WHITE PAPER ON DISTRIBUTED MISSION TRAINING FOR AIR FORCE RESERVE COMMAND

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EXECUTIVE SUMMARY

Distributed Mission Training (DMT) is a future technology application being advocated by several Air Force acquisition and MAJCOM offices to operate simulators in a broad, networked environment. DMT's purpose is not only to train individual aircrews, but also to develop, measure, and refine USAF's ability to conduct complex military actions through the networked integration of numerous weapon platforms, platform types, and command and control; all through the use of modern simulation and networking technologies. It is envisioned that eventually many forms and types of simulations and real entities will be able to interoperate within a common synthetic battlespace.

This white paper analyzes the merits and risks of DMT and includes a plan for AFRC to help accentuate merits and mitigate risks.

There are many assumed benefits to DMT, and there are many assumed risks as well. A full realization of the DMT concept/vision will not occur for many years. Initial DMT applications by the active duty MAJCOMs are using an incremental approach because of technology and budget limits and the need to manage risk.

AFRC investment in DMT concepts for AFRC flight simulation programs should initially be limited to those aircraft types with the highest likelihood of Return-On-Investment (ROI). **AFRC funds should *not* be used to network flight simulators unless the training value received is known to be worth the investment. AFRC should begin to define training value now.**

This is the second of two white papers on related but distinctly separate issues. The first white paper analyzed the merits and risks of Fee-For-Services (FFS) as an acquisition strategy for training services. **DMT and FFS are analyzed separately, since they are two separate and distinct issues.**

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WHITE PAPER SCOPE

This is the second of two white papers dealing with critical issues associated with the potential infusion of modern simulation technologies into Air Force Reserve Command (AFRC) simulation and training assets using innovative business strategies. These issues, technologies, and strategies are driven by recent, parallel guidance and directives from Secretary of Defense and Air Staff offices to decrease DOD acquisition overhead and to increase the use of simulation as a cost-effective tool to enhance and maintain USAF mission capability and readiness. These white papers are intended to be used by AFRC staff and senior managers to better understand the critical issues and best manage AFRC resources and assets.

The first white paper explored the apparent merits and risks associated with Fee-For-Services (FFS) as a particular acquisition strategy. This second white paper assesses the apparent merits and risks associated with Distributed Mission Training (DMT) as a particular simulation application.

This white paper does not include discussions on the various methods available to fund DMT operations. The theme of DMT deserves wide-scale dissemination because it can/has influenced many components of industry and the services. This white paper is meant to do that. Funding options remain the closed business of the Government.

These critical issues are treated in separate white papers because **FFS and DMT are independent of each other**. FFS can be applied to programs with no connection to DMT. DMT can be implemented using any acquisition strategy. Recent USAF flight simulation acquisition initiatives have involved both of these issues and, at times, **the issues have been perceived as being merged. They are not.** The issues should be considered separately to best plan, manage, and execute flight simulation programs tailored to the unique needs of AFRC (to include AFRC gaining commands) well into the next century.

FLIGHT SIMULATION NETWORKING HISTORY

The earliest digital flight simulators built in the late 1960s included the simulated presence of other vehicles to train pilots in target acquisition and rendezvous skills. Other vehicles (most often simulated aircraft) could be controlled by the instructor or follow scripted paths and behaviors driven by software algorithms. The earliest Computer Image Generators (CIGs) developed in the 1970s provided out-the-window scenes for flight simulators that included the presence of moving models of other aircraft, aircraft carriers, or ground vehicles. These moving models moved and behaved according to instructor or scripted inputs. Although these early flight simulators did not include networking, the method of simulating the presence and behavior of other entities remains as a very efficient, functional cornerstone of many modern flight simulators.

The simulated presence of other entities includes some significant limitations. Instructor control of more than a few entities could soon overtax his abilities to make entity movement appear natural and follow proper procedures. Moving models driven by software algorithms would not always exhibit the characteristics and behaviors that a real human operator would provide. The networking of simulations together is a logical method to help achieve improved realism.

In the mid-70s, the Advanced Simulator for Undergraduate Pilot Training (ASUPT) program at (former) Williams AFB, AZ experimentally networked their two, T-37 simulators together to train formation flight skills. The ASUPT devices were designed with identical software architectures and were co-located in the same facility. ASUPT was discontinued in the early 80s.

Also in the mid-70s, the Simulator for Air-to-Air Combat (SAAC) program at Luke AFB, AZ fielded their pair of networked flight simulators to train air-to-air engagement skills. These devices also had identical software architectures and were co-located. The SAAC devices are still networked and operational.

In the mid-80s, two C-130E flight simulators at Little Rock AFB, AR were networked together to support formation aircraft training. These devices also had identical software architectures and were co-located. These networked devices provided realistic and correlated visual, air-to-air skin paint radar, air-to-air TACAN, Station Keeping Equipment, and communication cues to two C-130 crews. The C-130E network was developed at a cost of less than $20,000 and took just several months to complete. The network was disconnected shortly after the successful completion of tests because current courseware did not make frequent use of formation simulator training and the network caused two otherwise independent devices to become interdependent for availability purposes, and this caused a scheduling burden.

The lessons-learned-bottom-line from these programs is that the **networking** of co-located flight simulators with identical software architectures and already possessing an ability to simulate the behavior of moving models **can be fast, easy, and cheap**. An additional bottom line from the C-130E program is that a successful flight simulator network with proven training value may not be sufficient to overcome the inertia of existing courseware and training management philosophy.

In 1978, the Air Force experimentally networked an A-10 flight simulator located at Williams AFB with a SAAC flight simulator at Luke AFB. The devices were built with different software architectures and located fifty miles apart. The networking medium was a standard, commercial phone line. Considerable time and effort was spent to develop a software exchange data protocol to let each simulator receive and transmit required data over a phone line with minimal bandwidth. It worked. The network was discontinued following the successful completion of tests.

In the early 1980s, DARPA sponsored the U.S.Army's Simulator Networking (SIMNET) program that successfully fielded several hundred inexpensive, ground armor trainers that could be networked to train team skills and mass exercises across long-haul networks. SIMNET also included the development of software algorithms to simulate the group and individual behaviors of armor forces. This allowed many more entities to appear to be present in the training scenarios. These Computer Generated Forces (CGF) were experimentally expanded to include aircraft, ships, and (to a degree) command and control elements. SIMNET developed and refined a software exchange data protocol that could be used between devices with different software architectures. SIMNET served as the foundation for most networking initiatives that followed.

In the early 90s, AFSOC and AETC sponsored the development of the Special Operations Forces Network (SOFNET) at Kirtland AFB, NM. SOFNET connected high fidelity fixed and rotor wing flight simulators located at Kirtland for purposes of team training and mission rehearsal. SOFNET initially used its own, internal protocol to communicate between a number of different software architectures, and added a DIS capability for long haul networking experiments with other far-ranging locations. SOFNET is still in use for training and mission rehearsal of operational aircrews.

Many other examples of flight simulator networking experiments and capabilities exist across the services.

ADVANTAGES OF FLIGHT SIMULATOR NETWORKING

The primary advantage of simulator networking is fidelity. As alluded to earlier, the fidelity of algorithmically or instructor driven moving models or manned threat behaviors can be limited for some training tasks. A full range of realistic human behaviors is hard to faithfully emulate, especially with variable task loading and the complexity of multi-place crew interaction. By networking real crews together, the subtleties of human action, reaction, and interaction within a common environment can be present. These often subtle differences between the fidelity of simulated entities and networked simulation may or may not be worth the expense and effort of networking…depending on the tasks required to be trained.

Another advantage of simulator networking is that components of C4/I can be integrated into the training event as additional entities. EA-6B, AWACS, intelligence, and command functions can have just as much of a role in the success or failure of a mission as the combat crews delivering ordnance. If flight simulator training is to progress past the training of skills to the training of mission success, the integration of C4/I components into the simulation network can help achieve that.

Perhaps one of the more important advantages of simulator networking is the effect it can have on crew behavior and perception. Combat aircrews have a tough job. Their tasks may often result in actions that cause other people (the enemy) to try to kill them and those other people may have the means to do so. Dangerous tactics may be used to evade even more dangerous enemies. A rational aircrew would not choose to keep their job unless they were confident that their machines, their skills, and their plans were superior to the enemy's. This characteristic of their job often results in strong aircrew egos and intensely competitive personalities. When a pilot is flying in a simulator environment where he/she is networked with peers and operations officers flying other networked simulators, every mistake and success he makes may be visible to the other participants and their mistakes and successes may be visible to him. This is the same as in the real world. The pilot will approach the same simulator event much more seriously and react much more realistically during networked operations than during stand-alone training with only an instructor present.

DEVELOPMENT OF SIMULATION NETWORKING STANDARDS AND ARCHITECTURES

Distributed Interactive Simulation

In the early 1990's, DARPA, the Defense Modeling and Simulation Office (DMSO), and the Army sponsored the Distributed Interactive Simulation (DIS) research and development initiative that used SIMNET as its basis. DIS was chartered to develop and promote network protocol standards to support networking of many forms of simulations as well as properly instrumented, actual (live) entities. DIS included the development of a single data exchange protocol and numerous networking tools that could be used by any simulator program. DIS also sponsored many demonstrations of broad networked simulations, the capture and synthesis of correlation metrics, and the advancement of CGF algorithms. Over seven years, DIS sponsored biannual conferences with over a thousand attendees and sponsored well over a thousand technical papers dealing with a wide variety of networked simulation issues. Numerous DOD simulation programs included the requirement to be DIS-compatible.

A weakness of the single, DIS protocol standard was that it was meant to serve all forms of simulation, including crew training, studies and analyses, war gaming, engineering development, and others. The data needs and computational methods of different forms of simulation vary widely. Not all forms of simulation were well supported by the DIS protocol without the addition of tailored extensions and the elimination or simplification of some data types. Also, the everything-for-everyone concept could quickly oversaturate the bandwidth of available network media and overtax the ability of each simulation to spend computational time parsing through the torrent of protocol data units flooding the net. Also, DIS focused more on what gets passed across the net and less on how the data is computed or used within each simulation. How data gets computed and used can contribute to correlation errors between networked entities unless software architectures could be developed in a structured, reusable fashion.

DIS compatibility was mandated within some U.S. Army organizations, but never from a high enough level to require the activation of complex bureaucratic processes. Exceptions or waivers could ordinarily be secured through relatively simple and unencumbered statements of cost, schedule, and performance impact of DIS compliance for each program. DIS was usually treated as a means to an end…a tool. It was not construed as an end in itself. This is good.

High Level Architecture

In the mid-90s, DIS weaknesses lead to the development of High Level Architecture (HLA) through DMSO sponsorship. HLA allows logical groupings (federations) of networked entities (federates) to develop their own protocols (Federation Object Models, or FOMs) based upon top-level HLA architecture rules. Each federate would disclose its internal computational processes in a Simulation Object Model (SOM). The entry of a new federate to the network could require a modification of that federate's SOM, a modification of other federates' SOMs, or changes to the FOM. Not all simulation Federations would interoperate using the same protocol. **HLA compliance does not guarantee interoperability,** not even with entities within their own federation. Smart systems engineering and a firm understanding and control over factors that effect correlation errors between simulations are still required to achieve interoperability.

HLA also includes guidance for object-oriented software architectures to promote software reuse and decrease the risk of excessive differences in computational products. The HLA program includes design tools, test tools, interface specifications, tutorials, a help desk, and ever-improving standard run time infrastructure software. HLA also includes plans for data repositories and standard transmission (interchange) formats for a wide variety of geographic data bases. **The technical logic behind HLA appears sound.** Its method of implementation is another story.

In September 1996, the Under Secretary of Defense for Acquisition and Technology published a directive memorandum that mandates the use of HLA across most forms of DOD simulation. **HLA compliance must be achieved by certain dates or the simulation will not receive funding for new starts, modifications, or operations.** The date for modifications or new starts was the first day of fiscal '99. The date for operations is the first day of fiscal '01. Compliance is required even for many DOD simulations without a validated, operational networking requirement. Request for waivers or exclusions can be submitted for consideration by a high-level executive counsel on a case-by-case basis. Time extensions for HLA compliance may also be granted on a case-by-case basis. The directive does not apply to the internal software architecture component of DOD simulations. **The HLA directive does not include funds for compliance.**

This directive characteristic of HLA radically changed it from being a tool, to becoming an end in itself. The edict was from a top-down position with sufficient authority to have the edict itself become viewed as an "operational" requirement within some service staff offices. In addition, this requirement was not coordinated with any war fighter headquarters before the directive was issued.

The effort required to modify existing, high fidelity flight simulators to be HLA compliant can be considerable, with the few known examples of partial compliance near the $1 million level, and full compliance in excess of $2 million. Most USAF flight simulation programs have adopted a wait-and-see philosophy and have allowed other programs to invest in HLA compliance first without risking their own operational funds to conduct work that has limited or no basis in operational requirements.

The HLA compliance edict appears draconian and potentially risks the expenditure of funds that result in no operational benefits; however, it serves the valuable functions of 1) forcing DOD simulation programs to reassess their requirements for networking, 2) providing easier funding for those simulation programs with validated, operational networking requirements, and 3) providing test cases to improve on HLA and associated tools for future programs.

Continuing DIS development activities have ostensibly ceased with the advent of HLA and its directive mandate, with the exception of DIS-to-HLA adapters and conversion tools.

DMT PROGRAM DESCRIPTION

Mea Culpa

This section of the white paper describing DMT is principally based on information provided via Government Internet web sites. Some of the data appears to be over a year old. Other information was gained from recent discussions with individuals having secondary roles in DMT program execution and from personal attendance at DMT planning meetings during the previous year. The DMT concept has been evolving rapidly. Some of this white paper's conclusions and observations regarding DMT may be outdated. It is hoped that personnel working closely with DMT will review and submit updates and comments regarding this document to help ensure that AFRC pursues the best possible path toward DMT integration and realization of the overarching USAF DMT vision.

DMT Background

DMT is founded on the observation that "We fight as an Air & Space team, but we seldom train together as a team." Team training is becoming much more difficult and expensive because of limited airspace availability, security restrictions on electronic warfare use, environmental impact concerns, insufficient funds for exercises, reduced flying time, high PERSTEMPO and OPTEMPO, and concerns over flight safety. A solution to this problem is to use modern flight simulation and networking technologies to conduct team training with unconstrained, realistic tactics against authoritative threats in a realistic but safe synthetic environment.

The DMT conceptual model envisions the eventual networking of most USAF flight simulators with command and control, Air Operations Centers, and intelligence functions for the practice and refinement of total force combat skills in a realistic synthetic battlespace. The DMT plan includes a gradual increase in aircraft types, support, and command elements into the DMT network, with a full capability not envisioned until at least the year 2010.

Direction for the execution of DMT programs exists in USAF Program Management Directive (PMD) 6077(25)/PE064227F, dated 13 Apr 98. Among other tasks, the PMD directs ASC/YW to assist MAJCOMs and the ARC to develop acquisition strategies and to use CTSS (FFS) to the maximum extent practicable. **The DMT PMD directs HLA compliance only so far as it can support the functions required.** The PMD also directs MAJCOMs and the ARC to identify and fund training systems to be added to the DMT network.

The former ACC/CC strongly endorsed and supported this plan and ACC remains as the lead MAJCOM for DMT development. ACC has procured the services of three DMT systems, using a Fee-For-Services (FFS…aka Commercial Training Simulation Services, or CTSS) acquisition strategy. The FFS acquisition strategy was thoroughly discussed and analyzed in the previous white paper that characterized its risk as **HIGH**.

Current DMT Systems

The initial DMT system is for the F-15C. Boeing is on contract to field two networked "pods" of four simulators each, one at Eglin AFB and the other at Langley AFB. The system includes GCI and threat role-player stations, a briefing/debriefing system, and connectivity with the F-15's digital mission planning system**. The F-15C DMT system is not currently required to be HLA compliant, but plans to be.** The devices are principally complete, and await correction of last minute deficiencies before they become capable of full tactical training sometime early next year.

The second DMT system is for AWACS. Plexsys is on contract to deliver the initial suites of networked AWACS consoles, Instructor Operator Stations (IOSs), and briefing/debriefing stations to Tinker AFB over the next several years, with other systems scheduled for delivery to Tyndall AFB, Elmendorf AFB, and Kadena AB. **The AWACS DMT system is not currently required to be HLA compliant, but plans to be.**

The third DMT system is for the F-16, Block 50. Lockheed-Martin is on contract to initially field a "pod" of four networked F-16 devices at Shaw AFB, with others to follow**. The F-16 DMT system is not currently required to be HLA compliant, but plans to be.** Lockheed-Martin reached agreement with Boeing to use several key components from the Boeing F-15C design for their F-16 system. These key components, such as the threat modeling system and visual out-the-window display system, must share common characteristics to achieve an acceptable level of correlation when the F-15C and F-16 systems interoperate in a networked environment.

Although the Lockheed-Martin agreement with Boeing was ostensibly to share the burden of a large up-front corporate investment, it also resulted in the sharing of key, proprietary subsystems that reduce correlation error between networked entities. This places strong pressure on subsequent DMT service providers to adopt the proprietary Boeing subsystems as well. Time will tell.

DMT Operations and Integration (O&I)

The DMT concept includes a separate contract for a DMT O&I contractor who will be responsible to define and ensure the complete interoperability of the USAF DMT program. The DMT O&I contractor will serve as the DMT network architect, provider, and manager, and will design the standards necessary to network multiple, dissimilar simulations within one common synthetic environment. The DMT O&I contractor will work with the DMT service providers (Boeing, Lockheed-Martin, etc.) to define these standards and the DMT service providers will implement them in their designs.

DMT service providers are disallowed from competition for the Two-Phase DMT O&I contract, which is currently in the process of selecting among four Phase One contractors to determine which will be the single, Phase Two contractor. Phase Two downselect is expected to occur late this year or early next year. The winning Phase Two DMT O&I contractor will also be disallowed from competition as a future DMT service provider.

The DMT O&I contractor has the task to remain abreast of technology development. This is good. New and better ideas do not exist only in DMT service providers' houses. The challenge will be trying to inject other party technologies into the proprietary DMT designs that are allowable with FFS; for reasons discussed in the previous FFS white paper.

The DMT O&I contractor also has the task of supporting the Government during the future source selections of DMT service providers. This is also good, and should provide the Government with experienced insight to help compensate for continuing downsizing of Government acquisition personnel and the slow erosion of Government technical expertise.

The Challenge of Correlation

The reason for the DMT O&I contractor setting standards is to ensure interoperability of dissimilar simulations. Dissimilar simulations may present differing cues to crews flying in the same environment. These differences can eliminate the validity and utility of the DMT networking event. For example, if the pilot in one simulator has a superior visual system to the pilot flying another simulator and they are engaging in a mock battle as adversaries, the pilot with the better visual system may win even if his tactics, cross checks, and skills are inferior to the loser's. Once the pilots learn the simulators' strengths and weaknesses, they will modify their tactics and behaviors to leverage their simulator's strengths against the weaknesses of their adversary's to win. These are clearly NOT acceptable simulation results. Correlation standards must be developed to prevent this.

Merely having a network of connected simulators does not mean that the results of the networked event will be acceptable or valid. Building a network that works is easy. Building one that works correctly is tough.

The measurement and control of correlation errors across dissimilar, networked simulations is a very complex and difficult challenge. Correlation errors that affect training value can be caused by a number of factors that span the perceptual domains of Appearance, Behavior, and Time. Appearance (how things look) can be affected by where things are, their size, color, contrast, scale, attitude, etc. Behavior (what things do over Time) can be affected by skill, intent, doctrine, capability, etc. Time (when things happen) can be affected by latency, periodicity, frequency, sequence, etc. Interoperability standards for a networked flight simulation system must consider these and many more factors to control otherwise unacceptable correlation errors.

The Challenge of Standards

Interoperability standards can be expressed in two different ways. The first and easiest way is to express them is in terms of operational performance characteristics; for example, "The network shall not contribute time delays perceptible to aircrews or adversely influence their behavior." This may be the desired operational outcome, but is very difficult for an engineer to design and test to.

The second and harder way is to express them in engineering terms; for example, "The network shall not exhibit average time delays in excess of 22 milliseconds and maximum time delays in excess of 33 milliseconds for sites up to 1500 nautical air miles apart. Both average and maximum values shall be measured over a minimum thirty-minute period of continuous networked operation by aircrews using all simulation systems. Time delay is that time between the initiator's host flight CPU output signal and the receptor's host flight CPU input signal." This may seem like a lengthy piece of gibberish to a crew dog, but can provide an engineer with a much clearer understanding of what is required, how to design it, and how to test it. A challenge with this engineering approach is that the technical description must still support the operational outcome of "no perceptible time delays." Engineering metrics must always meet customer expectations for programs to be successful from a customer standpoint.

Current Government acquisition streamlining initiatives place the job of developing technical descriptions on the contractors' shoulders. The contractor has the job of reducing operational terms into engineering terms to support design. The contractor may require access to their own skilled operator Subject Matter Experts (SMEs) and scarce human factors studies and training transference reports to confidently make this translation. Or they can just make their best guess, cross their fingers, and hope that the inevitable final acceptance schedule slip isn't too long. In any case, their technical descriptions and metrics become their intellectual property and tests of their metrics may not be available to the Government.

It is unknown what degree of technical specificity the DMT O&I contractor will be allowed to use during development of the DMT interoperability standards.

Interoperability standards should precede interoperability design. This has not occurred with DMT. The F-15C, AWACS, and F-16 DMT system designs precede the DMT O&I contractor's attempt to set standards. The application of new standards to existing design may require expensive modifications of the existing design unless the new standards mimic existing design. Prenegotiated FFS amortization rates and schedules may require adjustment if the FFS service provider is required to change existing design to meet new standards. This places strong pressure on the DMT O&I contractor to adopt standards that support the proprietary templates of the initial DMT service providers' designs, and **may effectively limit the competitive base for future DMT service providers.** Time will tell.

Standards are a two-edged sword. If they are too restrictive they can inhibit competition and stagnate the technology base. If they are too loose they can eliminate the validity of the simulation event and/or teach false habit patterns and behaviors. For some simulation characteristics, standards can be developed that define the maximum allowable degree of correlation differences, and not mandate exactly identical performance. This will give the competitive and technology bases some breathing room. For some other simulation characteristics, exactly identical performance may be required to not negatively impact mission capability. The flight simulation community does not know for sure which characteristics are which. Despite the many years of discussions on this subject and the hundreds of papers authored on this subject, the community does not know what the allowable correlation tolerances may be. They appear to be specific application and simulation dependent.

In lieu of having no authoritative data, the DMT O&I contractor will be under considerable pressure to develop standards that mandate exactly identical performance across the board. This will not only inhibit competition, but also **risk stagnation of the technology base**. New, better, and innovative approaches may be disallowed because they deviate in performance from standards that were, in turn, based on proprietary design approaches. The successful DMT O&I contractor will have an unenviable job when developing standards.

The Challenge of HLA

The DMT PMD requirement to implement HLA compliance only in so far as it can support required functions is wise. The DMT PMD's conditional HLA requirement relates specifically to the lack of a sufficiently robust Run-Time Infrastructure (RTI), provided by the HLA authors, and the additional time delays caused by converting from internal data representations to HLA structures and back again. The HLA authors have not yet appeared sufficiently knowledgeable or sensitive to the flight simulation community to produce a useful RTI. RTI Version 1.3 Next Generation (NG) appears to be the next trial release from the same authors, but has been delayed because of technical difficulties. RTI 1.3NG may work. Or the next one might. Time will tell.

The majority of HLA's rules (with the possible exception of "Time Management") appear logical and supportive of real time flight simulation applications. HLA has definite technical merits. A fully functional RTI makes sense. The USAF DMT community should more proactively participate in HLA RTI authorship, or assume the role of RTI authorship and build one on their own. This does not appear to be a clearly specified task of the DMT O&I contractor, but probably should be. It must be noted that this potential DMT O&I contractor task includes the same serious risks as those described earlier during discussions on standards development.

Bottom Line Challenge for DMT O&I

The DMT O&I contractor is required to enter into Associate Contractor Agreements (ACAs) with DMT service providers. This is principally intended to provide the O&I contractor with access to proprietary and/or competition sensitive information as a part of their job of developing interoperability standards. Under the terms of the DMT O&I contract, the O&I contractor is not relieved of any contract requirements or entitled to any adjustments because of a failure to resolve disagreements with the associate contractor(s). The DMT service providers have no apparent responsibility to make the DMT network successful.

This means that **the DMT O&I contractor may be left in a "meat grinder" between Government acquisition and customer expectations**, with the DMT service providers standing on the sidelines looking very innocent and uninvolved.

In a real sense, if the DMT service providers do not wish to cooperate, they won't. This places strong pressures on the DMT O&I contractor to appease DMT service providers during

DMT standards development, further increasing the risk of sole-source standards and technology stagnation.

DMT TECHNOLOGY SHORTFALLS

Several significant DMT technology shortfalls still exist for the full implementation of the DMT concept. Shortfalls exist not just in the engineering sciences, but also in the supportive data required to develop engineering solutions. Perhaps the most important, near-term shortfall exists in the lack of usable metrics and meaningful criteria for the control of correlation errors, as previously discussed. Simply making the DMT O&I contractor responsible for it doesn't make it happen. This is as naïve as expecting a contractor to provide "guaranteed concurrency," or expecting a contractor to build a geographic data base that will sufficiently correlate to future, unspecified data bases of future, unspecified programs with future, unspecified requirements.

Other outstanding technology shortfalls exist in areas involving visual system resolution, visual field of view, geographic data base development, realistic and validated threat modeling, and non-obtrusive methods of accomplishing Night Vision Goggle training. The technology shortfalls associated with the long-term DMT goal of mission rehearsal are considerable, and not addressed here.

Although it may not always be interpreted as a technology shortfall, the serious lack of meaningful human factors data on the result of correlation errors across all domains of human perception adds risk to the future goals of DMT. Continuing and long-term investment in this area is required.

Another area that is partially the result of a technology shortfall is in the larger transport delays caused by communication over longer distances. Some of these delays are caused by the additive time budgets of switches, relays, transponders, converters, encryption/decryption buffers, etc. that exist along the data path. These technologies are sure to improve with time and add more trainable tasks to networked simulation. However, part of the overall system delay is not caused by a technology shortfall, but by an immutable physical limit called The Speed of Light. An engineering solution will not be found to fix "The Speed of Light Problem" until Zefram Cochrane discovers the Space Warp in 2051AD (unadjusted for Star Date relativity). Until that time, some networked simulation tasks will not be trainable beyond certain distances. Period.

A PARTIAL, LOW RISK PLAN FOR AFRC NETWORKED FLIGHT SIMULATION

As previously noted, networking of co-located flight simulators having identical software architectures can be fast, easy, and cheap. For this type of network, DIS or HLA are not required and not preferred. The simulators merely share a subset of their internal data representations ordinarily meant to drive simulated moving models. Some aural cuing and IOS engineering is also required, as well as designation of a master synch. This method adds the least amount of transport delay. The use of DIS or HLA protocols, conventions, and architectures adds considerably to complexity and cost. This method does not.

As also previously noted, AFRC investment in networked simulation is not recommended unless the training value is known to be worth the investment.

A method exists for AFRC to inexpensively identify if such an investment is worthwhile for selected weapon systems.

AFRC could select a weapon system with a mission type that has a high potential for payback from networking with other, like entities, and has at least two flight simulators having identical software architectures located at the same facility. The devices could be inexpensively networked using shared internal data representations and crews could fly them in an integrated and fully correlated synthetic environment. Role players to represent other entities or threats could be added as necessary to fit the mission profile. Performance measures, expert observation, or crew opinions could be collected to provide data regarding training value. Data could also be collected to determine if a new training task (such as networked formation training) is achievable within the availability limits of the devices and if the new system interdependencies add too much of a burden on device scheduling. With this data, AFRC could more confidently determine if networked simulation provides a sufficient training bang per buck of investment for that particular weapon system.

If warranted by the data, a second step could be taken to maintain the internal network, modify some of the internal software to satisfy HLA rules, and add an HLA portal or gateway for connectivity to other, dissimilar entities. This second step should not be accomplished unless the other entities are known and their data representation needs and capabilities are defined in accordance with HLA conventions. This second step would, of course, require revision if DMT's networking architecture standards follow a proprietary design template and deviate from HLA conventions.

This plan will not work for all AFRC weapon systems, but could work for some. Cost of proving the value of flight simulator networking using this method would be perhaps ten percent of the cost of partial HLA compliance (based on other programs' experiences and previous MAJCOM investments), and the engineering effort could still be useful if the decision was made to convert the devices to full HLA or DMT compliance.

SUMMARY

The DMT networked simulation concept is a bold initiative that shows much promise. The DMT concept is being strongly advocated by influential USAF and MAJCOM acquisition and command offices. The reasons for the development of the DMT concept are to apply modern simulation and networking technologies to fill in a training shortfall, enhance USAF mission capability, and accomplish this inexpensively. The initial DMT system is nearing completion. Several others will be fielded in the next several years. The DMT concept plans for the slow evolution of DMT to incorporate additional simulations and mission elements with time, as technology continues to grow and risks become better known and more manageable.

Flight simulation technologies have long been considered essential for ensuring safety-of-flight and decreasing the risk of loss of life, and are being called upon to serve an increasingly crucial role in achieving and maintaining DOD and USAF mission capability**. The potential value of networked, team training to mission readiness appears strong.**

Strong reliance is being placed on DMT to attain, maintain, and refine mission capability. This requires DMT to possess very high fidelity to the aircraft and to the real world environment. Simulation technology continues to grow rapidly, but **DMT technology shortfalls still exist** for the full implementation of the DMT concept. Visual cuing, geographic data base development, threat modeling, and Night Vision Goggle training still lack the fidelity required of DMT.

Standards must be developed to support interoperability and correlation between different networked simulators. Standards development will occur after at least the first three DMT systems have completed their design. This places the cart before the horse**. DMT standards will be very difficult to develop** and support not just already fielded DMT systems, but the competitive and innovative technology bases as well.

DMT networked simulation appears to offer training advantages for many required mission competencies and crew skills, depending on the mission, aircraft type, tasks, and availability of other, less expensive and proven technologies (such as simulated entities) to accomplish the same thing without networking. An investment in networked simulation should occur only if the investment is proven to be worth the training value received. Some weapon systems may receive no training value from DMT networked simulation and any premature investment would be wasted. Others may receive considerable value and be well worth the investment.

AFRC should continue to follow the training philosophies of the parent-aircraft MAJCOMs, but **AFRC should invest in DMT networked simulation only if the training bang per buck is clearly worth it.**

Work to measure the training value of AFRC networked simulation should begin now.

Please address any comments or questions to the undersigned or to Mr. Michael J. Sieverding, ARINC support to AFRC, 480-988-6561/DSN474-6156/ michael.sieverding@williams.af.mil.

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