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C -211 A White Paper on the Conceptual Requirements for an Operational Airpower Planning Tool
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A White Paper the Conceptual Requirements for an Operational Airpower Planning Tool

The current operational Air Tasking Order (ATO) planning tool, Theater Battle Management Core System (TBMCS) application Theater Air Planner (TAP), is approaching obsolescence. This application runs on a Uniplexed Information and Computing System (UNIX) platform. Most computers in the Air and Space Operations Center (AOC) are Windows/Intel-based PCs. The TAP application is the culmination of a long line of outstanding computer applications that minimized the time and manpower needed to create the United States Message Text Format (USMTF) ATO message. We must now posit conceptual requirements for the next generation Operation Airpower Planning tool. The design philosophies to achieve the capabilities required of the Operation Airpower Planning tool and the USMTF ATO production tool are diametrically opposed, despite their essentially identical role in directing assigned tactical forces.

The purpose of the ATO and Air Control Order (ACO), as defined by the USMTF, is "The ATO is used to task air missions and assign cross-force tasking and may also be used for intra-Service tasking," while "The ACO is used to provide specific detailed orders for airspace management from a higher command to subordinate units." To clarify our goal in creating the next generation Operational Airpower Planning Tool, we must understand the history of the USMTF ATO production tool. The ATO message is divided into two sub-sets, Mission Data Lines (MSNDAT) and Special Operation Instructions (SPINS). Traditionally, the AOC staff creates MSNDAT and Air Force Forces (AFFOR) staff creates the information required for SPINS. Both sets of information and the information in the ACO message are required to execute combat air power.

Automated building of the ATO message started with a Disk Operating System program, Frag Works, which ran on a 286 PC in the early 1980s. The program allowed ***one*** person (generally a clerk-typist) to fill blank fields in the USMTF message (Today, we would call this message a text or flat file). A group of experts performed all planning (including sortie deconfliction and tanker scheduling) by hand calculation or using another stand-alone computer system. Expert planners would hand the clerk-typist sheets of information to type into message format. The operational data required by expert planners to create a cogitative plan was organized on grease boards or legal paper. The operational data had to be nearly complete before experts could plan individual ATO mission lines to be handwritten on sheets submitted to the clerk-typist.

The next evolutionary leap was the Contingency Theater Automated Planning System (CTAPS). The application in this program that created the ATO message was the Computer Assisted Force Management System (CAFMS), a [Dumb] Oracle Database networked with several UNIX client PCs. All mission planning was still by hand calculation or use of stand-alone computer systems. Information was written on worksheets, passed to a ***group*** of clerk-typists (CAFMS technicians), and typed into database fields using Sequel Query Language. CAFMS held both operational and mission planning data. It allowed Combat Operations to retrieve, sort, and manipulate data as required. ***Any*** data that complied with the rules governing that field could be entered. The ATO was printed as a flat file of data from the CAFMS database. All USMTF message fields could be retrieved from this database. The expert planner reviewed the ATO printout to ensure data was entered correctly. CAFMS did not reduce manpower required to organize and coordinate the essential data, but it did substantially decrease time required to type the ATO.

The next generation application, Advanced Planning System (APS), "rode on top" of the legacy CAFMS data structure in the next version of CTAPS. APS was designed to initiate data

organization and expedite creation of individual mission lines. APS was a [Smart] database. It incorporated some of the tools used in the standalone computer systems and reduced the need for hand calculations. All required general planning data was entered in APS fields by CAFMS technicians to create an APS data store before the exercise or contingency. The data included base location, aircraft and mission type, standard convention load, fuel burn rate, and other data. Large groups of data such as Airspace individual Air Control Measures or Intel's Target Nomination List were imported from creating organizations. Hand entry and import of information had to be complete before multiple expert users could begin to type the thousands of mission lines of a large ATO. An APS error message would flag the operator if computer algorithms recognized a conflict. For example, the error message: "Unflyable Mission" might prompt the user to review the planned line and find it to be short 100 lbs. of fuel. For aircraft flying 8 hours 100 lbs short of fuel, an operator could determine the "problem" insignificant, and override the computer. APS was adept at pairing fighters and tankers and determining appropriate fuel for strike missions. It did straight line planning for each mission line created. Air mobility command elements did not use APS to plan theater and strategic airlift. In the earliest version of APS, certain fields could not be overwritten and not all fields in the USMTF message could be automatically filled in creating the ATO message. When planners completed entry into APS, the data was transferred back to the legacy CAFMS database. The ATO message went back to the [dumb] database where airlift missions, SPINS[1] and information needed to fill in other fields was added. The final ATO message produced with APS was still a USMTF flat file.

The APS application successfully represented data and constrained use of resources with detailed data models that combined a relational database with a volatile knowledge base and implemented business rules in algorithms. Some of its behavior models were pure physics (rate/time/distance) that prevented objects from attempting to occupy the same space at the same time.

The sizeable investment in APS and the success it achieved led to creation of TAP based on the same design philosophy. TAP inherited much of its computer code and many input screens from APS. It incrementally "fixed" most user problems associated with APS; updated the year group of the USMTF message created[2]; and implemented time and ATO production manpower reduction protocols.

In light of this history, it is clear that an effective Operational Airpower Planning Tool must look beyond the design philosophy that created the current USMTF planning tool. To achieve leadership goals, we need a planning tool that can be used by most AOC crewmembers; will store, manipulate, and calculate information required by their duty position; and is scaleable, flexible, and easy to use in creating output, which could be the USMTF ATO message.

TAP's "twin" application in the Execution Tools Suite is the Execution Management Replanner (EMR). EMR provides a common look and feel and similar data models, but its procedures for synchronizing databases are a hindrance. There are few differences between TAP and EMR applications, as they share a source code baseline and have the same basic architectural design. Hence, EMR will not be discussed further, except this caveat: information produced by an Operational Air Power Planning tool should allow replanning and visualization of information by Combat Operations and external organizations.

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[1] SPINS were generally compiled in a word processing program such as Microsoft Word

[2] Every 2 years, a new version of USMTF messages is released and all military computer systems must be able build and use the newest messages.

The first critical requirement for an Operational Air Power Planning tool is scalability. CTAPS and TBMCS are not scaleable in design. The TBMCS design and testing requirement was a worst-case "cold war" scenario that created an ATO to execute 3000 missions on any given day. This design and testing criteria worked in large-scale exercises and in both Gulf Wars. TBMCS was not adaptable to situations of significantly smaller scope with considerably less manpower. Ingenious "work-arounds" were continually employed by organizations engaged in combat (e.g., Operations Northern and Southern Watch) and in training of tactical forces (e.g., Red Flag or wing and squadron local exercises).

Scalability is comprised of four components:

1. Ability to plan and execute operational air power ranging from one assigned aircraft to all aircraft needed to support a theater scale conflict in periods ranging from less than a day to an extended period. Small-scale operations must be managed without a large highly trained manpower pool.
2. Applicability to any organization with an operational air power planning and execution need from a small unit in local training to a Joint Forces Air Component Commander (JFACC) staff with major theater war or major command.
3. Output in both Management Information System (MIS) and military message format. The current ATO is produced in "hard copy" only for extremely communication-disadvantaged users. Most users of the ATO message "pull" it from a webpage. Current procedure is to post it in different types of files (e.g., MIS files could include .doc, .pdf, ..xls or military message file like .ato).
4. Output automatically available to coalition member countries in both their required military message format and MIS format to be placed on networks to which they have access. In Gulf War II, the ATO was put on transfer media (floppy disk), placed in a PC, and run against a Practical Extraction and Reporting Language script to remove fields in mission lines and paragraphs not releasable to the coalition member receiving the message. After parsing, the message was placed on the appropriate network as a file and coalition countries used their manpower to interpret and execute missions they had agreed to provide.

The second requirement for an Operational Air Power Planning tool is flexibility. CTAPS, TBMCS, and most systems of record (SOR) in the past 20 years were stovepipe designed for defined input and output with a static process and algorithms to reach a predefined goal. Planning systems in this century should attain flexibility through six characteristics:

1. **Group Planning**-many manual and semi-manual processes were created ad hoc to organize information for a cognitive operational air power plan. The most important characteristic of an Air Power Planning tool is to accommodate a large rapidly changing membership both physically and virtually present in building the Operational Air Power Plan as a cognitive concept. TAP does not "plan." It deconflicts data by comparing it to previously entered internal information. In most cases, the tanker plan was entered at the end of the planning cycle and any conflict would prorogate throughout completed mission lines. Each "error" would have to be corrected by the builder of each mission line affected. A system with cognitive ability could calculate tanker resources, equate this data to gallons of gas for offload, and allow the planner to assess the requirement for "X" packages of aircraft in tasking tanker support before mission lines are created.
2. **Known Data Import**–Computer-based planning tools should, as directed or scheduled by the operator, automatically import data and information from known data sources. In TBMCS, all

information on friendly forces is manually entered and most of that data is in another computer system. For example, Blue Force location is in the Joint Operations Planning and Execution System. It can be acquired by an account holder requesting an F11D report on aviation units. The location of every base on earth is tracked and updated by Air Mobility Command, but we continue to accept a 5% input error rate for bases hand typed into TAP for each exercise or contingency.

3. **Cut and Paste**- A simple function such as "cut and paste" should be available to the operator to transfer information and encourage information exchange from semi-formatted documents (e-mail, text chat, etc.) to system data storage and data output. In TBMCS, simple activities such as printing in color or exchanging information from UNIX to PC can be excruciatingly difficult. "Cut and paste" might easily transfer information to pair a fighter in one ATO period to a tanker in a previous one, a data transfer that is very difficult to accomplish now.

4. **Pre-populated Information**-Static or near static information should be pre-populated in the planning system, have the capability to be reset to its initial state, if required, or amended for addition and growth. When a TBMCS is brought on line, its databases are empty, although the names and basic characteristics of all the world's aircraft and munitions are known. Semi-static information like the Airfield Digital Aeronautical Flight Information Files that update airfield information are produced every 28 days and should be incorporated.

5. **Human Understandable**- Input should be the same in style and function as the largest market share commercial application in the home/school environment. Output of machine-readable military messages and information should be in human readable format. TBMCS implemented this output concept by displaying ATO and ACO messages in tabular view, but "words" from the message could be truncated in the table. Of 247 USMTF messages available to TBMCS, only the ATO and ACO can be viewed in human "friendly" format. Identify Friend or Foe (IFF) modes and codes to plan against are never displayed in human readable form. IFF available codes are four place sequential base 8 numbers and most humans understand base 10 numbers. Therefore, in all conflicts and major exercises, codes assigned and used have to be hand tracked. An enterprise wide mapping function should be used and background maps should be similar for display of data to the human warfighter.

6. **Build Military Messages**-Organizations that are extremely disadvantaged in communication capability require a hard copy of the USMTF ATO message. An Operational Air Power Planning tool should fill in fields of known military messages and validate compliance with rules governing them. Each of the messages could be required by someone in the Combined Air Operations Center. One example is the Situational Report. Currently, builders of this message use other systems and workarounds to get information in TBMCS to populate ATO or ACO message fields. These messages should also be available to other joint military nodes on the same security level network.

The final cornerstone of a 21st century Operational Air Power Planning tool is ease of use. Most people in today's military are computer savvy. They grew up with internet, e-mail, text chat, advance computer gaming, and other concepts. They do not need training on how to turn on a PC. A commercial-off-the-shelf (COTS) mind set must be brought quickly to bear in solving military operational problems. Ease of use, in a military setting, must incorporate six basic concepts.

1. **Intuitive**: The TBMCS 1.1.1 TAP System User Manual is 875 pages. Most of it defines how the operator will input required data. Comprehensive understanding of the TBMCS program

down to network level can require 2 years of dedicated training. A newly assigned AOC crewmember, expert in his function, should be intuitive on how to enter and manipulate data in the Operational Airpower Planning tool. For example, an expert at aircraft scheduling should be able to sit down at a PC client and start inserting his information. If a user manual is required, it should be no longer than COTS manuals for the commercial home/school market.

2. **Administrative Simplicity**: most SOR are designed, built, and tested as standalone solutions. In the AOC Weapon System, all computer applications that deal with information of the same security level must operate on a common network and, in many cases, applications must be on the same physical servers and clients. System administration from account creation to complex functions like system rebuild should be designed from an enterprise solution with the goal of single entry of data and Graphical User Interfaces. Just as manpower to sustain complex weapon systems like F-4 fighters was considerably reduced with maintenance concepts included in F-16 design, computer applications can go from standalone solutions to enterprise solutions.

3. **Output for Senior Leadership**: Any organization, including AOCs, with PowerPoint software generally use it to convey decision quality information to leadership. Most slides are created and then updated for recurrent daily briefings. In the AOC, the de facto result has been that each cell/organization produces its required output document (ATO, ACO, Aerospace Operations Directive) *and* a PowerPoint briefing for senior leadership on that product. Some applications in the AOC incorporate automatic slide building applications (i.e., Master Air Attack Plan Toolkit and TBMCS 1.1.3 Accenture Strategy Tool), but these tools create slides in a deterministic manner and are not available to everyone. Anecdotal information from users is that they are not amenable to General Officer briefings due to creative slide building constraints. Creation of intra-document links between components of a briefing is a difficult and time-consuming task exacerbated when information is arrayed across numerous non-congruent security based classification levels of networks. The faulty logic used in the AOC is that human intervention is necessary if the semantic/creative relationship that exists between components of documents is to remain viable.

4. **Non Deterministic Environment**: Microsoft applications are very successful in building tools in which the user provides data but the milieu remains constant (e.g., the user can enter data where and how he determines best to solve his problem in Excel, the Excel program does not require the how and where the data is to be entered. In TBMCS, you can only enter the data into pre-formatted data repository slots). One of the major challenges affecting systems as large and complex as TBMCS is time and cost to update the data store (TBMCS uses commercial Oracle and Sybase databases). Data service layers and XML tagging allow less deterministic data transposition between application and databases, but if a user needs to add tables, rows, or columns or change the relationship of the data, it must go back to the “factory” and it may be years before the potential solution is available. There are always tradeoffs in designing software to be both robust and flexible. Military systems dealing with the “Cold War” monolithic threat had to lean toward the need to be robust. Military systems in the uncertainty of the fragmented threat of a modern world should lean toward flexibility.

5. **Effective Human to Computer Linguistic**s: One of the most vexing problems in interactive design for an advanced Command and Control (C2) node is when implementing concepts demonstrate the fundamentally asymmetric nature of the relationship between humans and computer systems. The human advantage for symmetric interaction is based on three fundamental abilities: listening, thinking and speaking. Computer systems “listen” poorly, “think” some, and “speak” well. The current typical application gives the warfighter system user

very little to say or do and then hoses him down with megabytes of audiovisual extravaganza. This explains, to some extent, the style needs to be encapsulated in an Operation Airpower Planning Tool concept design as an attempt to balance the needs of human warfighters with computer systems. A successful model of human to computer interaction is "TurboTax." This program converts often bizarre contradictory tax laws, rules, and regulations to a relatively simple series of "computer asked-human answered" questions. There are other problems to consider, but warfighter effectiveness could clearly be enhanced by expenditure of computer resources that balance the needs of both man and machine.

6. **Embedded Fuzzy Logic**: the lack of fuzzy logic is one of the best examples of a major failing of TBMCS. There are many different ways to name an aircraft. In some fields of the USMTF message, the type of aircraft is only represented in predefined patterns, (e.g., you have an F16 or an F16A, but no F-16 or F16-A). Other entry fields are based on previously entered TAP data stores (e.g., if Fort Drum is a base in the TAP data store, you can fly to Fort Drum but you cannot ***not*** fly **to** Ft. Drum. If an entry for Ft. Drum is required, the user has to go back, update the data store, and then plan his mission line). Both cases require a user trained on how to enter data and familiar with the limitations of the system. With embedded fuzzy logic, you type "Stinkbug" and the F-117 symbol populates wherever it needs to occur. The next generation Airpower Planning tool must have embedded in its code the understanding of the advantages fuzzy results produced by the analog tools of previous non-digital generations (the SR-71 was made by the non-computer generation).

A new application, Theater Battle Operations Net-Centric Environment (TBONE), is one of several tools being developed to replace TBMCS and TAP and eliminate well known peccadilloes. It is too early in the TBONE development cycle to determine if it will become another ATO production tool or a truly conceptual Air Power Planning tool. As TBONE continues its accelerated developmental schedule, PowerPoint slides developed by diverse organizations indicate TBONE is approaching success. All organizations should tout their success. A recent set of slides indicate TBONE has reached 70% of its goals. The current Department of Defense 5000 series regulation, using the concept of spiral development, encourages fielding software at the 80% capability level. Sometimes, a software program is fielded without reaching 100% of desired goals, but at the 80% capability level. This is outstanding policy if the undone percentage is not critical to mission accomplishment. Undone percentages of mission critical requirements can lead to unsafe conditions, confusion in the battlespace, and unexecutable taskings.

The most recent TBONE Limited Objective Experiment report did not evaluate TBONE against needed "AOC engine" replacement requirements. It correctly evaluated TBONE against current available capabilities. Both slides and reports could easily place in the mind of individuals a false impression of where TBONE is in its developmental cycle if they are not involved in the daily "heavy lifting" of operational C2. In the future, TBONE may have slides and reports showing 99% of goals or capabilities reached, but the measurement is irrelevant in determining if this "engine" is ready to go and fight an airpower war. Software systems should not put human beings, other scarce resources, or mission success at unreasonable risk because of developmental pressures and timelines. This paper is to define the four key "cylinders" TBONE must have to be a successful replacement to TBMCS and TAP as the engine of the AOC, no matter what percentage desired capabilities or goals are reached.

One of the main functions that TAP accomplishes for the user is to determine if a mission is flyable or un-flyable equal to or better than manual operational[3] planning. Using our engine metaphor, determining if a mission is flyable is top dead center of the number one cylinder. Both the expert aircrew planner and the non aircrew technicians rely on this function. The TAP application key constraint checking capability concerns associations between missions – are the escorter/escortee, tanker/receiver, and package membership consistent in time and space. For example, the expert planner might receive the error message: "Unflyable Mission" after building a new mission line. In most cases, the "error" would prompt the user to review the planned line and see what caused the problem. If the "problem" was a mission 10 minutes short of required turn time, the expert could use his judgment and adjust the mission line as necessary. In our example, if the new mission line showed a large aircraft flying 12 hours that had a 6-hour turn time and was 10 minutes short of needed time, an expert operator could determine the "problem" insignificant and override the computer. For the non aircrew technician, the Flyable/Non-flyable flag highlights when the expert aircrew planner should be queried.

The number two cylinder of our new engine is the ability to determine if a mission needs refueling and, if so, allow pairing of that mission to a refueling aircraft. The amount of gas (aviation fuel) aloft and available drives the air war. Any determination of operational efficiencies relies on airborne fuel used; any decrease of capability will directly extend days and hours of air combat. TAP was created to eliminate the manual (less accurate/slower) methods of determining fuel usage and help pair fighters to tankers. TAP is adept at pairing fighters and tankers and determining approximate fuel needed for strike missions. It did straight-line (operational level) planning and fuel calculations for each mission line created. TBONE must have the capability to resolve the airborne refueling problem with a high degree of accuracy.

Our third engine cylinder is building, at least, all current mission types and mission lines created by TBMCS within a valid USMTF message. The valid USMTF message is the legal order. It is how the JFACC directs tactical units and, in some cases, communicates with individual flights. TBMCS builds a 1998 and a 2000 USMTF message, TBONE builds 2000 and 2004 USMTF messages. Organizations that are extremely disadvantaged in communication capability might only have a hard copy of the USMTF ATO message. Other military C2 organizations and systems require valid messages sent to them or pulled down from a web page. The TBONE tool should fill in fields of ATO/ACO military messages with valid entries according to the rules governing it. When reviewed by aircrews flying the tasking described in the ATO, the message must be have enough information to plan and fly the mission. Often, in exercises, messages are valid by the rules governing the message but fail to reach "adequate information" criteria. The third cylinder also includes the ability to import and/or build mission lines created by other Services, nations and organizations with their organic C2 systems. The ATO is used to coordinate all airpower and must correspond to multi-community needs.

The fourth and last cylinder relates directly to third cylinder. Just as TBONE must be able to build a change "zero" message, it must also be able to build or import changes (1, 2, 3…etc.) to the ATO/ACO during execution. The technical challenge is to build valid and "flyable" changes and not to negatively impact the information used to build the following day's change "zero"

[3] In years past, manual operational planning was accomplished using paper rulers, different colors for various aircraft, marked with speeds and approximate fuel flow and numerous area charts.

message. There are unwritten “business rules” developed by military aviation receivers of the ATO, besides USMTF, for how changes should be created, for example:

1.) TBONE needs to prevent missions/airspaces that ***have not changed*** from coming out in a change. Undetermined changes drive tactical users nuts trying to figure why the change was sent.
2.) On the other hand, if my mission ***did*** change, the AOC must reissue the entire mission and associated missions in the change. If you fail to mention a mission associated tanker (because, in the “mind” of the software, the tanker did not change), a tactical user will not know if the tanker was or was not changed or cancelled.
3.) Mission numbers must not be reassigned from unit x to unit y after the ATO comes out. Unit x does not read unit y tasking and won’t figure it out. The result is that you could have two units executing the same mission. The ATO must convey something like “Unit x Mission 1001 is cancelled. Unit y now has new mission 1001A.” TBONE must work within the “rules” expected by the tactical community.

The four cylinders of the AOC engine provide the Commander the capability to plan, execute, and assess theater-wide air and space operations. Too often, in the past, the staff using the provided C2 system spent considerable time, energy, and effort making the system work in accordance with system design criteria and not in accomplishing the military goals of their commander. If TBONE can eliminate the notorious eccentricities of TBMCS and TAP and still accomplish the goals of the four cylinders needed by any engine of the AOC, the warfighting commander, his staff, and the nation would be welled served.

In conclusion, if there is a single key to a more efficient advanced Operational Airpower Planning tool, it is being able to analyze and react to changing military conditions much more rapidly. To do this, Senior Leaders, Cell Chiefs, and C2 warfighters inside the AOC need appropriate and better-organized information in a system that is scalable, flexible, and easy to use. Information technology itself has revolutionized the way organizations operate throughout the world. Unfortunately, despite increasingly powerful computers and communication networks that span the globe, many senior military leaders and decision makers cannot obtain critical information that already exists somewhere in their organization. Every day, the Air Force and Department of Defense (DOD) create billions of bytes of data about all aspects of their work in protecting the nation: millions of individual facts about military resources, potential enemies, ongoing operations, and people. For the most part, this data is locked in myriad computer systems and exceedingly difficult to access. This phenomenon is best described as "data rich, information poor." Experts estimate that only a small fraction of data that is captured, processed, and stored in any computer enterprise by a large organization is actually available to leaders and decision makers. While technologies for manipulation and presentation of data have literally exploded, only recently have those involved in developing Information Technologies (IT) strategies for large organizations concluded that large segments of senior leadership are "information poor." The three cornerstones (scalability, flexibility, and ease of use) of an operational concept for strategic advancement of a large IT planning system are inextricably linked. If only some concepts of one or two cornerstones are accomplished, it will be easy to spend billions to produce a tool capable of building an ATO, but it will not be a tool that helps humans build the cognitive conceptual Operational Airpower Plan.

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