MSIAC's M&S Journal Online

Volume 1, August 2006

The Modeling and Simulation Information Analysis Center (MSIAC) M&S Journal Online is now available as an automated service.
Simply send an email to journal-subscribe@pan.msiac.dmso.mil to be added to our mailing list.
This list is for the Journal Online only and will not be used for any other purpose.
Please note that it is not necessary to subscribe each month.
If you would like to submit a technical paper for consideration for the Journal Online,
please email it along with contact information to msiachelpdesk@msiac.dmso.mil.

COMMUNICATION MODELING OF TRAINING AND SIMULATION TRAFFIC IN A TACTICAL INTERNET

Carlos Leon-Barth[1], Ronald F. DeMara[1], and Henry Marshall[2]
Department of Electrical and Computer Engineering
University of Central Florida
Orlando, FL 32816-2450
jleonbar@mail.ucf.edu.com, demara@mail.ucf.edu,

Simulation & Training Technology Center
RDECOM, AMSRD-STTC
12423 Research Parkway
Orlando, FL 32826
Henry.A.Marshall@us.army.mil

ABSTRACT

This paper addresses the bandwidth and latency optimization of Embedded Simulation (ES) communications within tactical Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) networks while supporting an Enroute Mission Planning and Rehearsal (EMPR) for ground combat vehicles and other use cases. Simulation data obtained from One Semi Automated Forces (OneSAF) Testbed Baseline simulations is consistent with Future Combat Systems (FCS) Operations and Organizations scenarios of multiple-platoon, company, and battalion-scale force-on-force EMPR vignettes. The resultant simulation traffic is modeled and assessed within a hierarchical communication architecture consisting of Manned Platforms, Distributed Common Ground Systems (DCGS_A) and Multiband Integrated Satellite Terminal (MIST)s interconnected to Joint Tactical Training System (JTRS) and Warfighter Information Network-Tactical (WIN_T) networks, as foreseen by Future Combat Systems (FCS). The mentioned battle support vehicles operate as routers and hubs that interconnect Unmanned Air Vehicles (UAV), Unmanned Ground Vehicles (UGV), Apache Helicopters (Ah64) and Land Warriors (LW) with Continental United States (CONUS) based on a wireless C4ISR network infrastructure. The entire operation is directed and controlled via a CONUS based ground station and its corresponding satellite network.

Within this environment, three areas of ES bandwidth and latency research are addressed: *Simulation Traffic Analysis*, *Data Transmission Optimizations*, and *Traffic Modeling Tools / Demonstration sets*. Simulation Traffic Analysis tasks include the development of a tentative network for FCS and Simulator Training systems that can be used to analyze Packet Data Unit (PDU) transmissions of the most critical entity actions and assessment of the *operational-distribution of PDUs*. Future Data Transmission Optimization tasks include the development of *burst-free transmission scheduling*, *PDU replication*, *data compression*, and *OPFOR control hand-off* techniques. Traffic Modeling Tool activities include the creation of *libraries for network capacity planning* and a self-contained *traffic modeling demonstration package* using Omnet++. Within this environment, we present results for *capacity estimates* for ES bandwidth in FCS battle applications.

FCS Bandwidth Optimization Problem.

Over the past decade, the U.S. Army's principal modernization initiative has been its digitization effort, designed to significantly improve the fighting capabilities of soldiers on the battlefield. But implementing that initiative presents significant challenges. Digitization requires the rapid transmission of large amounts of information over significant distances. Experiments conducted to date as well as recent operations in Iraq, where troops employed some of the results of the service's digitization efforts, have shown that that requirement is difficult to fulfill in any terrain conditions.

Consequently, the focus of the Army's modernization program has shifted in 1999 to what it terms transformation—making its forces deployable more quickly while maintaining or improving their lethality and survivability. Although digitization is no longer the Army's primary modernization initiative, it remains a key element of transformation. In the past several years, questions about the size of the information flow associated with digitization and the communications bandwidth to support it, have spurred the Army to adopt several large radio and network communications programs to study the total network capacity of Training Simulations and Real-Time battle communications to predict future FCS design considerations.

Future bandwidth demand shall increase as suggested by Rehmus[1] on his report to the Congressional Budget Office (CBO). He predicts that the peak network demands for the year 2003 are greater at the Brigade and Battalion levels by a factor of 10 to 20 when compared to standard network demands for networks that serve the Operations Officers (ops nets). That is, one message arrives on time for every 10 to 20 sent. Future advances in communications equipment that the Army plans to support include Joint Tactical Radio System (JTRS), Warfighter Information Network-Tactical (WIN-T) and Multiband Integrated Satellite Terminal (MIST) to further support communications at the brigade division and corps command levels increasing further the bandwidth needs. FCS shall exceed the current demands by 10 fold at the Corps and Division Command areas, due to the increase in video and imaging information[5]. In addition, lower communication noticed at other command levels will also increase in the future due to the added support systems and unmanned vehicles planned for FCS use.

Foreseeing the immense bandwidth needs, the Army is trying to reduce its current bandwidth demands by slashing functionality. Broadcasting UAV images, teleconferencing and other bandwidth intensive applications is no longer possible. Useful information has been replaced or eliminated to accommodate the existing network technology such as JTRS and WIN-T. Ironically, decreasing bandwidth needs reduces the success of the Army's digitization Initiative.

The Army faces a number of problems in implementing its IT strategy on the battlefield. The service needs much more bandwidth than it has available today to support both its current systems and those planned for the future. Being Bandwidth the central issue for the communications system, we propose to study the future network requirements. Unfortunately, real time bandwidth measurements are rather complex, particularly when the network topologies are not well defined. To analyze the communication needs we propose to obtain Semi-Automated Forces (SAF) data from the OneSAF Testbed Baseline Simulator (OTB), used by the Army to plan, execute and review battles in remote locations. OneSAF can provide useful data to further study the future network requirements of FCS. Then, using a network constructive discrete simulator such as OmNet++[2], it is possible to further study the future bandwidth needs and suggest possible optimizations.

Bandwidth considerations for FCS Simulation model.

FCS networks, vehicles and system functionality depend on existing and emergent technologies. Thus, effective bandwidth measurements for future combat systems are difficult due to the inventiveness of the designs. However, certain Bandwidth expectations for certain vehicles are estimated based in information provided by Army Subject Matter Experts (SME) [5]. Data rates have been assigned for certain vehicles for voice, data and imagery. Table 1 lists the effective data rates for FCS vehicles.

FCS Vehicles and Effective Bandwidth.

FCS Vehicles and Support Systems	V:VOICE D:DATA I:IMAGE V:VIDEO	VOICE DATA RATE (Kbps)	VOICE DATA PACKET SIZE (KB)	DATA DATA RATE (Kbps)	DATA PACKET SIZE (KB)	IMAGERY DATA RATE (Kbps)	IMAGERY PACKET SIZE (KB)	VIDEO DATA RATE (Kbps)	VIDEO DURATION (sec)
Aerial Common Sensor	D,I			60	60	60	6144	1000	10
AQF/Prophet	D			30	60			1000	10
AWACS	V	100	20						
Comanche	I			5		5	6144	1000	10
Global Hawk/Predator UAV	D,I			300	60	300	6144	1000	10
J-STARS	NA			NA	NA	NA	NA	NA	NA
Rivet Joint	D			300	60				
Satellite	D,I			600	60	600	6144		
U-2 ASARS II	D,I,V			300	60	300	6144	1000	10
Unmanned Aerial Vehicle (UAV CL I)	D,I,V			0.017	5	10	410	1000	10
Unmanned Aerial Vehicle (UAV CL II)	D,I,V			0.017	5	10	410	1000	10
Unmanned Aerial Vehicle (UAV CL III)	D,I,V			0.017	5	10	820	1000	10
Unmanned Aerial Vehicle (UAV CL IVa)	D,I,V			0.017	5	10	820	1000	10
Unmanned Aerial Vehicle (UAV CL IVb)									
Unmanned ARV-A(L) (2.5 ton)	D,I,V			0.017	5	10	410	1000	10
Unmanned ARV-RSTA (6 ton)	D,I,V			0.017	5	10	820	1000	10
Unmanned Ground Vehicle (MULE)	D,V			0.017	5			192	86400
Unmanned Ground Vehicle (SUGV)	D,I,V			0.017	5	10	820	1000	10

Table 1: FCS Vehicles Effective Bandwidth.

Tanenbaum [6] defines Bandwidth as the range of frequencies transmitted without being strongly attenuated. It can be attenuated as transmission distances increase. Bandwidth units for digital media is known as Bit Rate, the number of bits per second transmitted; not to be confused with Baud Rate the number of signal changes per second. Bit Rate and Baud Rate are related by the following equation.

$$\text{Bit Rate} = \log_2 M * \text{Baud Rate} \ [7]$$

Therefore, Bandwidth decreases with distance and terrain interference and transmission medium used, an additional channel characteristic that needs to be modeled when building C4ISR network channels. Note that Throughput is analogous to Bandwidth.

Communications traffic can be thought of either approximately continuous or episodic. In the former case, called continuous-flow information (throughput), a bit per second (bps) is the relevant measure; in the later case, referred to as episodic, the size of the message file (in bits) is the appropriate gauge. Table 1 one depicts voice, data, video and imaging throughput for the most common vehicles. Notice that some vehicles transmit voice data only, as the Airborne Warning and Control System (AWACS), while others transmit voice, video and images using the same channel, e.g. UAV.

Building a network simulation using OmNet++ modules to represent FCS network communications is possible. The resultant Bandwidth capacity of the C4ISR based FCS network can be simulated by encoding the corresponding wireless channels and their bandwidth capacity. Satellites, Vehicles and Land Warriors can be modeled as network components with specific data generation characteristics and effective bandwidth. Since all modules in the system transmit in broadcast mode (DIS specification), the overall network throughput and the channel collisions can be analyzed to optimize the available bandwidth. Moreover, channel bottlenecks and slack time can be studied to further optimize the overall throughput. However, simulation and modeling and the software that makes then function is designed according to certain assumptions about the communications network in which they operate and the rates of information available as parameters. Therefore, the results of this experimental simulation are an attempt to provide measurable results and determine the possible network tribulations that future combat systems may present as they intercommunicate through different networks and satellite links in benign environments.

OMNet++ Modeling

OMNeT++ is a discrete event simulation environment. Its primary application area is the simulation of communication networks, but because of its generic and flexible architecture, is successfully used in other areas like the simulation of complex IT systems, queuing networks or hardware architectures as well. The simulator provides component architecture for models. Components *(modules)* are programmed in C++, then assembled into larger components and models using a high-level language *(NED)*. Models are provided free of charge[3].

For this particular simulation we choose to model a communications topology based on a battle scenario suggested by the Army SME. The *used case* involves land-unmanned vehicles, air and land support and UAVs, all communicating at a Brigade level. (A brigade is the smallest Army force structure that utilizes a satellite link [1]. A brigade is typically commands the tactical operations of two to five organic or attached combat battalions. Normally commanded by a colonel with a command sergeant major as senior NCO, brigades are employed on independent or semi-independent operations. Armored, cavalry, ranger and Special Forces units are categorized as regiments or groups [2]).

Four communication channels are necessary and modeled according to the characteristics suggested in C4ISR document for wireless communication [4] and the bandwidth predictions for JTRS (200 Kbps) and WIN_T (2.5 Mbps) networks obtained from [1].

The following figure 1 is generated by the OMNet++ simulator and depicts the current network layout. The first channel is the *wireless ground to satellite (wirelessGS.)* This channel connects CONUS networks with the satellite network that transmits battle command information to remote locations all over the world. The second channel, *wireless to ground network (wirelesWSGN)* supports apache helicopters (AH-64) and Distributed Common Ground Systems (DCGS) vehicles that serve as a router to *WIN_T* networks*.* The third channel, *WIN_T* connects DCGS vehicles with Manned Platform Vehicles as they also serve as a router for JTRS networks. The last and fourth channel connects wirelessly all Unmanned Ground Vehicles (UGV), Unmanned Air Vehicles (UAV) and Land Warriors (LW) together.

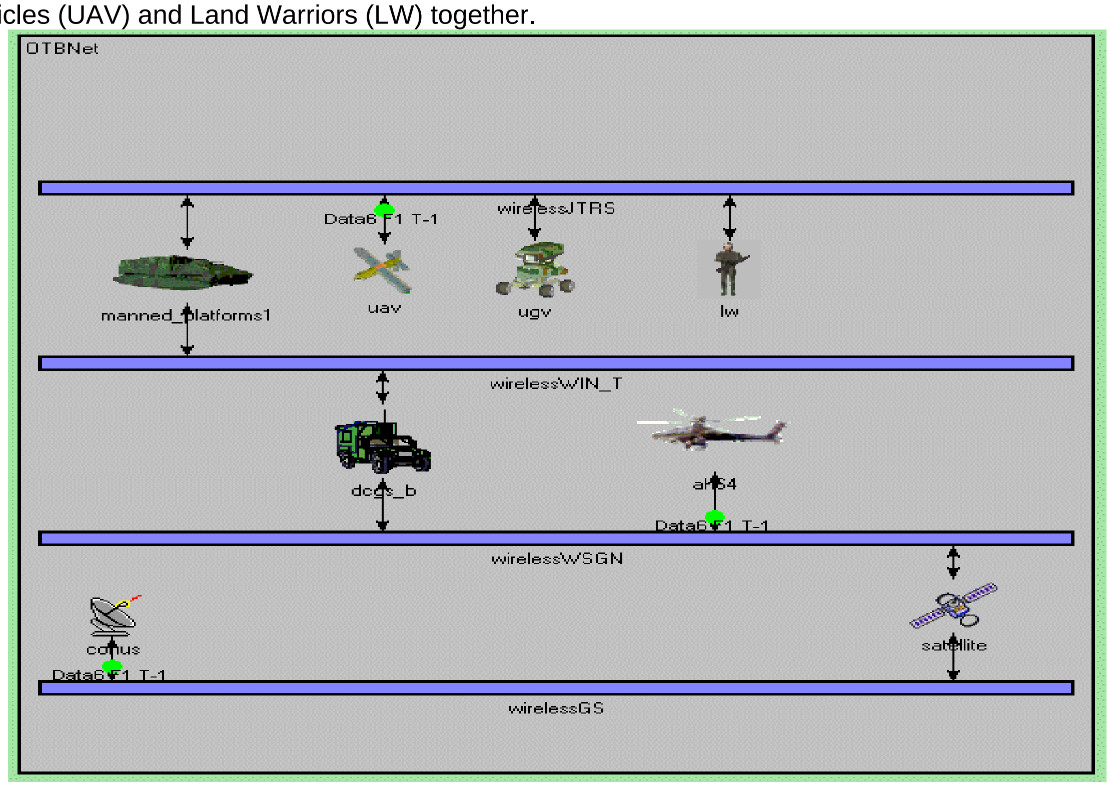

Figure1: OMNet++ C4ISR network channel connections for WIN-T and JTRS networks.

Each channel depicted in blue (elongated rectangles), serve as a bus that transports data from one network channel to the other. Channels are modeled according to the channel characteristics of the protocol. e.g., Wireless LANs use IEEE 802.11 protocol.

Models connect to each channel using *nodes* a sub-module provided by the channel. There is a one to one correspondence between modules and channel nodes. Figure 1 depicts several green colored circles, these are the packets sent by each host generator. Each module is defined according to the desired module specification and characteristics.

A simple module contains a *Generator* and a *Sink*. *Generators* are sub-modules programmed to generate packets at their discrete time only limited by the throughput of the channel it connects to. Generators will broadcast a packet when the packet's time is due. If the packet is to be sent at time t, but the bus due to its limited bandwidth cannot service it, a negative time slack is created and recorded. If the packet leaves on time, a positive slack is recorded. If the packet is serviced, but on his way out to the channel collides with an incoming packet, a *collision* is detected and recorded. The *Sink* on the other hand, will retrieve packets from the channel with a destination address of –1 (Broadcast Destination) or its own destination (network dependent number). Figure 2, depicts the internal configuration a UAV as shown by OMNet++.

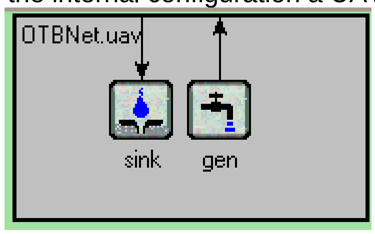

Figure 2: UAV internal sub-modules.

The *Generator* can be programmed to create data packets at a specific data rate and size or it can read data from data text files a rate determined by each in packet's timestamp. When data from an Army simulator is provided such as OneSAF, data can be parsed and reorganized to be read later by the *Generators*. Figure 3 depicts the current data format for packet generation using a text file, therefore for this method, data from OneSAF needs to be parsed accordingly to meet the following requirements.

Column 1 contains packet time information in Hexadecimal 1/100 of a second. The next column contains the packet size information. Original data is converted to generate columns three and four. The *Generator* module reads the data text file and generates Column 3 which contains the converted time in Min:Seconds.Hundreths of a second. Column 4 contains the line number.

0x4f690c7a	32	:18:36.707	1
0x4f7ab058	32	:18:37.676	2
0x4f8ca818	32	:18:38.663	3
0x4ffc8a88	92	:18:44.809	4
0x513da63a	100	:19:02.448	5
0x51752798	92	:19:05.497	6
0x531629f4	92	:19:28.404	7
0x53617074	100	:19:32.539	8
0x548db8ba	92	:19:49.034	9

Figure 3: Data format for packet generation using a text file.

In cases where a single module will generate three different types of data, three *Generators* will be contained in each module, one for each data type and rate.

Once all network components are in place, different network configurations can be explored by rearranging the connections to the channels. Statistical results based on different simulations can be used to aid future designs. The goal is to determine if the current bandwidth utilization is wide enough to accommodate FCS.

Simulation Results

Peak effective bandwidth demand for future combat systems can exceed the current expectations. The Army has studied the peak demands for continuous flow-information on division, brigade and battalion levels for the digitized division. The study has found that peak effective bandwidth can be between 2.5 Mbps and 4 Mbps. Our intent is to find the possible bottlenecks in the system and further optimize transition to obtain better bandwidth optimization.

Vehicles such as the Manned Platforms, Army Battle Command System (ABCS) and the DGCS act as centers of communication in the battlefield. Such vehicles act as routers for the JTRS and WIN_T networks and Satellites used in battle at the Brigade, Division and Corps levels. These vehicles are suspects of intense collisions due to the intense routing they perform. The present simulation shall provide collision information on these vehicles as results are obtained from OTB sample data. Unfortunately, the used cases utilized for FCS using OTB have not yet been released as unclassified. Such data and the results of the proposed OMNet++ simulation shall be available prior to the oral presentation.

However, the following graph presented on figure 4, depicts the bandwidth utilization results of an earlier simulation at the satellite module using similar OMNet++ models that supported Joint Tactical Training System (JTRS). The OTB vignette supported six C-130 Hercules air carriers on flight and the communication between them as a battle training simulation was executed inside the three vehicles that each plane transports. Data used on this Omnet++ simulation was also obtained from OTB. It is easy to observe that a 200 Kbps channel is necessary at the satellite link to provide optimal service.

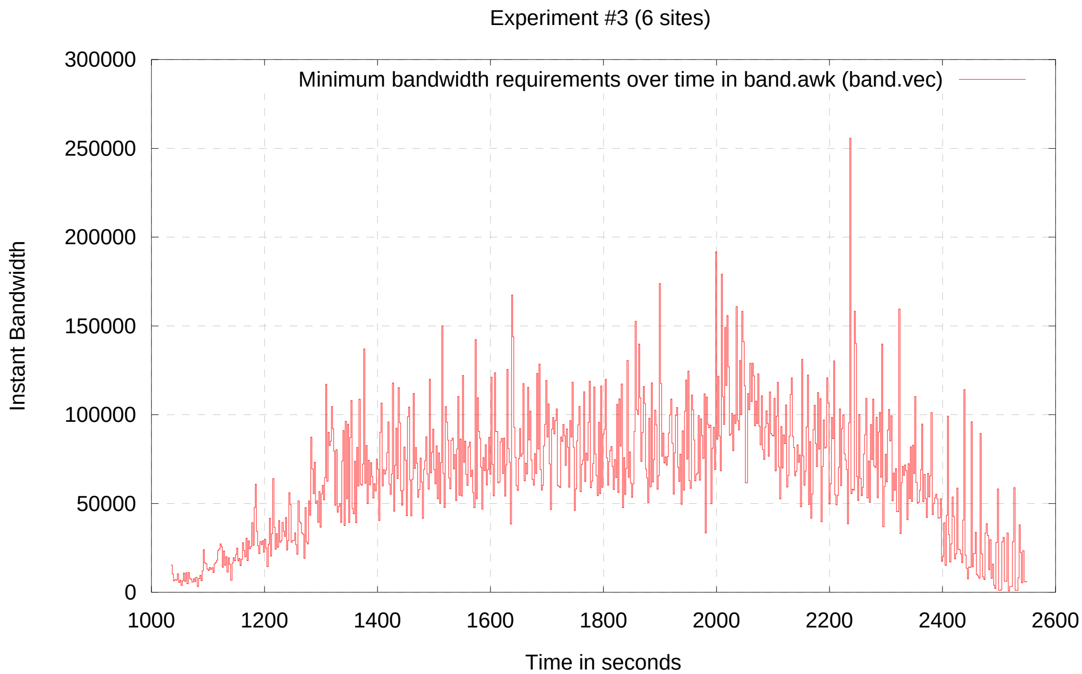

Figure 4: Bandwidth Utilization Results

The suggested data rates depicted on table 1 for the unmanned vehicles are ready to be used and incorporated into the respective modules and provide additional data to the JTRS and WIN_T networks. As we receive the Army OTB unclassified data that represents the bandwidth utilization of our C4ISR proposed network, our simulation shall produce similar results as proved useful in earlier simulations.

References

[1] Rehmus, P. Gilmore, M. (2003) **The Army's Bandwidth Bottleneck.** [Electronic Version] *The Congress of the United States, Congressional Budget Office,* Washington DC, August. Retrieved November 19, 2003, from http://www.iwar.org.uk/rma/resources/cbo/08-28-Report.pdf

[2] **The Army's Force Structure.** Retrieved November 28, 2003, from http://www.militarydial.com/army-force-structure.htm

[3] **OMNet++ Discrete Event Simulator System.** Retrieved on November 26, 2003, from http://www.omnetpp.org/.

[4] Web, Richard. **C4ISR Architecture Framework 2.0**. (1997, December) Retrieved on November 26, 2003 from http://www.defenselink.mil/nii/org/cio/i3/AWG_Digital_Library/pdfdocs/fw.pdf

[5] Francis, Paul L. **Understanding FCS.** (2003 August) Retrieved on October 26, 2003 from http://www.gao.gov/new.items/d031010r.pdf

[6] Tanenbaum, Andrew S**. Computer Networks.** 4th ed. (2002) Prentice Hall
[7] Spragins, John D. **Telecommunications: Protocols and Design.** (1992) Addison-Wesley Publishing Company, Inc.

BIOGRAPHIES

Carlos Leon-Barth is a Research Assistant and Ph.D. student in the Department of Electrical and Computer Engineering at the University of Central Florida. He earned a BS (1993) in Electrical Engineering from University of Florida, MS (1996) in Computer Engineering from the University of Central Florida. He was previously a Consulting Engineer for IBM Global Services in Armonk, New York from 1996-2002. His research interests are performance analysis of Computer Networks and Simulation.

Ronald F. DeMara is an Associate Professor in the Department of Electrical and Computer Engineering at the University of Central Florida. He earned a BS (1987) in Electrical Engineering from Lehigh University, MS (1989) in Electrical Engineering from the University of Maryland, and Ph.D. (1992) in Computer Engineering from the University of Southern California. Prior to joining UCF, he was an Associate Engineer at IBM Corporation in Manassas, Virginia. His research interests include design and performance analysis of Computer Architecture and Distributed Systems. He has published over 80 papers in these areas. He is a registered Professional Engineer in California, senior member of IEEE, a member of ACM, and ASEE.

Henry Marshall is the Principal Investigator for Mounted Embedded Simulation Technology at the Research, Development and Engineering Command (RDECOM) Simulation and Training Technology Center (STTC). Prior to this assignment he worked at the Simulation, Training and Instrumentation Command (STRICOM) where he spent 11 years as lead for the CGF/SAF, HLA and Linux Porting developments on the Close Combat Tactical Trainer (CCTT) system in addition to being a OneSAF team member. His twenty years with the Government have been mainly in CGF and Software acquisition. He received a BSE in Electrical Engineering and an MS in Systems Simulation from the University of Central Florida.

VIDEO GAME TRAINING

Eric Minton
Today's Officer
January 24, 2005

Here is something parents everywhere won't want to read: video games can make you smarter. Not that you should let your kids sit six hours in front of a computer or Xbox playing virtual warriors. But when such stints use real-life scenarios, include constant feedback and ratings, and meld with an overall training regimen that includes book study and live experience, video games make for a wiser and more adaptable individual and team player.

That is what the U.S. military is discovering as each branch embraces video games and gaming technology in their training regimens. This is more just catering to a generation that knew the joy of joysticks while growing up instead of toy soldiers and teddy bear tea parties. This is a trend driven by available technology, by budget constraints, by gaming's effectiveness in developing social and cognitive skills, and by, well, a generation of new soldiers, sailors and airmen who have known the joy of the joystick all their lives.

"Frankly, every 18-year-old has played a video game," says Michael Macedonia, chief technology officer for the U.S. Army's Program Executive Office for Simulation Training and Instrumentation (PEO STRI) in Orlando, Florida. "Every 18-year-old coming in the Army knows how to read, too. This is just another technology out there (Army training) can take advantage of." He points out that Army schools used to play

Avalon Hill battle board games, too. “The bottom line is we will do anything so that we don’t have to train through blood.”

Virtual blood is, of course, part of the video gaming culture, which brings us to the tricky definition of “gaming” technology. For the military it’s the ability to do the latest bells and whistles or, in video game land, special effects and interactive graphics. Layer into that the Internet and you have games played simultaneously by participants in classrooms, aboard ships, on aircraft and in bunkers. “We define what a game is by the emotional response in a player,” says Rosemary Garris, research psychologist with the Training and Human Performance Research and Development Branch at the Naval Air Warfare Center Training Systems Division in Orlando, Florida. Some of this she describes as the “silliness factor:” the player hits a target or right answer and gets an explosion or gleeful noise as reward. Games also track performance measurements, Garris says; i.e. keeps score.

Given these fun responses, the tug at our competitive natures and the ever-improving graphic displays every person interviewed for this story, from instructor to engineer to Marine colonel, used the word “cool” at least once games have an advantage over other media in a training curriculum in that they enrapture and motivate the students. Remember, though, the word “game” is not always about fun: think of the seriousness with which the military has always used that word, as in “war games.” Thus, the primary purpose of video games in training is to improve cognitive and decision-making skills. Though some games and simulator programs teach manual procedures and dexterity, the majority used by the military are mental games.
Military video game developers therefore make sure the experience is about handling a scenario rather than winning. “One of the potential drawbacks to using gaming technologies is that instead of the learning points and proper tactics, techniques and procedures you are trying to get across, (the student) wins by knowing how the game works,” says Michael Woodman, project manager for the Marine Corps Tactical Decision-making Simulations (TDSs). In other words, when developing video games for military training, “We don’t allow cheat codes.”

The four services work with established game developers, such as the Institute for Creative Technologies at the University of Southern California, Forterra Systems Inc. and BreakAway Games, to customize the games for their specific training needs. One such game is the Army’s version of one of the most popular games on the Internet, *Full Spectrum Warrior*, a 3-D strategy game in which the player maneuvers an infantry squad. “You don’t fire your weapon, you have to fire the squad,” Macedonia says. “You have to be successful in the mission, not lose any people, and follow the rules of engagement.” The Army also is developing a project called the Asymmetric Warfare Environment, a massive database server containing myriad 3-D virtual worlds that can be networked with personal computers and laptops anywhere in the world. “You could build a place like Fallujah, and people can go train in Fallujah whether they are in Tikrit or Alabama, and they can train together and ride together,” Macedonia says.

A new version of the Marine Corps’ *Close Combat: First to Fight* takes the artificial intelligence quotient a step further by giving all virtual members of the fire team abilities in Marine Corps doctrine known as “Ready-Team-Fire-Assist.” Instead of the player micro maneuvering the members of his team, those members automatically engage in mutual support tactics, “just like a real Marine would,” Woodman says. “So, the fire team leader can focus on his responsibilities as a team leader, focus on the commands he needs to give when they are called for.” The game could be set to a multiplayer mode, too, with other Marines maneuvering the team members. The Marine Corps also is developing an Anti-Terrorism TDS in which the player conducts real-time strategy from a third-person point of view, and Joint Terminal Attack Controller (JTAC), which provides a first-person point of view to a developing battle. The two games will be interoperable so that a platoon commander can maneuver forces using the Anti-Terrorism TDS while those forces, using JTAC, actually engage in the virtual battlefield. *First to Fight* will even be layered into the system. “It will enable us to work back and forth across the levels,” Woodman said.

The U.S. Air Force is using such networking capabilities to create a Distributed Mission Operations system hooking up different flight simulator sites around the world so that various crews can train together. This will allow virtual training of four-ship formations with other four-ship formations, with AWACS and with JSTARS and eventually with forward ground controllers all without spending an ounce of jet fuel. Meanwhile, on a much simpler level of technology and a heightened level of silliness, the syllabus for the Air Force’s T-38 pilots in training at Randolph Air Force Base, Texas, now includes a video game put together by Andrew

Ranft, program manager for T-38 Courseware at Air Education and Training Command Headquarters. With cockpit graphics and audio feedback, the hour-long game is intended as a refresher test on T-38 emergency procedures and operating limitations before the pilots' check flights. The four-part format is based on popular television game shows: *Jeopardy*, *Wheel of Fortune*, *Who Wants To Be a Millionaire* (rise in rank from cadet to chief of staff by answering questions: a wrong answer ends the game with the computer emcee saying "You are dismissed!"), and *Hollywood Squares*, an assembly of nine cartoon characters such as a crusty old instructor pilot and retired SR-71 pilot giving answers that may or may not be correct. "Everybody who sees it is wowed by it because it is so out of character of our normal courseware," Ranft says.

In the Navy, submarine trainees take a Virtual Interactive Shipboard Instructional Tour (VISIT), a scavenger hunt to get students acquainted with the ship, a game that is being expanded to include other types of vessels. Submariners also undertake a lot of training while underway, and because subs don't have room for full-scale simulators, sailors use laptops to play the Submarine Skills Training Network featuring periscope and equipment simulations. With the latter, the Navy is incorporating gaming elements, Garris says, such as vivid color, dynamic sequences and various feedback and effects. "Our theory is if you put the right components in, hopefully you can create those emotional responses in players that would encourage behaviors you want in students," she says. In tests, students who had used the simulators with game components scored better than those students who used the more traditional training.

This is a rare instance of researched data showing the cognitive benefits of computer games in training regimens. More prevalent is anecdotal evidence endorsing video gaming's effectiveness. Marine and Army officials say that informal surveys indicate that infantry units practicing on computers performed better in live training than units which had not gone through virtual training. "You get over the rough learning points in a very inexpensive manner," Woodman says of video game training. "When you go to live training you're past the little stuff, and the training you can do there is more advanced. Those Marines who spent a week with us (on TDSs) going into the field were better trained than Marines that had already spent two weeks in the field." Cost-effectiveness, as much as cognitive-effectiveness, is a major part of the equation in video game training and simulation. "Live field training is very expensive in terms of time, support, ranges, fuel, ammunition, the whole gamut," Woodman says. Consider the cost of MOUT training, Military Operations in Urban Terrain. In live training a unit could perform perhaps three evolutions "on a good day," Woodman says. On computer that unit can do up to 40 evolutions, honing skills through repetition and feedback. The computer also can introduce a variety of iterations and terrain, something not possible in a live setting. "That is not to say these games will ever replace live training; we design them to augment live training," Woodman says.

"For the true experience you can't do any better than doing it for real, doing it live," Colonel Walt Augustin, program manager for Training Systems, Marine Corps Systems Command in Orlando. "But, I would submit that you can learn certain skills faster on a game because you can go through it quickly, repetitively and get immediate feedback."

Saving money has always been the inspiration behind flight simulators since the 1930s; a student pilot who makes a mistake in flight can destroy an expensive aircraft, and the best way to practice avoiding fire is through simulation. "We don't like to shoot missiles at our good airplanes," says Mark Adducchio, director of engineering for the Simulator Systems Group, Agile Combat Support Wing at Wright Patterson Air Force Base in Ohio. "You're actually flying against perceived enemy aircraft and ground targets you can't really do without simulation. We strive to make our pilots sweat in our simulator cockpits."

Macedonia believes the Army turned to simulation training after the Vietnam War because not only were soldiers in that war poorly trained for the type of combat they encountered, but an all-volunteer Army made proper training a smart investment. "We were now actually investing in human capital. That was a big attitude change," he says. "So, the expenses that went into flight simulators (in the Air Force and Navy) went into training simulators (in the Army). What we're trying to do in training is to create virtual veterans. We want soldiers to years later remember a simulation and go, 'That was an awful experience.'"

The military did not jump into the gaming field until commercial companies, developing games for consumer entertainment, had developed the technology to the point that the services could afford to co-opt it. "As the technology improved, we were able to drive cost down," Macedonia says. The Navy hopes to drive the cost of video game training down even further by developing a gaming engine through open source technology, downloading bits and pieces of technology from the Internet. This would avoid licensing fees, says Curtis Conkey, principal investigator for the Naval Education and Training Command Personal Computer Simulation Experimentation Lab in Orlando. “In the Department of Defense a lot of technology has already been used for the high-profile simulators,” Conkey says. “There’s a whole layer below that of less critical trainers that still need to be built, has less budget and can’t afford a commercial gaming solution or the recurrent licensing fees of gaming.” The engine is being built at www.delta3D.org.

The technology, which has come so far so fast in the 10 years since a couple of young Marines adapted the coding of the game *Doom* to make it relevant to Marine Corps training, is still in its infancy. “We’re gong through changes as we speak,” says Col. Augustin. He was talking about both the technology of video gaming and acceptance of video gaming in military training. “Advocates at service schools are very proactive in implementing this technology in their courses and instruction. Others are more reluctant or resistant to the potential.” For his part, Augustin wishes he had such video game training as a young infantryman.
Still, even the most proactive aficionado would not contend that video gaming in its current state can replace live experience. But the time may come when computers can provide sense surround noises, vibrations and smells. Even today, graphics and computer effects can make an emotional impact, which is where training takes hold. Macedonia says that’s the marriage of psychology, technology and art. “Plain reality is not as good as an artistic version,” he says. “The human mind is an incredible gift of God. We can make that monitor disappear for people.”

Woodman has seen that immersive quality take hold among Marines training on video games. One instance was loaded with irony when a platoon leader in feedback session criticized video gaming because it could not replicate a key interaction between a leader and his men; namely, when a rifleman isn’t moving to the right position because he’s not paying attention or can’t understand, the squad leader will go over to that rifleman, grab his straps and point him to the proper place. Later that very day in another video training session, Woodman says, “I watched a fire team leader get up from his chair, go over to a fire team member, point at the computer screen and say, ‘Here! I want you here!’”

SIDEBAR: THE LINK BETWEEN WAR AND GAMES

Eric Minton
Today’s Officer
January 25, 2005

Edwin A. Link developed the world’s first true flight simulator in 1929 to train pilots how to fly before they step into the cockpit. He built it for the U.S. military, but because of budget constraints neither the Army nor Navy would purchase it. So, Link sold the contraption to amusement parks as a ride. The armed forces bought it during the pre World War II buildup.

This was just the first in a long and ongoing link between the amusement industry and armed forces, especially in the training arena. Hollywood used its A-list actors to make training films in World War II. Two U.S. Navy engineers invented laser tag, and Army trainers were the first to put it to extensive use. The engineers who developed a networked, full-immersive training simulator for the Army allowing helicopters and armored vehicles to train together in virtual reality installed a similar system depicting Formula 1 racing at a Las Vegas casino. The U.S. military and NASA developed the 3-D graphics that later showed up in Pong, the dawn of the video game age.

In the past 10 years the technology has been flowing in the other direction as military development budgets tighten while the booming entertainment business has goaded commercial developers. The same companies building the motion platforms and graphic displays for Star Trek, Disney and Universal Studio virtual reality rides provide flight simulators for U.S. and other air armed forces. For video game technology, the armed forces are going to commercial developers to customize games already popular among the general public. “Entertaining and training are about making memories,” says Michael Macedonia, chief technology officer for the Army’s Program Executive Office for Simulation Training and Instrumentation. “When you go outside classroom education, what you're trying to do with soldiers is provide experience. Entertainment is also trying to develop experiences, but from a different perspective: pleasurable experiences."

This is a symbiotic relationship, even in a physical sense. The Army (PEO STI), Navy (Naval Air Warfare Center Training Systems Division) and Marines (Training Systems, Marine Corps Systems Command) all have their VR and simulator development centers and research labs in Orlando, co-located with many of the amusement industry's top simulation and show control engineering firms. By partnering with commercial enterprises on developing video games, the services get access to proprietary technology while the game makers get access to military expertise in tactics, techniques and procedures, not to mention uniform insignia. Macedonia believes the symbiosis goes much deeper than that. It's all about story telling. Video games, simulators and movies tell stories, and storytelling can also make training stick. "Stories are what link these atoms of facts together so you can move backward and forward in your memory," Macedonia says.

THIRD SEMIANNUAL CBRN DATA MODEL TECHNICAL REVIEW A SUCCESS

By Sheila Vachher, CBRN Data Initiative Technical Lead

The Joint Program Manager (JPM) Information Systems (JPM IS) Data Acquisition Program Manager (APM), Dr. Thomas Johnson, the Chemical, Biological, Radiological, Nuclear (CBRN) Data Initiative Team, and the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD) Software Support Activity (SSA) Data Team held their third semiannual Technical Review of the CBRN Data Model. The review was held on January 10-12, 2006 in Edgewood, MD. The Data Team's semiannual Technical Reviews bring together a group of experts from across the CBRN community to review and make recommendations regarding the CBRN Data Model. This review in particular provided an excellent example of collaboration between the acquisition and the science and technology (S&T) communities. Although the CBRN Data Model is a product of the acquisition community, Mr. William Ginley of the Joint Science and Technology Office for Chemical Biological Defense (JSTO CBD) volunteered to host the meeting at the Edgewood Chemical Biological Center (ECBC) Conference Center, and several individuals from the S&T community participated in the review.

The CBRN Data Model is being developed by JPM IS for common use by the Joint Warning and Reporting Network (JWARN), Joint Effects Model (JEM), and Joint Operational Effects Federation (JOEF) programs. Because the programs share a common data model, semantic and syntactical inconsistencies among the programs can be avoided. This both facilitates information exchange and reduces development costs. The CBRN Data Model serves as a repository of Common Semantics and Syntax (CSS) for JPM IS programs. Although the CBRN Data Model is currently focused on JPM IS programs, the plan is for it to evolve and become an enterprise-wide model, spanning all CBRN Defense programs for all JPMs. Joint Project Manager Guardian is already working to extend the CBRN Data Model to support their data needs, in preparation for adopting the CBRN Data Model within the Guardian program. The January Technical Review of the CBRN Data Model focused on version 1.3, which was released in October 2005. In contrast with previous reviews, this review focused specifically on the changes that were made between versions 1.2 and 1.3 rather than trying to cover the entire model. The reasons for this were twofold.

First, many attendees had attended previous reviews and had a good understanding of the overall model already and secondly, as the model grows, it is not realistic to try to cover all the details in a few days. The review did include an overview of the CBRN Data Model methodology and structure to orient new attendees. One of the most significant changes between versions 1.2 and 1.3 involved the addition of numerous transport and dispersion variables to the CBRN Data Model. The transport and dispersion variables added were discussed in detail, and grouped by the categories of meteorologyrelated variables, facility-related variables, CBRN event-related variables, and CBRN release and calculation-related variables. Another significant change in version 1.3 was the addition of entities and attributes to describe chemical and biological sensors, and to support capture of their output. This necessitated adding entities and attributes to describe networks and electronic addresses as well. Entities were also added for radiation sensors, but they will be more fully specified in version 1.4 (due out Spring 2006).

Responding to the community's requests, the Data Team presented a use case demonstrating how to use the data model for a specific CBRN event. The specific example traced a nuclear detonation because it would be human observable and make use of numerous related entities. The Data Team outlined which entities in the data model would need to be populated in which order as the incident progressed. The use case was very well received, and in an open discussion of training approaches, several attendees recommended basing future Technical Reviews on use cases.
Miscellaneous other changes in version 1.3 were also presented to the group. These included the remodeling of entities related to CBRN event, and changes to control feature. In addition, U.S. Mission Oriented Protective Posture (MOPP) Levels and some population information were added.

In addition to the sessions that focused on the CBRN Data Model itself, on the first day, Mr. David Godso from the SSA briefed the group on architecture from the point-of-view of the JPEO-CBD. On the second day of the Review, Cmdr. Rex Cobb and Dr. Glenda Hayes from the Defense Information Systems Agency (DISA) briefed the group on Net-centric Enterprise Services (NCES) and Service-Oriented Architectures (SOA). These briefings were quite pertinent since the common CBRN Data Model and XML schema facilitate implementation of the NCES-compliant SOA.

The recommendations made by attendees throughout the three-day meeting were documented in the form of action items. These were reviewed with the group, and have been published to the CBRN Data Model distribution list. Along with the conference presentations, the action items can be found on the JPEO-CBD Integrated Digital Environment (IDE) at the following link: https://jpeocbd.altess.army.mil. After logging into the IDE, please follow these links Software Support Activity/ Data/Data Products/Data Model Technical Reviews/ to see information about the current and previous reviews.

Approximately 55 people from a wide variety of backgrounds attended the technical review. The JWARN, JEM and JOEF programs were represented. There were also representatives from JPM IS, Joint Requirements Office (JRO), JPM Biological Defense (JPM BD), JPM Nuclear Biological Chemical Contamination Avoidance (JPM NBC CA), JSTO CBD, Defense Threat Reduction Agency (DTRA), ECBC, Joint Medical Information Systems Office (JMISO), and Office of the Chief of Naval Operations (OPNAV) among others. In addition, a representative from Defence Science and Technology Laboratory (DSTL) in the United Kingdom (UK) attended the technical review. The UK plans to use the CBRN Data Model for some new systems they are developing, so they are taking a strong interest in the development of the CBRN Data Model.

The next semiannual CBRN Data Model Technical Review is slated to be held in July, 2006 in San Diego, CA, although the exact dates and location have not yet been set. In general, and at the request of attendees, the Technical Reviews will alternate between the East and West Coasts, although there may be occasional exceptions.