "test". In addition, 28 targets received at LAWS prior to December 4 (all nominated by PTW+) were deleted, leaving a sample of 176 targets. A target was defined as fired on if the Fired Status block (the FRD column) in the Mission Coordination: Fires table was green. A green FRD block indicates that the LAWS terminal received an acknowledgement from the firer that the mission was fired. Other targets, which do not exhibit this condition, were also considered to be fired on. In the sample of 176 targets there are three that have a red block labeled NAK (not acknowledged) in the FRD column. This means that the mission timed out without receiving an acknowledgement from the firer that the mission was fired. There were a further seven missions that are yellow in the FRD block. For unknown reasons, these blocks did not time out (were not turned red). Those targets that are yellow or red in the FRD block may have been fired on and for the purposes of this analysis they are presumed to have been fired on. Finally, there are six TACAIR missions listed as flown but only one of which shows a green FRD block. These targets are also presumed to have been fired on. Operating under these assumptions, 93 (53%) of the 176 TCTs critical targets were fired on. GISRS-M was the nominator of 72 (41%) of the 176 targets. The data for GISRS-M nominations are more complete and considered to be more reliable than for the sample as a whole. Accordingly, the GISRS-M data will be looked at independently of the data summed over all nominators. For GISRS-M, 28 of its 72 nominations (39%) were fired on.

B.2 TCT FIRERS

Table 1 provides a breakdown of the weapon types employed against the TCTs that were fired on. It is emphasized that these data apply only to the engaged targets. In some cases, the targets that were not engaged were matched with specific firers. These unprosecuted matchings are not contained in Table 1. Almost half of the 93 targets engaged (44%), were engaged with MLRS. For the GISRS-M nominations, 32 percent of the engaged targets were engaged with MLRS.

TABLE 1. FBE-F TCTS FIRED ON

		#TARGETS	FIRER TYPES					
NOMINATOR	# TARGETs	FIRED ON	MLRS	TTLAM	ERGM	LASM	TACAIR	UNKNOWN
1 CAV 2BDE	5	0						
GISRS-M	72	28	9	7	1	3	4	4
JSWS	19	7	5		1	1		
C5F LAWS	10	7	1		4			2
JFK LAWS	7	4			2	2		
JYG LAWS	2	2			2			
DOCC LAWS	20	20	18					2
PTW+	22	17	8	3		4	2	
JSOTF	19	8		2		5	1	
TOTALS	176	93	41	12	10	15	7	8

B.3 TCTs NOT ENGAGED

Table 2 presents those TCTs not fired on and gives a breakdown of the reasons why the targets were not fired on. In many cases, the LAWS Mission Coordination: Fires table provides the reason for not firing the mission in the form of a three letter indicator displayed on a red or cyan Element Approval block (the TGT column). In some cases, the remarks or other data in the LAWS Viewing Fire Mission/Targeting Information window provided a plausible reason the target was not engaged. Below, these reasons have been divided into four classes:

1. Not a desirable target.
    a. Dumb target (DMB).
    b. Redundant target. Target already being processed (RUT).
    c. Not High Value. Does not meet attack guidance (NHV).
    d. Target killed (KILL).
2. Operational constraints.
    a. Effects not achieved. Weapon system not effective (ENA).
    b. Target in a no fire area (NFA).
    c. Route in conflict (RTE).
    d. Friendlies in area (FRD).
    e. Restricted fire area (RFA).
    f. High target speed (SPD).

g. The nominator defined the Not Later Than (NLT) time as equal to the acquisition time (N=A).

3. Denied (DEN) - These missions were denied for unspecified reasons. If more information were available they would probably fall into classes 1 or 2.
4. Deficiency of data, time or resources.
   a. Past intelligence cutoff time or additional target intelligence required (INT).
   b. Require mensuration data (MEN).
   c. No known reason for not engaging (?).

It is assumed the targets in this class 4 were not prosecuted due to a deficiency of time, target information or resources. As table 2 indicates, about half (57%) of the targets defined as not fired on fall into class 4. The corresponding figure for the GISRS-M nominator is 52%.

TABLE 2. FBE-F TCTS NOT FIRED ON

		#TARGETS	NOT DESIRABLE				OPERATIONAL CONSTRAINTS								LACK DATA		
NOMINATOR	# TARGETs	NOT FIRED ON	DMB	RUT	NHV	KILL	ENA	NFA	RTE	FRD	RFA	SPD	N=A	DEN	INT	MEN	?
1 CAV 2BDE	5	5															5
GISRS-M	72	44	4	3	4	1	1	1	2			3	2		7	3	13
JSWS	19	12				1			1						6		4
C5F LAWS	10	3		1													2
JFK LAWS	7	3		1											1		1
JYG LAWS	2	0															
DOCC LAWS	20	0															
PTW+	22	5			2				1					1			1
JSOTF	19	11		2	3					1	1				1	1	2
TOTALS	176	83	4	7	9	2	1	1	4	1	1	3	2	1	15	4	28
			TOTAL=22				TOTAL = 13							1	TOTAL = 47		

DMB = Dumb target

RUT = Redundant target. Target already being processed

NHV = Not high value. Does not meet attack guidance

KILL. Remarks in the Targeting Information window indicate the target has been killed.

ENA = Effects not achieved. Weapon system not effective

NFA = No fire area

RTE = Route in conflict

FRD = friendlies in area

RFA = restricted fire area

N = A. The LAWS Targeting information window gives target acquisition times and Not Later Than times that are identical

DEN. Target denied for no specified reason.

SPD. Remarks in the Targeting Information window report a high speed for the target

INT= Intelligence. Past intell cutoff date. Remarks indicate this flag is also used to indicate needing additional intel data.

MEN = Need mensuration data.

? The reason the target was not fired on was not indicated and is not obvious from the operator remarks.

B.4 TIMELINES

In principle, LAWS provides the data to create a timeline for each TCT mission. The LAWS Viewing Fire Mission/Targeting Information window has data fields for acquisition time and No Later Than (NLT) time. In addition, the LAWS Mission Timeline Report reports (ideally) and provides a time tag for a number of events in the process of prosecuting a TCT. These include: The time the target nomination was received at the LAWS server (At FSC), the time at which the fire when ready command was transmitted from LAWS to the fire direction system (the XMT When Ready event) and the receipt of a confirmation that the mission has been fired (the Fired Report event). Unfortunately, in many instances, one or more of these events and associated times are missing, or are in error, for missions that otherwise appear normal. Although the Mission Coordination: Fires lists contains 93 missions that have been defined as fired, the majority of these had insufficient data to construct a complete mission timeline.

Figure 1 presents a histogram of the interval from acquisition time until the nomination was received at the LAWS server for missions that were fired.

Figure 2 presents a histogram of the interval from receipt of the target nomination at the LAWS server until fire. To provide the fire time, the ideal would be to use the Fired Report time from the firing unit. However this time was lacking or in error (particularly for MLRS firers) in the majority of cases. Consequently, the time of the XMT When Ready event was often adopted as the fire time.

Figure 3 presents the interval from acquisition to fire. The times in **Figure 3** under represent the time for a projectile to reach the target because many use the XMT When Ready event time to represent the fire event time, and they do not include the projectile time of flight to the target.

Figures 1A, 2A and **3A** are the same plots as the corresponding plots described above except they are limited to the targets developed by the GISRS-M nominator for which the data are generally more complete and reliable. **Table 3** below summarizes the timeline data.

TABLE 3. TIMELINE DATA

FIGURE	# ENTRIES	MEDIAN TIME (MIN)
Acq-LAWS Interval (Fig. 1)	46	28
Acq-LAWS Interval GISRS-M (Fig. 1A)	27	18
LAWS-Fire Interval (Fig. 2)	61	33
LAWS-Fire Interval GISRS-M (Fig. 2A)	15	16
Acq-Fire Interval (Fig. 3)	28	119.5
Acq-Fire Interval GISRS-M (Fig. 3A)	15	75

FIGURE 1. ACQUISITION TO LAWS INTERVAL

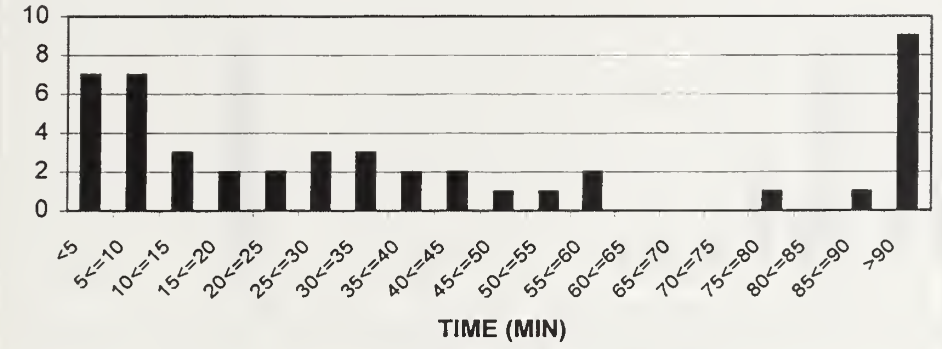
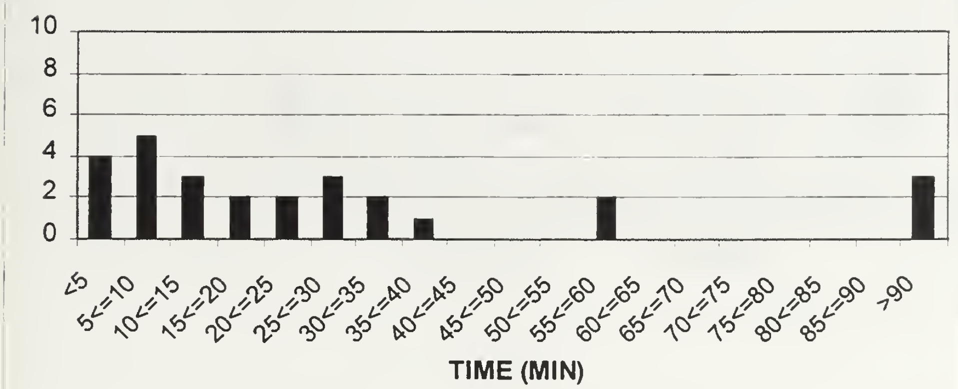


FIGURE 1A . ACQUISITION TO LAWS INTERVAL
GSIRS-M NOMINATOR



Figures 1 and 1A present the intervals between the sensor acquisition time and the time the target was received at LAWS. Figure 1 includes data for all nominators. Figure 1A includes data only for the GSIRS-M nominator.

FIGURE 2. LAWS TO FIRE INTERVAL

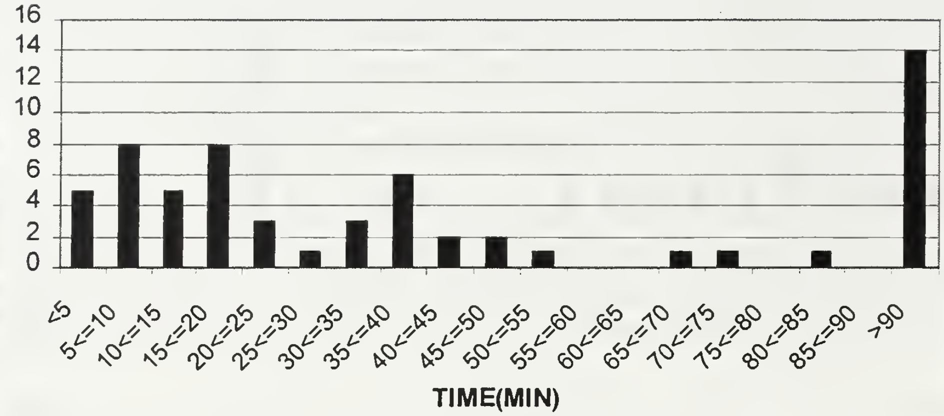
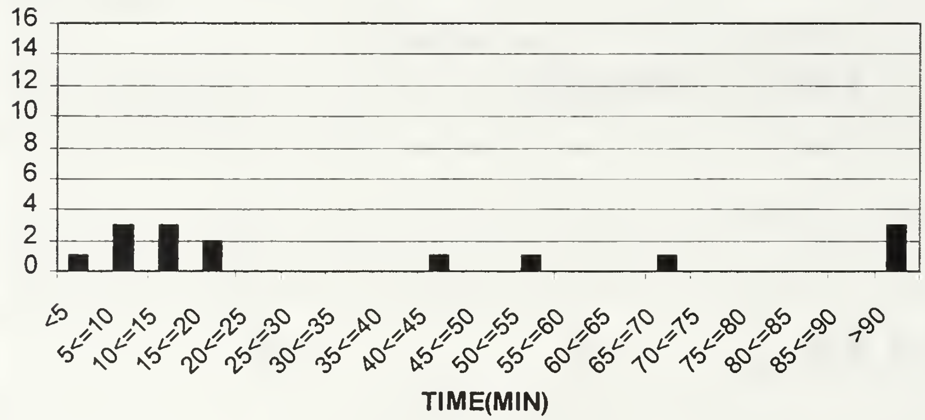


FIGURE 2A. LAWS TO FIRE INTERVAL
GISRS-M NOMINATOR



Figures 2 and 2A present the intervals between the time the target was received at LAWS and the time the Fired Report event was received at LAWS from the firer. When there was no Fired report Event, the time the fire when ready command was transmitted to the firer was used in place of the Fired Report time. Figure 2 includes data for all nominators. Figure 2 A includes data only for the GSIRS-M nominator.

FIGURE 3. ACQUISITION TO FIRE INTERVAL

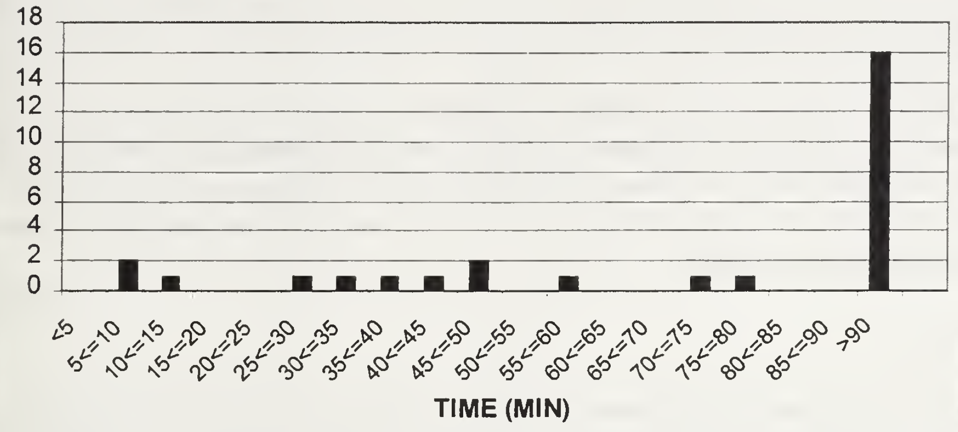
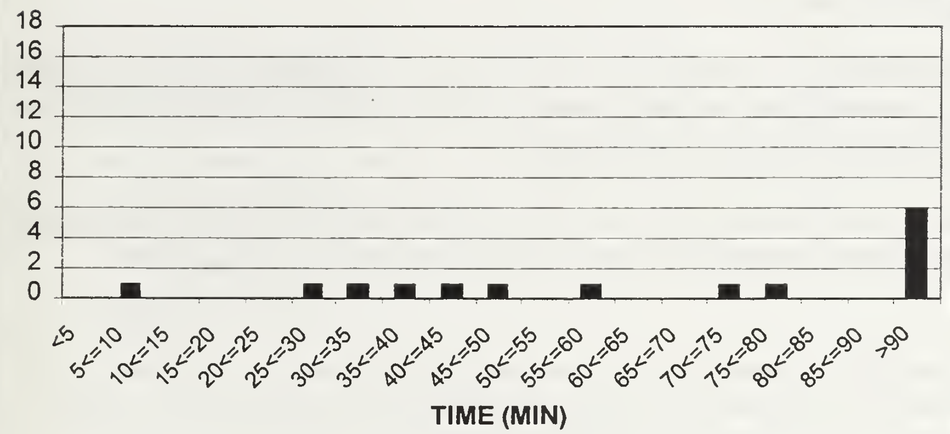


FIGURE 3A . ACQUISITION TO FIRE INTERVAL
GSIRS-M NOMINATOR



Figures 3 and 3A present the intervals between the sensor acquisition time and the time the Fired Report event was received at LAWS from the firer. When there was no Fired report Event, the time the fire when ready command was transmitted to the firer was used in place of the Fired Report time. The reported times represent lower limits to the engagement times for TCTs because of these missing Fired Report times and because weapon time of flight is not included. Figure 3 includes data for all nominators. Figure 3A includes data only for the GSIRS-M nominator.

B.5 NOT LATER THAN TIME (NLT)

The success of an engagement against a TCT must be judged, in large part, on whether the target was engaged within the specified target dwell time. There were 23 missions that were fired and for which an NLT time was specified. For those 23 missions, only in one case was the mission fired within the target dwell time, in 18 cases it was not. In four cases there are insufficient data to determine if the time constraint was met.

B.6 TCT THREADS

Tables 4 through **8** present the sensor to engagement threads for time critical targets for each target nominator. These data apply to the 93 missions previously defined as fired. The target type, acquiring sensor and munition fired data were collected from the LAWS Viewing Fire Mission/Targeting Information window. The primary points to be made regarding these data are:

1. There does not appear to be much relation between these experimentally observed threads and the 16 TCT threads defined in the Fleet Battle Experiment Foxtrot Fires and Precision Engagement Roadmap (section 19).

2. The LAWS data lack specificity. One sensor is defined as ELINT but which type of platform mounted the sensor is unidentified. Another "sensor" is Photo Interpretation (PI) but there is no indication what the original source of the image was.

3. The Engagement thread data reported by the LAWS nominators (C5F, JFK, JYG and DOCC) was incomplete. In particular, in almost no case was the acquiring sensor specified.

4. The LAWS operator and/or nominators do not use standard terminology. For example, in a number of cases target type is referred to as SSM. The remarks indicate this target type is used to apply to ballistic missiles, cruise missiles and surface to air missiles.

TABLE 4. SENSOR TO ENGAGEMENT THREAD FOR THE GISRS-M NOMINATOR

SENSOR	RPV						ELINT						PI					
WEAPON	TTLAM	MLRS	LASM	ERGM	TACAIR	?	TTLAM	MLRS	LASM	ERGM	TACAIR	?	TTLAM	MLRS	LASM	ERGM	TACAIR	?
TARGET																		
SAM	1	3	1			2			1			1						
CM						1								1				
BM	1	1																
M	1	1										1		1				
AAA																		
PTG	3			1	3													
ATT BOAT																		
SUB					1													
ACFT			1															
RADAR							1							1				
ANTENNA																		
BLDG																		
AMMO DP																		
?																		
TOTALS	6	5	2	1	4	3	1		1			2		3				

SAM = Surface to Air Missile
CM = Cruise Missile position
BM = Ballistic Missile position
M = Missile position
AAA = Air Defense Artillery position
PTG = Patrol Boat, missile
ATT Boat = Fast attack boat
ACFT = aircraft
AMMO DP = Ammo dump
? = unknown

PI = Photo Interpretation

TABLE 5. SENSOR TO ENGAGEMENT THREAD FOR THE PTW NOMINATOR

SENSOR	RPV						ELINT						PI					
WEAPON	TTLAM	MLRS	LASM	ERGM	TACAIR	?	TTLAM	MLRS	LASM	ERGM	TACAIR	?	TTLAM	MLRS	LASM	ERGM	TACAIR	?
TARGET																		
SAM													2		1			
CM																		
BM																		
M														2				
AAA																		
PTG		3									1			1	2		1	
ATT BOAT																		
SUB																		
ACFT																		
RADAR														2	1			
ANTENNA																		
BLDG													1					
AMMO DP																		
?																		
TOTALS		3									1		3	5	4		1	

SAM = Surface to Air Missile
CM = Cruise Missile position
BM = Ballistic Missile position
M = Missile position
AAA = Air Defense Artillery position
PTG = Patrol Boat, missile
ATT Boat = Fast attack boat
ACFT = aircraft
AMMO DP = Ammo dump
? = unknown

PI = Photo Interpretation

TABLE 6. SENSOR TO ENGAGEMENT THREAD FOR THE JSWS NOMINATOR

SENSOR			SLAR			
WEAPON	TTLAM	MLRS	LASM	ERGM	TACAIR	?
TARGET						
SAM		3				
CM						
BM						
M			1			
AAA				1		
PTG						
ATT BOAT						
SUB						
ACFT		1				
RADAR		1				
ANTENNA						
BLDG						
AMMO DP						
?						
TOTALS		5	1	1		

SAM = Surface to Air Missile
CM = Cruise Missile position
BM = Ballistic Missile position
M = Missile position
AAA = Air Defense Artillery position
PTG = Patrol Boat, missile
ATT Boat = Fast attack boat
ACFT = Aircraft
AMMO DP = Ammo dump
SLAR = Side Looking Airborne Radar
? = unknown

TABLE 7. SENSOR TO ENGAGEMENT THREAD FOR THE JSOTF NOMINATOR

SENSOR	SEAL SR						SOF TM					
WEAPON	TTLAM	MLRS	LASM	ERGM	TACAIR	?	TTLAM	MLRS	LASM	ERGM	TACAIR	?
TARGET												
SAM	1				1							
CM			1						3			
BM												
M												
AAA			1				1					
PTG												
ATT BOAT												
SUB												
ACFT												
RADAR												
ANTENNA												
BLDG												
AMMO DP												
?												
TOTALS	1		2		1		1		3			

SAM = Surface to Air Missile
CM = Cruise Missile position
BM = Ballistic Missile position
M = Missile position
AAA = Air Defense Artillery position
PTG = Patrol Boat, missile
ATT Boat = Fast attack boat
ACFT=Aircraft
AMMO DP = Ammo dump
? = unknown

TABLE 8. SENSOR TO ENGAGEMENT THREAD FOR THE LAWS NOMINATORS

SENSOR:	UNKNOWN					
WEAPON	TTLAM	MLRS	LASM	ERGM	TACAIR	?
TARGET						
SAM		3		2		
CM				2		
BM						
M		4				1
AAA						
PTG						
ATT BOAT			1	1		
SUB						
ACFT				1		
RADAR		7				
ANTENNA		2				
BLDG		2		1		1
AMMO DP		1				1
?			1	2		
TOTALS		19	2	9		3

LAWS nominators include:C5F LAWS, JFK LAWS,
JYG LAWS and DOCC LAWS.

In almost all cases the acquiring sensor was not specified.

SAM = Surface to Air Missile
CM = Cruise Missile position
BM = Ballistic Missile position
M = Missile position
AAA = Air Defense Artillery position
PTG = Patrol Boat, missile
ATT Boat = Fast attack boat
ACFT = Aircraft
AMMO DP = Ammo dump
? = Unknown

B.7 DATA CAPTURE RECOMMENDATIONS

This analysis was entirely dependent on the data collected through LAWS. LAWS has the potential for providing detailed quantitative data, particularly in the development of time lines of the events in the process of prosecuting TCTs. However, in practice the data have been found to be rather incomplete. It is understood that the data collection potential of LAWS depends on a combination of operator training and software modifications to LAWS and/or the simulations with which it interacts. Listed below are some specific issues.

1. Some Mission Timeline reports lacked XMT When Ready events. This could occur even when, in the Mission Coordination: Fires table, the Fire Mission Status block (WRD) was yellow or green. When the WRD block is yellow or green there should be a transmit fire command event in the timeline.

2. Some missions that were presumably fired, lacked a Fired Report event. This, at least in some cases, is a result of the fact the firings are simulated and often the firers are simulated. This problem may be addressable by having a more responsive simulation.

3. For many MLRS missions, the Fired Report times as reported in the timelines were in error, being days or many hours after the XMT When Ready event. A large number of these erroneous Fired Reports had times within a few seconds of 7 Dec 13:48 (local time).

4. Many missions had no acquisition time reported in the Viewing Fire Mission/Targeting Information window. The nominator/LAWS operator must enter the acquisition time.

5. Most missions did not have a NLT time reported in the Viewing Fire Mission/Targeting Information window. The nominator/LAWS operator must enter the NLT time.

6. Many targets nominated by the CF5 LAWS nominator contained the word "test" in the target description. These targets were excluded from the above analysis. It is suspected that there are other test cases that were not so indicated. Operators need to ensure that all targets that represent practice events are clearly distinguished from those that relate to the MSEL events.

7. It would be helpful to expand the event data reported in the Mission Timeline report to routinely include other event data, e.g., acquisition time, expected time to engage, receipt of mensuration data, and receipt of route data.

8. The target priority specified in the LAWS Mission Coordination: Fires table bears no relation to the target priorities in the Attack Guidance Matrix. A uniform definition of priority should be established.

9. In only two of the seven cases where a target was denied because it was redundant (RUT) was the target it was redundant with identified. The operator should always specify the redundant target.

10. There are cases where TGT is not green (e.g. GS0070 = reviewed blue, GS2127 = denied RUT, PT0214 = red) but FRD is green. It is presumed these are cases where the LAWS

operator chose to override the review or denial. It would seem less confusing if the fire override automatically changed TGT to green.

11. There are cases where there is no denied or reviewed condition exhibited in the Mission Coordination: Fires table, but in the Viewing Fire Mission window, the Reason field, which displays the reason for a denial, contains a value (e.g. LE0034, Not High Value; JS0108, Intelligence). This appears to be an inconsistency.

12. There are a several cases where the mission was fired but the LAWS data contain no information on the identity of the firer. It is understood that for MLRS missions the specific fire unit and munition are specified by AFATDS and it is not known to LAWS, but in the FBE-F Mission Coordination: Fires table many MLRS missions do have firer and munition data. The operator should at least specify the mission is MLRS.

13. Most of the JSOTF nominated targets had acquisition times entered only as hr:min. Operators should specify all times in dd:hh:mm .

14. All times should be expressed in the same reference frame. At present, the acquisition and NLT times are reported in the Viewing Fire Mission/Targeting Information window in Zulu time. The Mission Timeline report gives event times in local time.

15. The nominators/LAWS operators need to be more specific with regard to the sensors acquiring a target. ELINT and PI are too generic, at least the platform type that the acquiring sensor is mounted on should also be identified.

16. The nominators/LAWS operators need to develop a standard terminology for the LAWS data fields. In particular, target type and acquiring source.