The Army's Future Aviation Simulation Strategy Study

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ABSTRACT

In early 2007 the Army commissioned the Future Aviation Simulation Strategy (FASS) study. The study was led by the Simulation Systems Development Directorate within Army Aviation & Missile Research, Development, and Engineering Center and included a research team from the University of Central Florida's Institute for Simulation and Training and Salinas Technologies, Inc. The study reviewed over 100 documents and made visits to several government and contractor facilities to assess the current state of simulation based training relevant to Army aviation. The team also projected future needs for training with respect to several factors; flexibility to configure simulators for future missions, collective training for air ground and joint operations, and projected advancements in simulation and training related technologies that might be relevant to Army aviation. The results of the study indicate that while current training needs are being addressed, additional research, development, and experimentation is needed to gain additional efficiencies in order to meet anticipated training requirements. These needs are expressed as gaps with suggested approaches for bridging the gaps. Approaches are grouped into technical, procedural, programmatic, and cultural areas. In many cases bridging gaps are expressed in terms of time phasing to leverage current initiatives. The study team recommends that a program of research and development be created to address these gaps and that a new start program be considered in the mid to far term to develop a new generation of aviation simulation devices.

ABOUT THE AUTHORS

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Dr. Yiannis Papelis has been involved in simulation research within academic institutions for over 15 years. He was a Visiting Assistant Professor at the University of Central Florida until recently when he joined ODU's VMASC as a Research Associate Professor. Dr. Papelis has lead numerous projects funded by government, industry and academia, and has consulted extensively for industrial sponsors worldwide. Dr. Papelis has a Ph.D. degree in Electrical & Computer Engineering from the University of Iowa.

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BACKGROUND

In early 2007 the Army commissioned the Future Aviation Simulation Strategy (FASS) study. The purpose of the study was to investigate how the Army and other agencies conduct collective training between air and air ground crews, trends in related simulation and training approaches, and a way forward to ensure that the Army is prepared to train air crews effectively in the future. The study was lead by the Simulation Systems Development Directorate within Army Aviation & Missile Research, Development, and Engineering Center and included a research team from the University of Central Florida's Institute for Simulation and Training and Salinas Technologies, Inc. Support and direction came from personnel at the Director of Simulation at Fort Rucker, PEO Aviation and PEO Simulation, Training, and Instrumentation.

To effectively conduct this study over 100 documents were reviewed, visits were made to government and contractor facilities; interviews conducted with technologists, training leaders, and acquisition personnel; and exercises and demonstrations were observed with trainees. These various reviews and interviews were conducted to assess the current approaches and requirements used for training, innovations in the research or acquisition pipeline, and additional innovations needed to bring the Army to where the study team and leadership feel are needed for the future.

Top level results of the study in terms of gaps and approaches to filling those gaps are presented in the following sections. The results are broken into four areas; technological, programmatic, cultural, and procedural. Additionally, key definitions that include interoperability, fair fight, and fidelity are needed to limit ambiguity and to ensure a uniform basis of understanding. A complete report is being prepared in parallel with this paper and that report may be obtained by contacting the Director of Simulation at Fort Rucker or one of the authors of this paper.

CURRENT AVIATION TRAINING AND EXPERIMENTATION

For collective training Army currently uses the Aviation Combined Arms Tactical Trainer (AVCATT) as its principal means for training aviation teams in inter-aircraft skills and uses the Close Combat Tactical Trainer (CCTT) in a similar role for ground systems. (AVCATT ORD, May 2003) These two systems are intended to be interoperable. Additionally, there is an emerging need for individual platform devices for the AH-64, UH-60, CH-47, etc. to be interoperable. Generally interoperability in the context above entails the ability to exchange DIS PDUs as described by IEEE 1278. The generally observed situation, though, is that different systems use different versions or extensions of DIS resulting in uneven and unrecognized acknowledgement PDUs among all simulators. Additionally, other known components of interoperability, such as terrain correlation and radio communications are often left to discovery during demonstrations or training sessions. The result is an interoperability that supports training within a single family of devices manufactured by the same company, but a labor intensive effort to achieve interoperability in more general situations.

The Army, under the direction of PEO-STRI is also moving forward on two exciting programs, SE Core and OneSAF. The SE Core contains two components; architecture and integration (A&I) and Digital Virtual Environment Databases (DVED). (SE CORE ORD, Feb 2005). The A&I component is creating standard components (e.g. C4I interface) for distributed simulations and the DVED component is creating a repository of standard data bases for use by visuals, Semi-Automated Forces, and sensors. A key aspect of DVED is the use of plug-ins for converting the internal device-independent data into vendor and platform specific instances that can be used in applications. OneSAF is developing semi-automated forces software for use in virtual and constructive simulations. (OneSaf ORD, Aug 2004).

The contractor lead for both programs is SAIC. The exciting aspects of these programs are the development of standard products for simulation, a highly integrated government-industry team, and the availability of these products for others to use.

Other services are also conducting leading edge R&D that will contribute to better understanding collective training solutions. For example, visits were made to the Air Force Research Laboratory Human Effectiveness Directorate in Mesa, Arizona and the Distributed Mission Operations Center in Kirtland AFB. The former group discussed useful experimentation involving the use of advanced technology to enhance human performance. The group at Kirtland explained the benefits of a sustained and professionally oriented capability needed to support distributed training exercises.

STUDY GOALS

A Future Aviation Simulation Strategy (FASS) should provide the following capabilities; be interoperable with other systems across the live-virtual-constructive domains, supply positive training to its users, be modular to support aircraft concurrency and simulator upgrades, easy to configure and operate, and be available 24/7 to users. (USAAWC DOD Br, Oct 2006) Clearly these are broad and encompassing goals. The premise made by the study team is that it is important to maximize the utility of existing systems, while considering the next generation of simulators. Existing systems are grouped into individual, crew, collective, and air-ground. For the purposes of this study collective entails two or more aircraft and air-ground is collective with the added element of inclusion of ground simulators or in support of ground personnel. With many simulators having a life of over twenty years with upgrades and updates, it is important to consider when upgrades to support collective training make sense and when it doesn't. Generally, the study team recommended using existing simulators that had some degree of interoperability in their design for collective training through the development of needed technology and interface devices that might be unique to the particular simulator. Salas, Bowers, Rhodenizer, 1998

GENERAL STUDY FINDINGS

Generally, the Army is able to effectively train its aviators today with its existing inventory of training devices. Such training has limited air-ground integration, is somewhat rigid in its use of devices, as well as stove piped with respect to pedagogical approach. Because the AVCATT is the only device explicitly designed for collective training between different aircraft, it is the de facto standard for collective training within the Army. However, the study team believes that uncertainty in future conflicts necessitates improved flexibility, where feasible, between existing simulations as well as future simulations.

Review of existing approaches for collective training and interoperable simulators within the Army finds the following;

1. Interoperability has made progress but has not been achieved on a consistent basis.
   - 1.1. Within live, virtual, or constructive domains
   - 1.2. Between domains
   - 1.3. For many of the subsystems within a simulator
   - 1.4. Within a usage category (e.g., training)
2. Terminology needed for collective training is not uniform or sufficiently succinct.
   - 2.1. Between different communities
   - 2.2. To support acquisition
3. Changes to simulators are costly, difficult, and not sufficiently responsive (timely).
   - 3.1. For concurrency with an aircraft
   - 3.2. For accommodating advances in various simulator technologies
   - 3.3. For accommodating changes in OPTEMPO
4. Achieving connectivity is difficult.
   - 4.1. Logistically
   - 4.2. Technical and usage expertise
5. The Army generally lacks a sustaining infrastructure to experiment with new M&S concepts.
   - 5.1. Experimentation facilities and design
   - 5.2. Process to influence acquisition
6. Lessons learned lack an effective feedback mechanism.
7. Existing business, acquisition, and usage practices are not in place to accommodate FASS.

The study team believes all of the above issues can be addressed at a reasonable cost through a focused program that addresses issues with current devices and takes appropriate steps in future devices through the requirements process, timely and relevant research, development and experimentation, and appropriate adjustments to the acquisition process.

DETAILED STUDY FINDINGS

Definitions

An important finding from this study is the need for unambiguous definitions that are understood by the various constituencies that use and develop combined arms or other types of distributed simulations. Principal among the definitions are those for interoperability, fair fight, and fidelity. The study team found existing definitions used by DoD and the services too ambiguous and open ended. The following definitions are offered.

Interoperability exists when different systems exhibit the "same" behavior (performance) when stimulated by a set of standard procedures. The term "same", above, should be framed for a given task or class, be within a specified tolerance or number of anomalies, and with a predefined number of statistically measurable trials. Standard procedures should be layered and decomposed to include but not limited to areas such as update rate, terrain data base, models, etc.

Fair Fight is obtained when the systems are interoperable and the system performance capabilities of the simulators are complimentary for a given task throughout the simulation environment. Fair Fight is also task dependent and includes items such as similarity in the equality made in use of the synthetic environment features, automated force behaviors, etc. Equality of use is determined within pre-determined tolerances.

Fidelity (from Webster's Dictionary) is the identification of key parameters for a system and the degree to which the aggregate of those parameters match a baseline system. In the case of simulations the study team suggests that fidelity be decomposed into physical, functional, and psychological components.

It is clear that while the definitions, above, offer alternatives to current definitions there is much left unsaid with respect to actual simulation components and specific metrics. The study team suggests that the determination of these factors and components be based on experimentation and discussion within the modeling and simulation community.

Procedural Aspects

Several important procedural steps should be taken by the Army to facilitate collective training. These include changes in how simulators are specified, training sessions for instructors and trainees, "How-To Manuals" and other reports capturing relevant information needed to create interoperable simulation environments, and new types of standards and assessment methods. (Nullmeyer & Spiker, 1998)

The study team recommends that system requirements used for procurement address interoperability with the same rigor as other subsystems. A simple look at current specifications shows a large disparity between the effort and detail used to address technical requirements (for example the fidelity and performance of the visual system) and the effort used to address interoperability. Additional space should be dedicated to describing what is expected and how it will be evaluated. Included here is what is the basis upon which a simulator is to compare for interoperability, fair fight, and fidelity. Associated with this expectation is a set of definitions that are measurable and unambiguous. Such definitions have been suggested, elsewhere in this paper, but additional work is needed to determine tolerances, acceptable numbers of anomalies, and hierarchical aspects of interoperability needed between various subsystems of the simulators, but there is no reason to wait to begin this recommendation.

Training sessions for instructors and students in simulation capabilities is recommended. These training sessions should be different for each audience. The study team found a wide variation in perceptions and knowledge of simulator capabilities among users. In particular, pilots who have received training in, for example the Army's Flight School XXI have an expectation of high fidelity in simulators that are not evident on all devices, such as AVCATT. A short session in simulator capabilities for different purposes could mitigate negative perceptions when using simulators with limited or selective fidelity.

"How-To Manuals", reports, and other materials should be promulgated and made readily and publicly available to those interested in connecting simulators. The study team found incidents of repeated experimentation with connecting simulators and uncovering issues with, for example, correlation in rendered data bases. These and other issues have existed for over 15 years, yet there does not seem to be an effective method of capturing these issues, approaches to their resolution, and effective promulgation and availability to the public.

A requirement to generate such reports, have them peer reviewed and placed in a publicly available and citable repository would help mitigate uncovering already known problems and facilitate resolution to these problems.

Standards that better support interoperability are needed. Included here are a suite of benchmark tests that assess how well one is making progress in connecting training simulators. Standards should include so-called pinging tests which probe a simulator's capabilities so that one can understand the extent to which a meaningful connection is possible. Also, standard benchmark tests can be created which drive suppliers to where the sponsor desires to be and measures progress toward meeting those desires. Such approaches are common in the graphics and IT world.

More focus must be given to addressing interoperability issues encountered during training at a top-down level. It is not uncommon for small group instructors or trainees to observe and correctly identify interoperability issues, however, there is no formal process for addressing such issues, and even when such issues are documented they are outside the scope of the contractors maintaining the system.

Technical Aspects

There are many technical areas that represent gaps in being able to easily connect simulators for interoperability. It is appropriate to say herein that the focus of the study team is to recommend technical approaches that result in simulators being designed for interoperability so that developers have a reasonable expectation for successfully integrating devices. The more salient technical issues are described in the following paragraphs.

The study team believes that the Army's SE Core (both A&I and DVED portions) and OneSAF programs are steps in the right direction for achieving interoperability and maturation of the modeling and simulation industry, but that further technical action is needed. Additionally, it is important to recognize that these programs are in development and as such, must be focused on achieving the program objectives within the cost and schedule parameters levied by the sponsor and not necessarily broader goals. (SE Core IITSEC State of the Union, Womack, 2006) These programs have other impacts on facilitating interoperable simulations supporting air-ground collective training that will be discussed in the Programmatic and Cultural discussions in subsequent sections of this paper.

OneSAF is currently being developed for the constructive simulation community and will interface with WARSIM. In this light, OneSAF provides a logical segue between the constructive world and the virtual community that encompasses Army aviation. However, OneSAF is developing a version for the virtual community and while it is hoped there will be bi-directional commonality, it is not assured. Accordingly, the study team recommended that the Army commit to maintaining bi-directional commonality between versions. Additionally, consistent thinning among different virtual simulators using OneSAF needs to be considered so that if different instances of OneSAF are running on different simulators, there is a method to deconflict them and avoid anomalous or correlated behavior issues. OneSAF is developing a feature for creating scenarios that is based on Microsoft's Power Point software allowing users ease of creating scenarios. The study team feels this approach should be investigated further to determine if it is the appropriate basis for the development of a scenario generation tool (discussed later in this section).

The SE Core program also represents a new approach for developing standard products for the simulation community. The A&I portion of SE Core is being developed for AVCATT and CCTT. The details of the components are currently not sufficiently known so that existing and future aviation devices can assess the impact of how these products can be used in individual simulators that might be required to connect.

The DVED portion of SE Core raises three technical concerns with the study team with respect to its use by the simulator community; one related to applicability, the second related to third party use, and the third related to cost effectiveness . DVED is architected to operate as a "master" repository of data whose quality will increase over time as improved version of data sets is fed back into the system, yet it is being developed focused on AVCATT and CCTT, both which will have the same visual system. Common source material is a necessary, but not sufficient condition for interoperability and other efforts must be undertaken if a variety of air and ground simulators are going to interact. Items that must be considered include rendered image differences resulting from effects such as polygon thinning, differing fields of view, level of detail changes, etc. Also impacts of special effects (e.g. muzzle flash) and model articulation/color must also be considered between different simulators. Right now, such issues are considered a problem of the plug-in developer; however, the study team considers this to be a fundamental technology gap worthy or independent research. The study team recommends that tools be developed to address these differences and that such tools be created to facilitate design, in addition to validation. Related to validation, the study team recommends that DVED products be independently validated to avoid any perception of bias. Finally, DVED requires the development of plug-ins to extract data in a form useful for a particular image generator. The study team was not able to determine if creation of plug-ins could be created by third parties and if so if they would be cost effective for third parties to produce and re-sell to users. Higher level measures of success are needed to assess program effectiveness. Such measures should include the number of third party plug-ins developed and the number of programs that choose SE-CORE for their virtual environment creation needs.

Finally, it should be mentioned in concluding remarks with respect to SE Core and OneSAF that the study team believes they are innovative and worthwhile efforts in their intent for creating a growing body of standard simulator products.

As mentioned above, the study team found a need to create tools that support and improve the efficiency of creating air-ground training environments. Two particular tools are needed; a correlation tool and a scenario development tool. Terrain correlation between rendered synthetic environments has been a recurring issue since the first heterogeneous connection of devices at the 1992 I/ITSEC. The problem is due to a number of issues including differing coordinate transformation algorithms, polygonization approaches, data base thinning, differing representation of culture, models, and effects, etc. The study team does not believe nor recommend that the situation causing these differences change, only that they be measurable. Although there have been efforts to measure differences in polygonized source terrain (e.g. UCF's Institute for Simulation and Training ZCAP), the study team knows of no products for measuring differences in rendered computer graphics images. As image generation technology is evolving, even the notion of a static polygonzied database is being replaced with databases consisting of core data that is dynamically polygoized at runtime. Determining correlation a-priori is a serious gap identified by the study team and it is recommended that fundamental research be conducted in this area.

A second tool the study team recommends developing is an automated scenario development tool. It is fully expected that the military will continue to develop simulators with different capabilities responding to the variety in user needs. Accordingly, it will be necessary to capture those various simulator capabilities.(AVCATT Component Integration Approach, SAIC, 2006) The complete study report demonstrated the wide range of systems and capabilities in today's Army flight simulation systems. Instead of creating a 'one size fits all' the study team recommended creating a useful taxonomy of aviation simulators and then creating a tool (perhaps based on OneSAF's Scenario Generation System) for guiding users in creating meaningful scenarios based on training needs and available system capabilities. Such a tool can address a multitude of issues. On a practical basis, it can reduce, or even eliminate the manual effort currently required to sustain a training session (restarting crashed pilots, creating targets that a trainee missed etc.) By utilizing dynamic conditions and high level coordinators, such a tool can also ensure that trainees encounter consistent training scenarios, even if their individual performance changes during a scenario. (Bell and Wang, 2002) Such efforts have yielded very successful results in ground vehicle simulators [], albeit for single person simulators. With access to such tools small group instructors can focus their effort on providing instruction and oversight, as opposed to monitoring scenario progress.

Hierarchical levels of interoperability must be created, dependent upon the set of training tasks being conducted using the simulators. All devices need not be of the same capability to achieve a fair fight, but the systems employed in the interactivity must have similar levels of performance. Included in the hierarchy of capabilities should be similar representation of the synthetic environment for tasks involving visual and sensor cues (terrain, manmade and natural culture, field of view), weapons effects and characteristics for engagement tasks (line of sight, flyout models, P_K and P_H), aircraft survivability equipment (radios, radar), etc. (TRADOC Pamphlet 525-66, *Military Operations Force Operating Capabilities*)

As previously stated, the study team recommends AVCATT be the hub for interoperating among aviation devices and CCTT serve that purpose for ground systems. The reason is that these are currently the only simulators designed for collective and combined arms training. In addition to steps being taken to use the same visual systems between these two simulators a complete exercise of interoperability capabilities should be exercised to determine capabilities and establish benchmarks for interoperation and needed improvements. For example, coordinate system commonality, default PDUs (for unknown entities) and radio commonality is needed between CCTT and AVCATT based on recent demonstrations conducted by the Army using both systems. Realizing that contractual, proprietary and technical may be involved, the study also recommends that both programs be more forward looking and accommodating to interacting with other systems.

As part of the FASS Study the potential for games to support the overall scope was reviewed. The focus of FASS being on collective and mission tasks, the need for distributed training tools and the power of desk top or even laptop games would certainly suggest that serious games could play an important role as part of FASS. Work by the Navy with Flight Sim, DARPA with Scud Hunt, Delta 3D and the new Real World initiative and of course America's Army have all demonstrated utility at fairly low cost for various domains. Games offer players opportunity to explore interplayer communications, shared visualization tools, and practice other types of skills embedded in many collective tasks. Army studies show that the "wired generation" is very different in terms of skills and attitudes than its predecessors. (Army Science Board, 2001). Games that are relevant and can be easily distributed to deployed forces to maintain critical skills not routinely being used or where other training is less available potentially fills an important gap. The above perceptions need to be confirmed through testing for example, a comment from the Initial Capabilities Document for Live, Virtual, Constructive-Integrating Architecture and Infrastructure (2005) says, " Commercial "wargames" are not military models and simulations. The difference is in the mathematical modeling and physical activity. The models used by DOD must adhere to extensive Verification and Validation. Commercial "wargames" are designed for entertainment where graphics, puzzle solving, and speed of display take precedence over the fidelity of mathematical modeling of the physical activity. The risk lays in the sacrifice of the fidelity of the simulation to produce stimulus used for training and mission rehearsal. …negative training may occur altering the decision-making process...". For these reasons, need, audience and potential of games for serious training, the FASS study team recommends further investigation into the use games as part of the FASS overall training strategy. The key will be to ensure sufficient analysis of task requirements are translated into well designed games that demonstrate training effectiveness and skill/knowledge transfer.

Programmatic Aspects

Four programmatic components are suggested by the study team. These include creation of a persistent network infrastructure supporting Army collective training, development of a virtual testbed to experiment with collective training strategies and simulator technologies, moving forward aggressively in addressing the details of interoperability, and creating communities of interest that review and add to the body of knowledge related to SE Core and OneSAF.

One impediment to training anytime is the availability of network bandwidth, network connectivity, and the proper level of security. The Army has access to networks to support simulations, but connectivity needs to be arranged in advance, connections are to the installation and not always to the simulation site, and security of the network and simulators is uneven often precluding large exercises. In addition, it is not always clear who has the responsibility for delivering the appropriate level of connectivity to the simulator. In their Distributed Mission Training program, the Air Force has a contractor run network and a contractor owned network where interconnections can be made between the multiple networks to support training or various experimentation. The study team recommends that the Army use this model in designing a network that will meet their evolving collective training needs.

It has been observed by the study team that interoperability is an ambiguous term and this paper has recommended a more distinct definition and establishment of metrics. This activity should not be done in a vacuum, but should be exposed to the widest possible audience for review and debate. The Simulation Interoperability Standards Organization is a good venue for such a discussion. Caution should be taken, though, to ensure that the process moves forward on a timely basis.

OneSAF and SE Core are both excellent examples of a new way of developing systems employing an integrated government industry team. However, this team is focused on delivering prototypes under specific contracting mechanisms and is therefore somewhat insular from the broader community. It is recommended that both programs actively create user groups and communities of interest so that companies, programs, and government agencies can better understand what is coming out of these programs, when it is coming, and opportunities these other constituencies can use to leverage the products of OneSAF and SE Core. Broadening the base of the user communities should have neutral to beneficial cost impact and provide ideas on extensions that the project team might factor into future versions. As stated earlier, it is also recommended that one version of

these products be produced and that a mechanism be established to have them independently vetted.
The study team recommends the creation of a virtual testbed. This testbed would leverage existing assets and capabilities resident in Orlando (simulation technology), Huntsville (aircraft and equipment), and Fort Rucker (training). These lines are not distinct, but are generally true. Additionally, other government and contractor locations would be brought in as needed. The virtual testbed would be used to evaluate concepts in a controlled setting. Many ideas are currently left to the acquisition process to determine whether they are viable resulting in cost and schedule risk to programs. The study team does not recommend the establishment of a fixed facility because of equipment and infrastructure costs, and rapid obsolescence in the fast paced technological world of simulation.

Cultural Aspects

Many of changes recommended have cultural impacts. Two of the principal areas are in training infrastructure and government-industry business relationships. The study team felt it important to bring these cultural issues forward because they will impact the speed and totality of acceptance of recommendations contained herein.

The Army's approach to training is reflected in its Aircrew Training Manuals (ATM's) for each platform. Some of the training requirements prescribe (i.e., direct) the use of simulation while other requirements describe (i.e. suggest) training among other alternatives to train a task. Currently, collective training is not included in those ATM's. Additionally, the study team found use of the AVCATT to be uneven at different installations. Some of this unevenness may be due to increased deployment of aviators given the current situation in Iraq and Afghanistan. However, some of the unevenness is due to perceptions from users and trainers that AVCATT is a step backwards in terms of training fidelity and therefore of lesser utility for training. Remedying this situation could be accomplished by making training using AVCATT a prescriptive requirement. However, a prescriptive requirement is not recommended by the study team due to overloading an already busy set of requirements on aviators. The study team recommends a cultural change requiring education (as noted), but also requiring time and leadership in making the benefits and approaches to simulation based collective training better known to and reinforced to the aviation community.

Cultural change is also anticipated resulting from the SE Core and OneSAF efforts. There are two important aspects to this change. First, if the government is developing standard products, they will assume a greater responsibility in the acceptability of the resulting system. Secondly, many simulation development efforts entail a large amount of systems integration. Standard products will move the effort and innovation from integration to products resulting in a changing business model for many contractors. The study team sees that recognition of these changes will require adaptation by the acquiring agency and development contractor.

NEXT GENERATION AVIATION SIMULATION SYSTEM ARCHITECTURE

While many changes are recommended to existing systems or those already in the pipeline, the study team recommends that the Army begin the process to investigate a new start program that supports advances suggested in the study, but bundles them into a coherent system. The Next Generation Aviation Simulation System (NGASS) should accommodate advances recommended herein, but also provide advanced features currently not readily apparent in aviation simulation devices.

The NGASS architecture is based on a system of systems concept. An individual NGASS is shown below in Figure 1 while a system of NGASS devices is depicted in Figure 2.

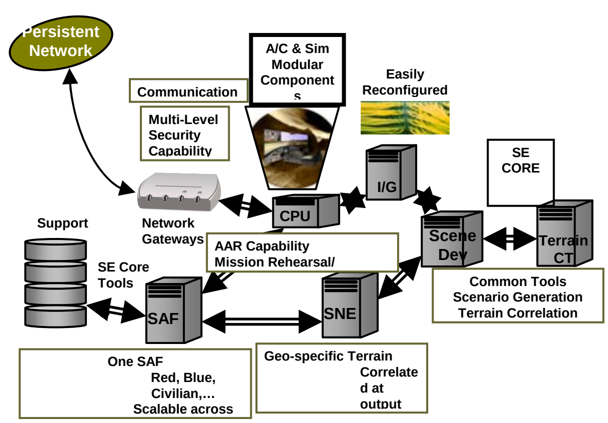

Figure 1. Individual NGASS Architecture

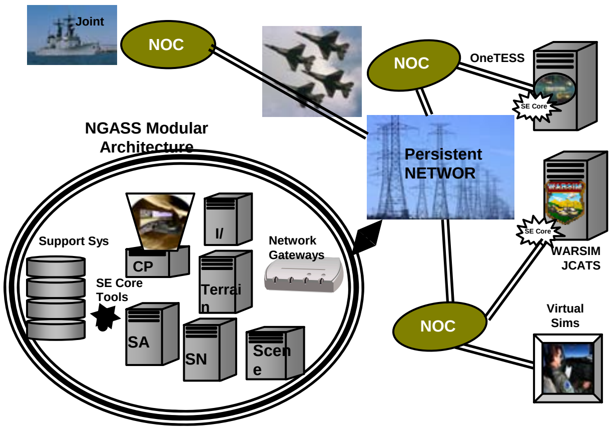

Figure 2. NGASS System of Systems Architecture

Many aspects of this architecture require further definition, but there are a number of areas known at the time of this work. In addition to the areas noted previously principal areas included in the architecture are government ownership (vice management) of the program, true modularity in NGASS components, use of re-host operational flight programs (R-OFP), integration with C4I equipment, and a catalyst for implementation of the Live, Virtual, Constructive – Integrating Architecture.

The NGASS will require active government participation and program ownership. This step might seem evident to many, but many aspects of current simulations remain proprietary limiting the procuring agency's ability to seek other sources to implement changes, conduct experiments, etc. While many innovations will continue to be proprietary, the study team believes that the proprietary nature of many systems can be protected through a detailed architectural framework, strong interface definition, accompanying performance specification for each component of the system. Enhanced performance or expansions of the interfaces can then re-baseline the system.

In a related area, the NGASS architecture must be sufficiently modular to accommodate changes in simulation AND aircraft components. Typical upgrades to simulators include image generators, displays, and instructional features (e.g., after action review). Common aircraft changes include aircraft survivability equipment, navigation, weapons, and radios. It is especially important strong interfaces be established and cross-correlated, where indicated, between these various systems to ensure concurrency. Additional aspects of modularity will be considered to allow the architecture to support variations in simulator fidelity. Included here is aerodynamics, propulsion, aircraft systems (e.g. electrical, hydraulic), etc.

A particular area of focus by the study team was related to the impact of using operational flight programs in the simulator. After careful review of current programs it was determined that the best path forward is to use re-hosted operational flight programs (R-OFP). This approach retains the OFP functionality, allows for reasonable periods for updates with respect to concurrency, and avoids problems that arise from using OFP's. Problems include acquiring and using operational computers and accommodating simulation unique functions such as freeze and restart.

Related to OFP's is accommodating current and future C4I equipment in the simulation. Accommodating the functionality and interfaces accompanying this equipment can serve multiple purposes in NGASS including facilitating collective training through tactical operation centers and establishing some level of a common shared environment with other systems, especially as may related to connections between live and virtual systems.

The study team also believes that while the current efforts related to creating a live, virtual, constructive integrating architecture (LVC-IA) are moving forward, the program is currently fluid with many approaches and instances of LVC. For example, the study team witnessed a specific instance of LVC in a demonstration at Fort Hood and heard of other efforts at Fort Leavenworth. There are also efforts from other military organizations that are addressing broad LVC-IA issues (e.g., JFCOM). The study team recommends that the evolution and eventual development of FASS can be the leader for instantiating LVC-IA and a baseline standard for others to emulate.

CONCLUSIONS

The results of the study indicate that while current training needs are being addressed, additional research, development, and experimentation is needed to gain additional efficiencies needed to meet anticipated training needs. These needs have been expressed as gaps with suggested approaches for bridging the gaps.

Our study recognizes the investments planned and made for aviation simulators for training and has suggested several courses of action that would increase the flexibility of existing or currently planned simulations to support collective air-ground training. It is also believed that the flexibility to train for the next conflict will grow because as history has shown the details of those conflicts are not known a priori. Accordingly, it is appropriate to plan for a new generation of simulators that embody these future requirements.

ACKNOWLEDGEMENTS

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