Operational Thread Development

A Structured Approach to Capability Analysis

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Abstract

This paper will introduce the *Operational Thread Development (OTD)* methodology for analyzing warfighting capability and assessing the contribution of potential solutions to filling identified capability deficiencies. The concept of *effects-driven*, *capabilities-based* planning and analysis has dominated the military force structure planning and acquisition cycles in recent years. Recently revised documents such as CJCSI 3170.01E, Joint Capabilities and Development System require a rigorous approach to analyzing potential solutions to warfighting capability deficiencies. However, attempting to implement this guidance in a large-scale field experiment has proven challenging.

OTD is a new, structured approach to planning, designing, and analyzing a large-scale field experiment that supports the capabilities-based construct. Specifically, this paper will describe the **framework** for capability analysis that was used for planning Joint Expeditionary Force Experiment 2006 (JEFX 06); a **process** for developing, executing, and analyzing operational threads; and a **web-based toolset** that supports this approach.

Background

JEFX 06 was the sixth in a series of large-scale Air Force experiments designed to assist the US Air Force prepare for the challenges of 21st Century Expeditionary Air and Space Force operations. To that end, the experiment attempted to anticipate and model a future command and control system, based on capabilities in the Space and Command, Control, Communications, and Computer, Intelligence, Surveillance, and Reconnaissance Concept of Operations (S&C4ISR CONOPS). Specifically, this experiment addressed four broad capability goals:

- **Continuous Theater Air Planning and Dynamic Execution (CAPE)**: Conduct continuous theater air planning. Provide near-real-time Situational Awareness (SA) using data links. Assess the effects of kinetic and non-kinetic actions and conduct dynamic execution.
- **Fusion for the Air and Space Operations Center (AOC)**: Given adequate preparation of the battlespace, fuse data and information from multiple sources and cross-security boundaries to rapidly achieve and maintain battlespace awareness supporting both kinetic and non-kinetic effects.
- **ConstellationNet (CN)**: Command, control, defend, and manage an integrated air, space, and terrestrial network to include airborne Internet Protocol (IP) networks. Enable near-real-time Joint Blue Force SA and Combat Identification for airborne and mobile ground forces operating in hostile territory.
- **Homeland Security / Homeland Defense (HLS/HLD)**: Collect, fuse, and disseminate information in coordination with joint and federal agencies in support of HLS/HLD Operations. Integrate Agile Combat Support (ACS) Expeditionary Site Planning.

As the managers of JEFX, the Air Force Experimentation Office (AFEO) brought together operators, engineers and software developers to generate new technology and develop processes that would improve operational-level warfighting capability across the four capability goals. During the initial planning, these capability goals were further focused by the experiment planners into specific capability deficiencies that included Measures of Success (MOS) to characterize progress in achieving the capability goals. In addition, AFEO employed an incremental development approach that included three preliminary "spiral" events as precursors during the months prior to the main experiment. The task for the analysis team was to develop a plan for assessing the contribution of new technology, processes, and organizational structures to these capability areas.

Analysis Framework

The concept of developing "threads" to supporting Air Force experimentation originated during JEFX 2004. During that experiment, the Army Close Air Support and Situational Awareness (ACASSA) initiative was developed around two "seams" and five supporting threads. The seams were analogous to capability deficiencies, and the threads identified unique solutions to close those seams. Ultimately, the Air Force Command and Control and Intelligence, Surveillance, and Reconnaissance Center (AFC2ISRC) AFEO leadership endorsed this model as a basis for the planning of JEFX 06. The benefit of such an approach was generally recognized, although there was some confusion regarding terminology, especially for those not involved in the daily planning of the ACASSA threads.

Terminology

Based on the ACASSA model, and as a result of leadership guidance, the AFEO Analysis and Assessment Branch led an effort to develop a complete and consistent framework for Operational Thread Development (OTD). The OTD framework included a standard terminology (Appendix 1). We recognized early that simply having a glossary of terms and common understanding was insufficient for developing a framework, process and web-based toolset that would eventually facilitate the large-scale analysis planning that typically precedes experimentation. As such, we referenced terms from joint and service doctrine and also developed a taxonomy of terms describing logical relationships among them, as depicted in Figure 1.

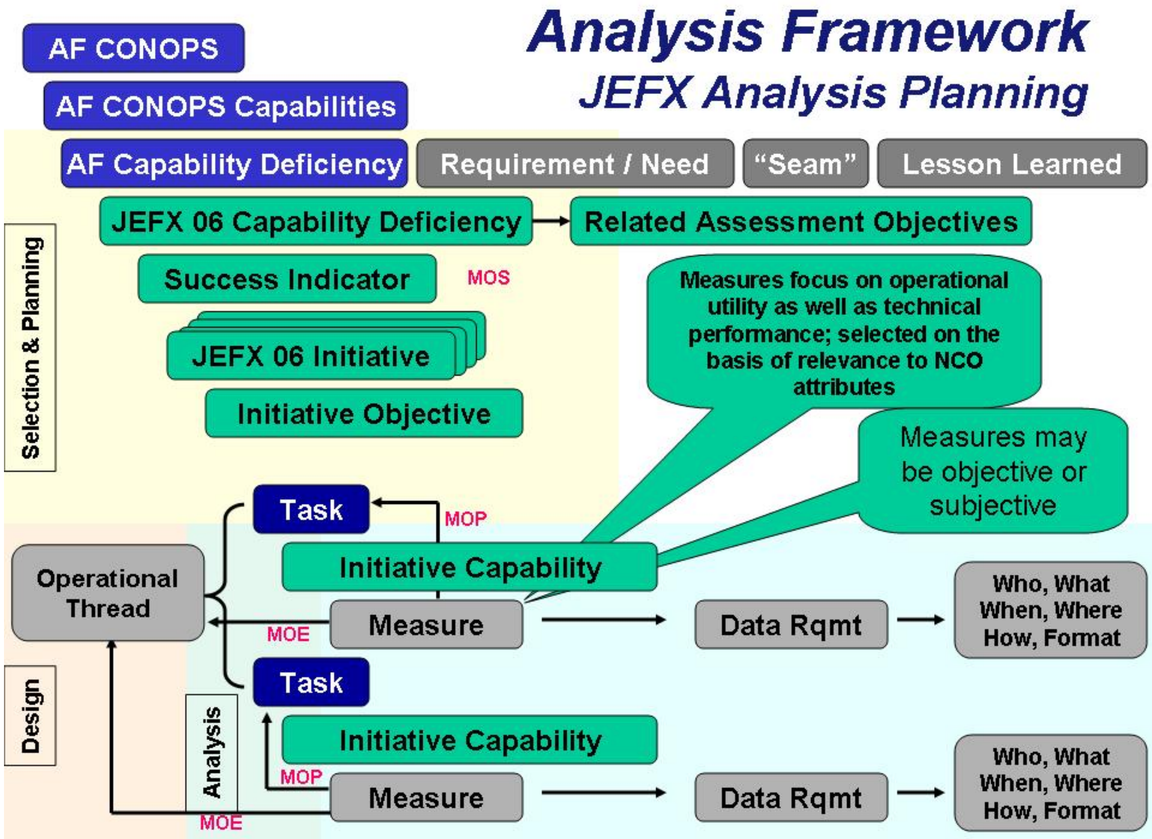

Figure 1—Analysis Planning Framework

Capability-Based Approach

In addition to standardizing terminology, we also found it necessary to revise our previous planning efforts to reflect a capabilities-based approach to experimentation. The basic challenge for the core analysis team was to develop an approach that would allow for a rigorous examination of warfighting capability, despite the fact that the very term "capability" was often mis-used or misunderstood. In fact, our basic premise was that a capability could not be directly observed and measured.

Because a capability cannot be directly observed and measured, each capability deficiency can be examined through the use of an "operational thread"—an important component to the overall operational assessment conducted during JEFX 06. An operational thread is a series of related operational tasks that are specifically focused to highlight the contribution of experimental initiatives or infrastructure systems to an Air and Space Operations Center (AOC) or other basic Command and Control (C2) process. An operational thread is a design feature of the experiment, allowing experiment planners to influence player activity in desired areas. These threads generally have a well-defined beginning and end, and are often executed within a single period during the experiment. Operational threads are typically stimulated by scenario events from the Master Scenario Event List (MSEL) but they may involve a significant degree of "free play" by the players.

The JEFX 06 operational threads were defined and prioritized prior to the second and third spiral events, based on a complete understanding of the chosen scenario, capability deficiencies, experiment initiatives, and underlying infrastructure. Specific scenario events were developed based on the identified operational threads. During previous experiments that did not consistently employ operational threads, MSELs were often associated with experiment initiatives without a clear indication of the desired outcome. Operational threads were scheduled in advance, to the extent possible, and related directly to daily experiment objectives. Developing experiment objectives and operational threads *prior* to spiral events ensures that assessment and experiment objectives **drive** experiment design and control.

A good example of an operational thread is Time Critical Targeting (TCT). There are specific events within a scenario that will *force* this thread to occur, and there may be several initiatives that contribute to each segment of the "kill chain" (Find, Fix, Track, Target, Engage, and Assess). The contribution of experimental initiatives to each kill chain activity may be measured in terms of timeliness, accuracy, completeness, or any other relevant Measure of Performance (MOP). Likewise, there may be overall Measures of Effectiveness (MOE) for this operational thread. For the TCT thread, the most significant measure may be overall time from finding a target, to engagement, and to assessment of combat effects.

Dr. Richard Kass, in his paper "Understanding Joint Warfighting Experiments: The Logic of Warfighting Experimentation," argues that experimentation is uniquely suited to capability development, provided that some basic requirements are met during the experiment design phase. Specifically, Dr. Kass outlines the relative merits of four types of experiment: Analytic Wargame, Constructive, Human-in-the-Loop, and Field. Large-scale, high-fidelity field experiments such as JEFX are best suited to relating results to operations. However, due to the large number of uncontrolled variables in such an environment, it has typically been difficult to isolate and examine a single variable—such as the contribution of a new technology or process. We believe that OTD has the potential for improving the utility of the results of field experimentation by helping to identify variables, ensuring that players and controllers are fully aware of analytic objectives for the experiment, and providing a context for relating the results to "real-world" operations.

Thread Development Process

Capability Development Teams

This experiment included the use of a new organizational construct for planning, managing, and controlling the experiment. The four Capability Development Teams (CDTs) were given responsibility for achieving each of the four Capability Goals—CAPE, Fusion for the AOC, CN, and HLS/HLD. The leadership of these teams played a significant role in developing the operational threads. Each CDT also designated Operational Thread Managers (OTMs)—one for each operational thread assigned to the CDT—who led the development of the operational threads. The OTM was also often the lead assessor for experiment initiatives highlighted within the context of their respective operational threads.

AFEO proposed a phased process for developing operational threads during the initial presentation of this concept to the CDTs. At that time, there was little feedback or discussion regarding this proposal. Over time, it became apparent that an incremental approach to accomplishing this complex task was required. As the managers of this process, AFEO staff was consistently trying to stay one step ahead of those who were doing the work. The basic phased approach is depicted in Figure 2.

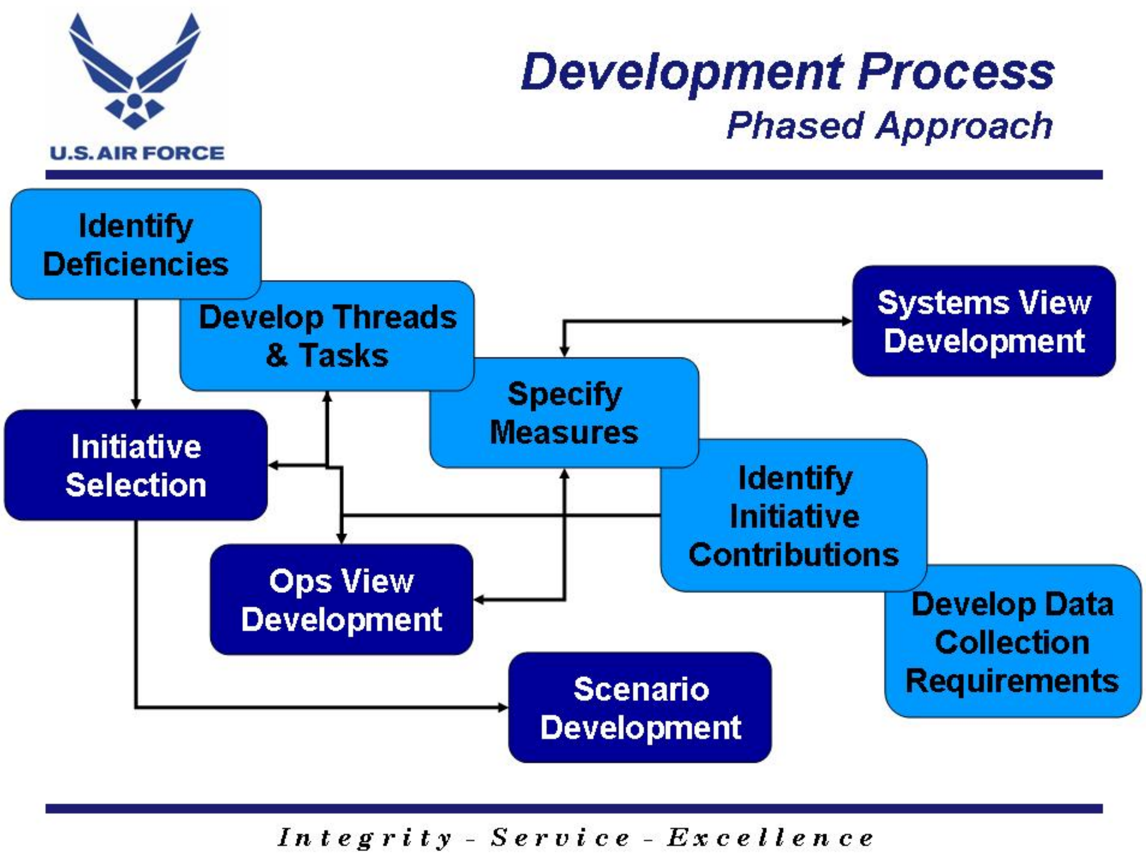

Figure 2—Phased Approach

The primary 5 phases are indicated in the center of this figure, and related activities are shown as well. The spiral development approach for JEFX allowed the assessment teams to manage the workload across several events, while constantly improving upon experiment design.

Phase 1, deficiency identification, was the primary focus of the Concept Development Conference (CDC), held in November, 2004. Some of this work had already been accomplished prior to the conference, leaving time at the CDC to focus on further defining the specific deficiencies and Measures of Success.

Capability Deficiency Identification

During the CDC, the four JEFX capability goals were further refined by the CDTs into 13 specific capability deficiencies that would be the primary focus of this experiment:

- CAPE Deficiencies
    - Continuous theater air planning
    - Enhanced situational awareness
    - Effects assessment

    - Dynamic execution
- Fusion for the AOC Deficiencies
    - Multi-Intelligence (INT) fusion for the kill chain
    - CAOC-Distributed Common Ground System (DCGS) integration
    - Multi-INT fusion for predictive analysis
- CN Deficiencies
    - Inadequate enabling of Command and Control (C2)
    - Inadequate enabling of defensive measures
    - Inadequate enabling of Joint Blue Force SA and Combat ID
- HLS/HLD Deficiencies
    - Counter Sea
    - CONUS Counter Air
    - Defense support to civil authorities – emergency response

After the CDC, deficiency-specific information was entered into the newly developed operational thread toolset. This additional information specified related Operational Requirements Document (ORD) or Capability Development Document (CDD) defined requirements. Deficiency identification was the fundamental first step, and is critical to all phases that follow. During the formal JEFX initiative selection process, four primary criteria were considered: relevance to defined capability deficiencies, potential for operational utility, technical maturity, and total cost. Immediately following deficiency identification and the initiative selection process, the CDTs began developing operational threads and defining the tasks that comprise each thread.

Thread Identification and Task Development

The idea that operational threads should or could be integrated in some way posed a conceptual challenge at this point in the experiment design process. Originally, the framework had not been designed to account for such a relationship, but we soon realized the importance of adapting to accommodate this requirement. The initial target for JEFX 06 was to have between 15 and 20 operational threads. Once we began to develop the threads, however, some participants questioned the rationale for having any more than a *single* operational thread. Ultimately, we selected an existing framework based on joint doctrine to provide a means of identifying the relationship among the operational threads. This framework allowed us to avoid having a single thread—which would have been difficult to manage—while providing an integrating framework that clarified the relationship among the various threads. The framework we chose is the Air Tasking Cycle, found in Joint Publication 3-30, Command and Control for Joint Air Operations, and depicted in Figure 3.

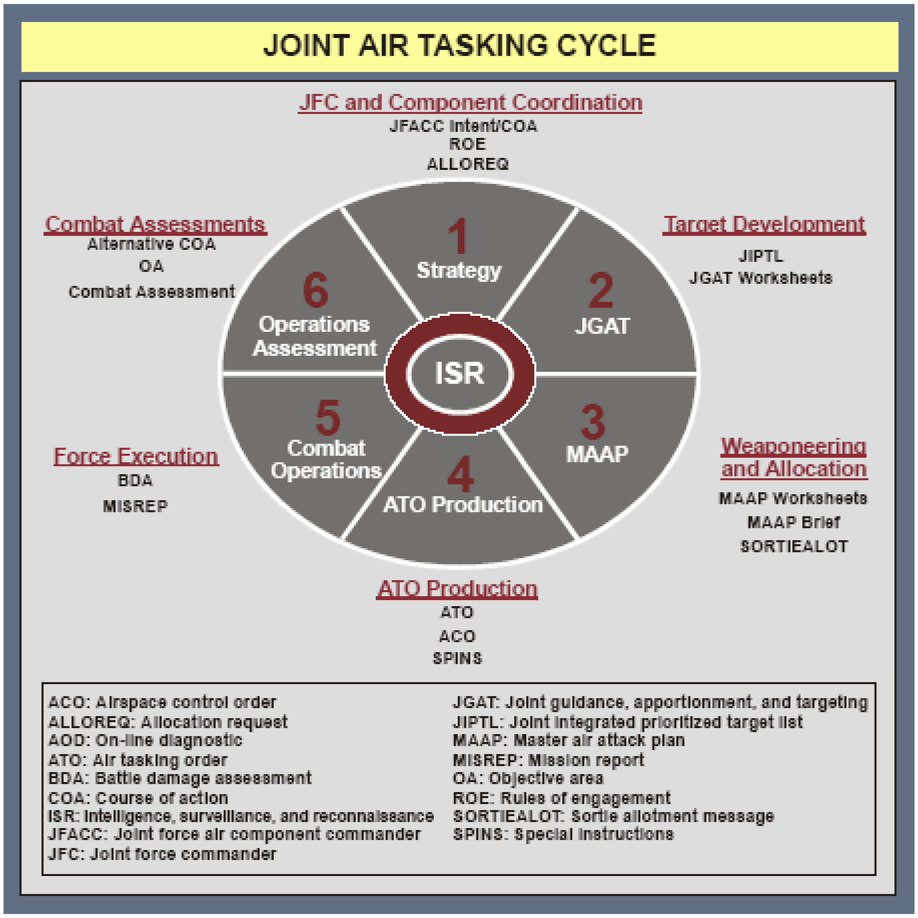

Figure 3—Joint Air Tasking Cycle

The CDT effort eventually resulted in 22 operational threads for JEFX 06:

- Joint Air Estimate Process (JAEP)
- Force Application
- Build Master Air Attack Plan (MAAP)
- Air Tasking Order (ATO) Production
- Base Infrastructure
- Enhance C2 SA with Non-Traditional Intelligence, Surveillance and Reconnaissance (NTISR)
- Prosecute NTISR
- Operational Assessment
- Tactical Synchronization
- Monitor the Common Operational Picture
- Special Operations Forces (SOF) Planning & Execution
- Prosecute TST

- Check weather (WX) for dynamic target
- IP platform requests WX
- Near Space Radio Net Utilization
- Combat Assessments
- Manage the Constellation Net
- Improve CN Defense
- Maritime Threat (Lead Federal Agency)
- Joint Blue Force Situational Awareness
- Air Mobility Division (AMD) Distributed Operations
- Phase IV Transition Planning

By selecting a framework based on joint doctrine and used by the warfighting community, it was much easier to communicate the analysis objectives to the rest of the experiment enterprise—including players, controllers, engineers, and leadership—and gain support for those objectives.

Once the CDTs and operational thread managers had defined the threads and tasks, the next phase was to develop Measures of Effectiveness (MOE) for the operational threads and Measures of Performance (MOP) for each task.

Measures Development

Developing measures proved to be the most difficult task for the team. A majority of the AIPT—and many of the individual CDT members—were recruited for specific subject matter expertise, but were not necessarily trained analysts. In order to facilitate the task of developing useful, relevant metrics, the AFEO core team of analysts chose the Network-Centric Operations (NCO) Conceptual Framework (Version 2) as a source document for developing measures. This document includes an annex of metrics that are related to many of the operational activities under examination in this experiment. This document was also useful since NCO was an underlying theme for JEFX 06.

Training the analysis team on the approach to developing operational threads and the use of the toolset was critical to the success of this endeavor. Throughout the process, the AFEO core team would provide training that was relevant to the particular phase of thread development that most teams were involved in. During the development of measures, the AFEO core team assisted each CDT in developing assessment plans that outlined the thread MOE and described the contribution of initiatives using MOP for each thread task. We also gained support from a separate team within the AFC2ISRC that was familiar with the theory of net-centric warfare and the concept for developing net-centric systems and processes.

The measures that were developed during this phase formed the basis for the most tedious phase of operational thread development—definition of data collection requirements.

Data Collection Requirements

As deficiency identification is critical and measure development is the most difficult phase of OTD, the development of a single, integrated list of Data Collection Requirements (DCRs) is the most tedious and coordination-intensive phase. The DCRs provided the "who, what, when, where, and how" planning details for obtaining the data necessary to compute the analysis measures. Development of DCRs served several purposes. First, development of a shared set of collection requirements prevented duplication of effort. This shared view of the DCRs was possible primarily through the use of a web-based toolset. In addition, detailed DCRs provided a tremendous coordination tool to distribute collection activities among a limited number of data collectors. Data collection activities were synchronized with the schedule for execution of the operational threads. Finally, the data collection requirements for large-scale experiments were historically fragmented, and not well-connected to the overall experiment objectives. The analysis approach employed for this experiment, and the supporting toolset that was developed to capture related information, provided a framework for the analysis team to document all of the required data.

For this experiment, the Joint Fires Interoperability and Integration Team (JFIIT)—a sub-organization of Joint Forces Command (JFCOM) J-8—led the data collection effort. The operational thread construct and supporting toolset provided a valuable method for communicating analysis objectives to the data collectors, as well as for establishing specific data collection requirements.

During the experiment planning phase, and also during the execution of spiral events, the JFIIT team met with each CDT and operational thread manager to refine the measures and associated data collection requirements. This interaction was critical to achieving a common understanding among analysts and data collectors. In addition, having three separate spiral events prior to the main experiment allowed the assessment team to continually refine tools and processes in preparation for the final event.

Thread Execution

During Spiral 2 for JEFX, the assessment team had the first opportunity to see the operational threads executed and refine the data collection process. A daily battle rhythm emerged that included a daily review of objectives, specification of the "threads of the day," data collection activity, and end of day review and analysis. In addition, several ideas were generated for improving the toolset, and several new features were implemented prior to the next spiral event.

Web-Based Toolset

The development of a web-based toolset that was incorporated into the existing experiment management system greatly improved operational thread development. This toolset was developed in conjunction with the conceptual framework for operational threads and, as a result, supports that framework.

Toolset Development

The OTD system was designed around a Microsoft Structured Query Language (SQL) Server 2000 back end and web-enabled front end with Microsoft Internet Information Server as the host.

The toolset uses Active Server Pages (ASP), Hypertext Markup Language (HTML), and JavaScript.

Prototype toolset development began in June 2005 using the Rapid Application Design Methodology (RAD). To the extent possible, requirements were gathered based on all information available at that time. This prototype and the RAD development methodology served to point out initial flaws in the OTD process, but were eventually determined to be unworkable.

The next toolset build used an alternative approach known as the Agile methodology. Based on the extensive changes to data relationships and an evolving OTD process, we believed this approach would yield improved results. The Manifesto for Agile Software Development describes the following tenets:

- **Individuals and interactions** over processes and tools
- **Working software** over comprehensive documentation
- **Customer collaboration** over contract negotiation
- **Responding to change** over following a plan

This methodology worked out much better and over the life of the project has afforded far more flexibility in building the toolset to support the OTD process that was being concurrently developed.

The lack of incremental testing opportunities was a critical challenge in the development of this toolset. Because users of the toolset were investing significant time in populating the database with thread information, we were seldom able to conduct preferred levels of toolset testing before fielding new increments. Over time, the users became dependent on the toolset and, therefore, any system problems could have negatively affected the ongoing OTD process.

Spiral 2 was the first extensive field test of the usefulness of the OTD toolset. The system worked without any major problems. Most fixes were made immediately and no OTD toolset work stoppages were encountered. After this event, as the OTD process continued to progress, new functionality was added to the toolset and testing continued during Spiral 3.

In preparation for the main experiment, the remaining required features of the toolset are being implemented. By providing assessment results pertinent to capability deficiencies and experiment initiatives, this new functionality will assist lead assessors in creating the experiment final report.

Toolset Security

The OTD system was developed within the security framework of the existing AFEO Webtools Portal so all user information and privileges are handled by the security functionality of the Portal. Only one new security group was created to support the OTD toolset: the Thread Administrators Group.

Security Roles:

- Thread Administrators: have overall privileges throughout the entire OTD toolset.

- Operational Thread Managers (OTMs): have full control over only the threads they have been assigned to as an OTM. OTMs can create and edit all required objects (e.g.; MOE, tasks, MOP) and provide assessments of the measures
- Thread Editors: have the same privileges as OTMs, except they cannot provide assessments of measures

Portal users with Assessor privileges can view all OTD information and provide comments for later assessment. All Portal users with general access can view the basic OTD data, although they have no access to assessment information.

Figure 4 depicts the basic relationship among the following database entities:

Threads: Operational threads, as described in this paper.

Tasks: The basic component of an operational thread.

Measures of Effectiveness (MOE): Characterize the overall effectiveness of a thread.

Deficiencies: Capability deficiencies, as described in the Analysis Framework.

Measures of Performance MOP): Characterize the performance of a single task.

Initiatives: New technology, processes, or organizational structures that contribute to a capability deficiency.

Data Collection Requirement (DCR): The information that must be collected in order to compute an MOP.

Additional information regarding the structure of the toolset is found in Appendix 3.

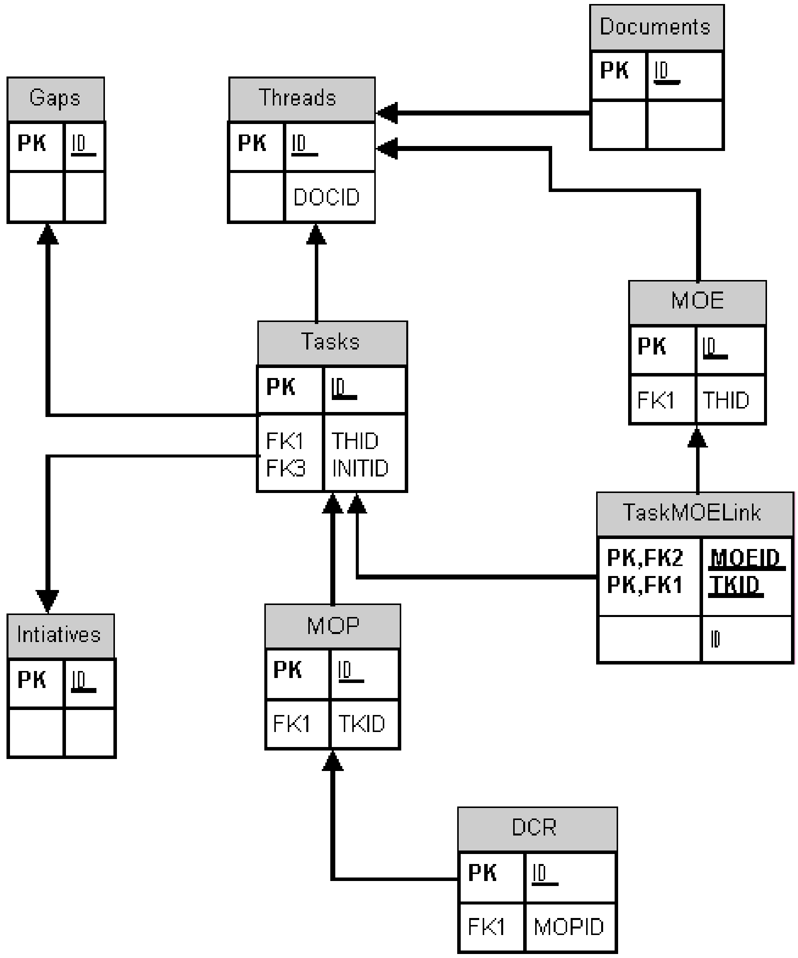

Figure 4—Basic Database Layout

Challenges

During the development of this toolset, we encountered and overcame many challenges:

- Overcoming resistance to change among those who had been involved in experimentation for many years
- Accommodating re-definition of key terms and relationships, based on new insights during the planning process
- Balancing the desire to add new functionality with the goal of keeping the toolset as intuitive and "user-friendly" as possible
- Accommodating the requirements of a large user base
- Understanding a process that was in development, and developing software to support that emerging process
- Keeping the requirements within reach of what could be accomplished in the time given

Successfully overcoming these challenges was the result of having a developer onsite that is familiar with experimentation. Based on daily coordination between the developer and the users of the OTD process, we were able to realize many benefits of having such a tool.

Benefits

The benefits of using a web-based toolset were numerous:

- Insight into the progress of thread development
- A single source for operational thread information, with no version control confusion
- Accessibility of information via a web browser and internet connection
- Linkage of all planning details, in context of the analysis framework
- Linkage of all results, in context of the analysis and reporting framework
- Forced adherence to the model—something spreadsheets do not
- Shared view among entire experiment enterprise

Finally, there are several enhancements that we would like to incorporate for the next major experiment.

Future Enhancements

- Development of a thick client version
- Further development of the reporting functionality

A depiction of the front page of the toolset is shown in Figure 5.

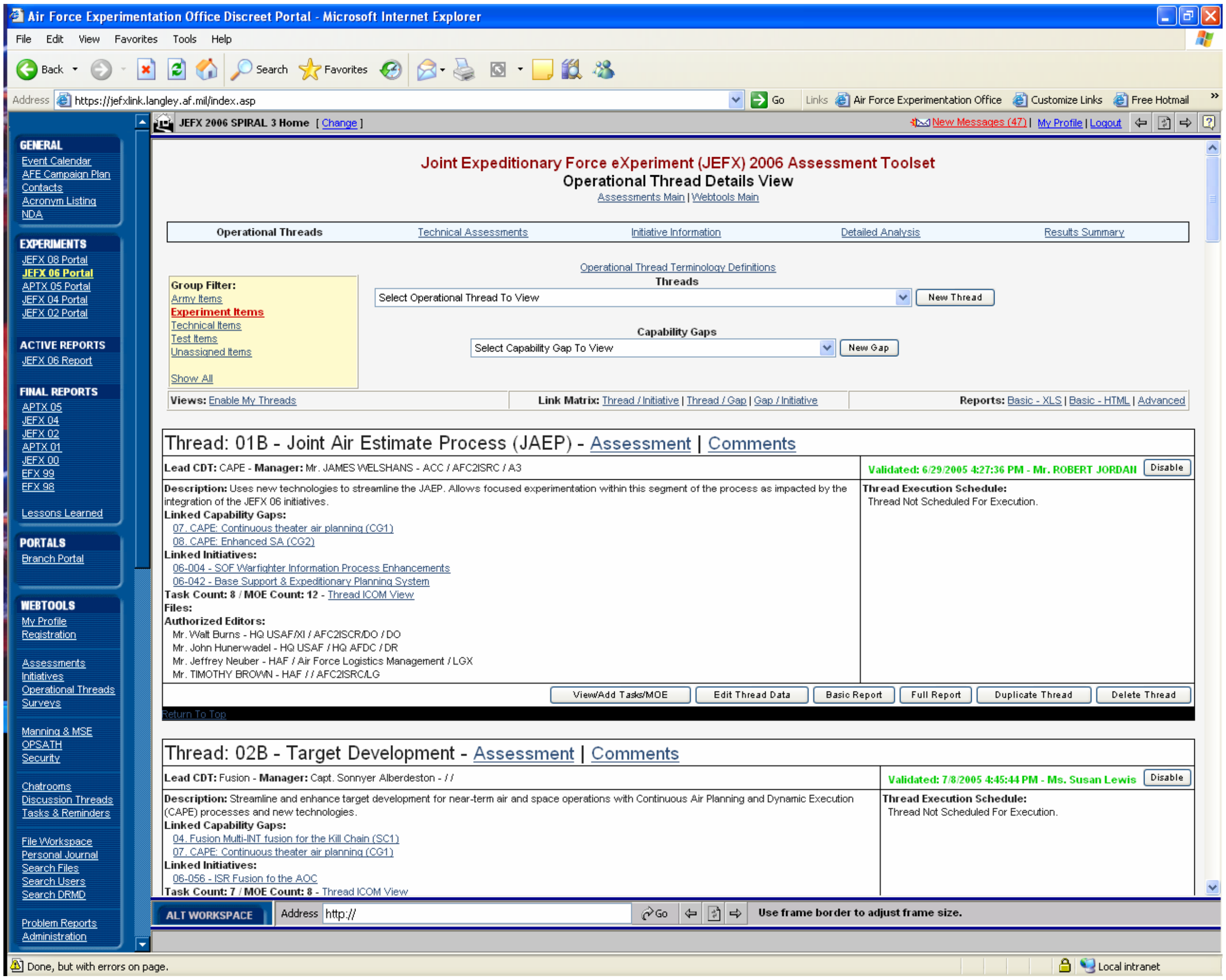

Figure 5—Online Operational Thread Toolset

As indicated in Figure 5, this toolset captures and displays relevant information about an operational thread. The initial view provides basic information, such as the number and title of the operational thread, the thread manager, linkage to capability deficiencies and experimental initiatives, and related files. A more detailed view—as shown in Figure 6—shows additional detail about a thread, such as Measures of Effectiveness (MOE) and the sequence of thread tasks.

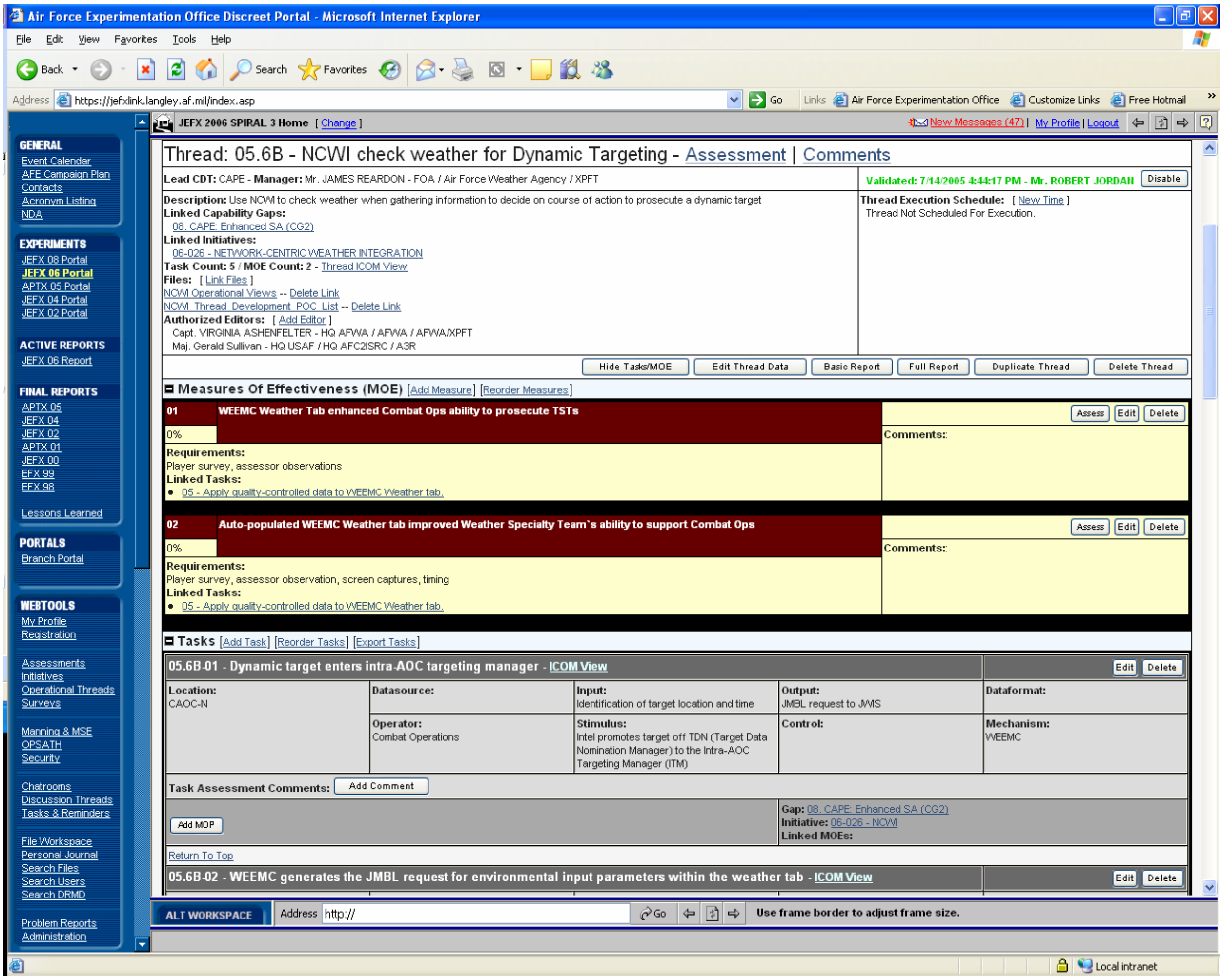

Figure 6—Detailed Thread View

For the planning, design, assessment and reporting of JEFX 06, this toolset was used extensively by the assessment team, experiment controllers, players, systems engineers, live fly planners, and others to capture and view important information.

Conclusion

Analyzing capabilities and assessing the contribution of new technology, processes and organizational structures poses a unique challenge for those involved in military experimentation. For practitioners of large-scale field experiments, conducting a rigorous analysis—one that could support acquisition decisions—is particularly vexing. Over the course of several years of conducting large-scale experiments, the Air Force Experimentation Office has developed a repeatable, rigorous process for experimentation and a supporting toolset for operational thread development that may be useful for others engaged in joint or service experimentation. Based on our experience during the planning, execution and reporting phases of Joint Expeditionary Force Experiment 2006, we believe that the development of operational threads improves the task of analyzing warfighting capability, ultimately leading to improved capability for the warfighter.

Appendix 1—Glossary of Terms

Analysis: Analysis involves decomposition of an area of examination into constituent parts for further study. In the context of this experiment, analysis activities involve in-depth examination of narrow areas of interest such as technical components of an initiative, specific operational processes, or specific areas such as communications or network architectures.

Assessment: For the purposes of JEFX, "assessment" is the broadest term that defines all the activities of the Assessment Integrated Product Team (AIPT.) Assessment is broader than "analysis" in that assessment is an activity that involves other experiment participants (e.g., operators) whereas analysis is primarily an activity for the AIPT. In addition, whereas analysis is primarily a decomposition activity, assessment is a process of synthesizing information to provide an overall appraisal of a broad area of examination. In the context of JEFX, assessment implies more than strictly placing value on a new technology, concept, or idea. Assessment in this context also involves collecting relevant information with the goal of providing an unbiased explanation of how a new concept or technology could integrate into an operational level C2 architecture.

Capability: The ability to achieve a desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks (CJCSI 3170.01E, Joint Capabilities Integration and Development System). Inherent to a capability are the organizations and people, processes, and technical means used to accomplish a military task or mission. Standard US Air Force capabilities are found in the Master Capability Library.

Capability Assessment: The capability assessment strives to determine how well the experiment addressed a particular capability deficiency, through the use of initiatives that supported operational activities (such as Crisis Action Planning.) The capability assessment complements the initiative assessment by examining areas outside the assessment of individual initiatives, and also putting initiatives into the context of a broader joint warfighting capability.

Capability Gap: The inability to achieve a desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks (CJCSI 3170.01E). For JEFX, this term is synonymous with capability "deficiency". Capability gaps are chosen by CDTs based on the experiment focus areas and capability goal statements. CDTs must be selective in choosing capability gaps; time and resource limitations often prevent us from achieving all aspects of a broadly stated capability goal

Capability Goal: A statement of intent, formulated by the respective CDT and based on experiment focus areas, that defines an end state for correcting deficiencies and closing one or more capability deficiencies during the course of the experiment.

Data Analysis Cell: A core team provided by AFEO to support the data analysis effort for JEFX. This group of analysts will review inputs from Jefxlink, produce summary results, and recommend additional data collection.

Data Collection Cell: A core team comprised of the Joint Fires Interoperability and Integration Team (JFIIT), 605 Test and Evaluation Squadron and the 505 Operations Squadron collectively responsible for planning and supporting the data collection effort. DCC responsibilities include collecting data from all required sources and facilitating a daily phased debrief for C2 and live fly players.

Demonstration: May or may not be connected to the experiment systems infrastructure and operational processes. Demonstrations will consume very limited or no experiment design resources, and there will be no experiment enterprise-sanctioned assessment beyond a brief description of the demonstration itself.

DOTMLPF: Doctrine, Organization, Training, Materiel, Leadership, Personnel and Facilities. These broad categories provide a useful framework for organizing results or recommendations. In some cases, JEFX results will provide additional information for inclusion into a formal DOTMLPF change recommendation package, as specified by the Joint Capability Integration and Development System (JCIDS).

Initiative: For the purposes of JEFX, an "initiative" is any specific equipment, concept, process or new technology that has been officially selected by the JEFX competitive selection process, culminating in approval by CSAF. Approximately 65% of the initiatives are required to have the capability for fielding within 18 months of CSAF approval. Initiatives are high-visibility elements of the experiment and will likely consume the majority of design and assessment resources.

Initiative Core Capability: The functions that an initiative provides to the warfighter, based on input from the sponsor. These are not to be confused with the capabilities described in an AF CONOPS, which are often higher-level.

Initiative Provider: The contractor or agency responsible for developing, providing, and supporting the initiative during JEFX.

Initiative Sponsor: The government agency responsible for submitting the initiative for selection, coordinating all support for the initiative during planning and execution of the experiment, and coordinating transition of the initiative.

Item of Interest (IOI): A technology, process or system that is included in the experiment architecture that facilitates the experiment and requires experiment management or leadership tracking and/or reporting.

Key Enabler: As part of the infrastructure, a Key Enabler is any technology, process, organizational structure, or idea that has not been officially selected by the JEFX competitive initiative selection process. Key Enablers are subject to the formal Configuration Control Board (CCB) process, and must be approved through that mechanism for inclusion in the experiment. Key Enablers are not eligible for JEFX program transition funding, and will generally be secondary to initiatives in terms of access to experiment design and assessment resources. Key Enablers may be pre-identified or may occur at any time during the spirals or main experiment, subject to the CCB process. Because this experiment is designed to foster innovation, Key Enablers will typically be assessed by the assessment team in terms of contribution to enabling successful demonstration of warfighter capability goals or as part of a solution to a warfighter capability deficiency. However, relative to initiatives, they will have a lower priority of access to resources. Key Enablers will typically be self-funded to include providing resources for assessment and other JEFX enterprise efforts.

Measure of Effectiveness: According to the AF Analyst's Handbook (produced by the Office of Aerospace Studies), MOE, when evaluated, "quantitatively—and occasionally qualitatively—describe how well tasks are performed." For C2 assessment activities (such as JEFX) the term "task" may be taken in a broader sense to mean "a series of related tasks"—a process. With this broadening of the standard MOE definition, JEFX assessment recognizes the importance of **process** to command and control. The NATO Code of Best Practices for C2 Assessment defines a "Measure of C2 Effectiveness" that focuses on the impact of C2 systems and processes within an operational context. This definition more closely applies to what we are doing in JEFX.

Measure of Performance: In the context of JEFX assessment, an MOP characterizes the *performance* of a single task. Unlike an MOE, it does not indicate the *effectiveness* of that task, or set of related tasks, but instead describes a very specific characteristic, such as the time to complete a specific task or the man-hours involved. Using the F2T2EA model, an MOP might be the number of sensors involved in accurately fixing an emerging target, or the time to complete the "Fix" step in the process.

Measure of Success: Conceptually the highest level measure within the analysis planning framework, MOS characterize the overall success in achieving a particular capability goal.

Operational Thread: An "operational thread" is a series of related operational tasks that are specifically focused to highlight the contribution of experimental initiatives or infrastructure systems to an Air and Space Operations Center (AOC) or other basic Command and Control (C2) process. An operational thread is a design feature of the experiment, allowing experiment planners to influence player activity in desired areas. These threads generally have a well-defined beginning and end, and are often executed within a single period during the experiment. Operational threads are typically stimulated by scenario events (from the Master Scenario Event List—MSEL) but they may involve a significant degree of "free play" by the players. Operational threads are often related to AOC processes, but they are unique to an experiment. Because initiatives sometimes involve activities that are different from current practice, operational threads can force an examination of those activities in a new context. Every operational thread should be associated with relevant measures of effectiveness and performance. These measures characterize the contribution of initiatives to the operational activity, and also indicate the overall effectiveness of the underlying AOC process.

Other Service Initiative: For the purposes of JEFX, an "other service initiative" is any specific equipment, concept, process or new technology that has been vetted through the JEFX enterprise. Other service initiatives are not eligible for JEFX program transition funding. Services are responsible for design, funding, assessment and transition. There may be some integration with JEFX, but they will not interfere with the experiment and may enhance experiment established threads.

Appendix 2—References

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5. JEFX 06 Concept Development Conference (CDC) Overview Briefing, https://jefxlink.langley.af.mil, presented 3 November 2004.
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7. Gartska, John and Alberts, Dave. "Network Centric Operations Conceptual Framework Version 2.0," http://www.oft.osd.mil/initiatives/ncw/docs/20AUG04_Version 2-0 Network Centric Operations Conceptual Framework.doc, accessed 5 November, 2004.
8. Kass, Dr. Richard. "Understanding Joint Warfighting Experiments: The Logic of Warfighting Experimentation," presented to 10th International Command and Control, Research and Technology Symposium (ICCRTS) 14 June 2005.

Appendix 3—Web-Based Toolset

The database contains the following data tables to support the toolset:

Table 1—Data Tables

Data Table	Description
Threads	This is the primary table holding the basic information about each thread and establishing the ThreadID that will be used as the foreign key (FKey) throughout the system.
MOE	Tied to a single Thread by the FKey: ThreadID. Tied to multiple Tasks via the MOETaskLink table
Tasks	Tied to a single Thread by the FKey: ThreadID. Tied to multiple MOEs via the MOETaskLink table Tied to Deficiencies by the FKey: GapID Tied to Initiatives by the FKey: InitID.
Deficiencies	Tied to Initiatives by the FKey: ThreadID.
MOP	Tied to a single Thread by the FKey: ThreadID.
DCR	Tied to a single MOP by the FKey: MOPID.
Initiatives	Holds information about the specific initiatives linked to the Tasks.
Documents	Holds information about the documents that are linked to the Threads and Deficiencies
Personnel	Holds information about users including permissions.

The supporting (normalized) tables are used to provide additional data about the object entities they support:

Table 2—Normalized Tables

Table Name	Description
ThreadGrp	Threads are assigned to Groups to for the sake of sorting and display. This table holds the information about each group.
ThreadPriv	Holds the security information about each Thread to include Owner and Editors personnel record ID numbers.
TaskEval	Holds the assessment/evaluation information about each Task. Tasks are assessed during each event so separate records are needed for each event.
DCREval	Holds the assessment/evaluation information about each DCR. DCRs are assessed during each event so separate records are needed for each event.
DCRSub	Allows users to subscribe to a specific DCR and be notified of changes.
ThreadExecSch	Holds the execution schedules (times) for each thread.

The linking tables are used to establish “many to many” table relationships:

Table 3—Linking Tables

Table Name	Description
ThreadDocLink	Links Threads to Documents.
MOETaskLink	Links MOEs to Tasks.
GapDocLink	Links Deficiencies to Documents.

Appendix 4—Acronyms

A

ACASSA	Air Support and Situational Awareness
ACS	Agile Combat Support
AFC2ISRC	Air Force Command and Control and Intelligence, Surveillance, and Reconnaissance Center
AIPT.	Assessment Integrated Product Team
AMD	Air Mobility Division
AOC	Air and Space Operations Center
ASP	Active Server Pages
ATO	Air Tasking Order

C

C2	Command and Control
CAPE	Continuous Theater Air Planning and Dynamic Execution
CDC	Concept Development Conference
CDD	Capability Development Document
CDTs	Capability Development Teams
CN	Constellation Net

D

DCGS	Distributed Common Ground System
DCR	Data Collection Requirement

H

HLS/HLD	Homeland Security / Homeland Defense

I

ICCRTS	International Command and Control, Research and Technology Symposium
INT	Intelligence
IOI	Item of Interest
IP	Internet Protocol

J

JAEP	Joint Air Estimate Process
JEFX 06	Joint Expeditionary Force Experiment 2006
JFCOM	Joint Forces Command

JFIIT	Joint Fires Interoperability and Integration Team
M	
MAAP	Master Air Attack Plan
MOE	Measure of Effectiveness
MOP	Measure of Performance
MOS	Measure of Success
MSEL	Master Scenario Event List
N	
NCO	Network-Centric Operations
NTISR	Non-Traditional Intelligence, Surveillance and Reconnaisance
O	
ORD	Operational Requirements Document
OTD	Operational Thread Development
R	
RAD	Rapid Application Design Methodology
S	
SOF	Special Operations Forces
T	
TST	Time Sensitive Targeting
W	
WX	Weather