It's a new world of simulation. This prototype links the individual nodes so the entire team can train together.

Planet Simnet

BY JOHN RHEA

WELCOME to the planet Simnet. But stay alert, because this has to be one of the more dangerous places known to man.

War rages interminably. The terrain is covered with tanks and armored personnel carriers, many of them engulfed in flames. Close air support (CAS) aircraft, both rotary and fixed-wing, pop up from behind trees and scream down to engage in missile duels with ground forces.

The frenzied chatter of troops under stress fills the radio waves. The incessant booming of artillery reverberates throughout this nightmare world. Danger of death is ever-present.

This is not a real world, though it is frighteningly realistic to Army and Air Force personnel who go there to learn the art of war. Planet Simnet exists in a prototype simulator network—whence its name—put together by the Defense Advanced Research Projects Agency (DARPA). The purpose of Simnet is to apply state-of-the-art electronics technology to the demanding task of training forces in combined-arms warfare.

Maintaining force-readiness levels is a constant challenge, one not likely to get any easier in an era of stagnant defense budgets and qualitative upgrading of hostile forces. Traditional training methods, principally field exercises and instruction on individual weapon simulators, cannot keep pace for two reasons. First, these techniques cannot duplicate the totality of tactical warfare. Second, they are too expensive to be used frequently.

Air Force Col. Jack Thorpe, the Simnet program manager at DARPA, is convinced he has a better idea. He has been pursuing it relentlessly for ten years. He proposes to use new technologies of microprocessors, high-speed data links (including fiber optics), and computer-generated imagery to create a new type of total warfare simulator.

Many Workstations, One Battle

Not a replica of a single weapon system built around a central computer, these new simulators are modular workstations linked in a network based on distributed architecture. Workstations can easily be added or removed without forcing a total reconfiguration of the system.

In Washington, D. C., DARPA Program Director Col. Jack Thorpe (left) and Lt. Col. James Schifflet (right) use their "Flying Carpet"—the BBN "Stealth" vehicle—to gather information on a simulated battle in progress on the Simnet system. Simnet allows a simulated battle to be evaluated by stealthy observers in several locations.

For the purpose of training, the main advantage of this approach is simple and compelling: All of the participants in an exercise—and there could be thousands of them in advanced versions of Simnet—are fighting the same battle.

Furthermore, these troops fight as teams, and they fight other teams of humans, not computers. Colonel Thorpe compares Simnet workstations to Alice's looking glass. They are entry points into an electronically created world of strife. The battle continues without interruption as trainees enter and exit this world.

Simple to Operate

In a military environment of high tech, "mil-spec'd" equipment, Simnet workstations are built around Apple Macintosh computers available at any computer store. One main reason is that these processors are inexpensive and simple to operate. Another is that Simnet's modular architecture doesn't care what kind of computer is used. Even simpler and cheaper personal computers can be substituted.

"We can pick and choose and mix and match," Colonel Thorpe says, thus avoiding the situation of being locked into a single system contractor.

Planet Simnet is rent-free, devoid of political or ecological constraints, can be made identical to anyplace on planet Earth (from Fort Knox to the Fulda Gap or even Red Square), and is nonlethal to its temporary inhabitants, who can blaze away at each other with the weapons of their choice.

Today, Simnet is a test-bed network of workstations located on two continents, all simulating ground and air vehicles. In the continental US, there is one star configuration having a central node at Fort Knox, Ky., and six outlying nodes. They are found at Fort Leavenworth, Kan.; Fort Hood, Tex.; Fort Rucker, Ala.; Fort Benning, Ga.; Mississippi National Guard headquarters at Camp McCain; DARPA headquarters in Arlington, Va.; and the Cambridge, Mass., offices of associate prime contractor Bolt Beranek and Newman (BBN). In Europe, three West German sites at Schweinfurt, Friedberg, and Fulda are tied into a central node at Grafenwoehr.

All the nodes can "talk" to each other over standard AT&T 56,000-bits-per-second long-haul communications lines. Internal communications at each location use Ethernet or other local area networks with data rates of 10,000,000 bits per second.

Each workstation for an M1 Abrams tank or an M2/3 Bradley Fighting Vehicle costs $250,000. The tab is $500,000 for one that simulates a generic CAS aircraft (it could represent an A-10 or an A-16, so Colonel Thorpe calls it an "A-13"). Prices represent only a small fraction of the cost of genuine articles.

Comparable savings are found in operations. Simnet's phone and electric bills are far lower than costs of gasoline and jet fuel. Colonel Thorpe estimates the total cost of the Simnet test-bed at about $60 million, of which DARPA put up $20 million. The Army will pay the remainder.

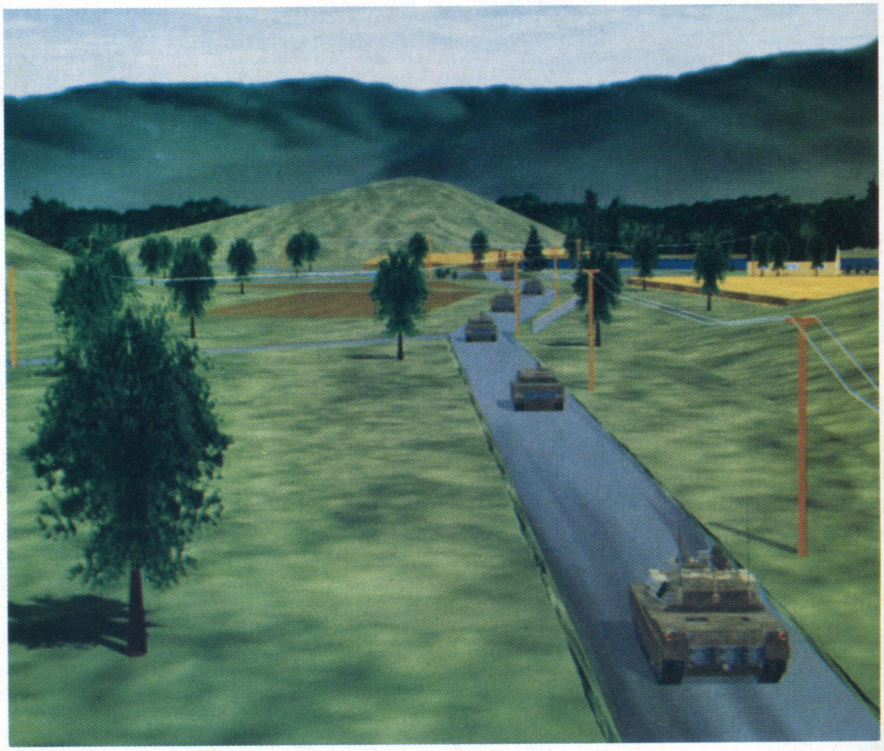
Red Flag in a Laboratory

"Simnet is like the National Training Center [the Army's major field exercise site at Fort Irwin, Calif.] or Red Flag [the Air Force exercises at Nellis AFB, Nev.] in a laboratory," Colonel Thorpe says. But there is a difference: In this electronic world, participants can do things they'd never dare to do in the real world.

The infantry can call in artillery support close to their positions. At Fort Irwin this distance is limited to one kilometer; in combat conditions it is 100 meters. The CAS pilots can learn how to dodge surface-to-air missiles (SAMs). Perhaps best of all, tanks don't cause traffic jams or tear up farmers' fields. This has been a problem in past Reforger exercises in West Germany, and the growing mood of pacifism there could seriously impair future readiness exercises.

Colonel Thorpe, holder of a Ph.D. in industrial psychology from Bowling Green State University, Ohio, first tackled the simulation problem in 1978, when he was a captain assigned to the Air Force Office of Scientific Research. At first, the idea was to examine what simulators could do that couldn't be done in aircraft. USAF was understandably cool to the idea because it threatened to reduce flying hours. "No wonder people hated us," recalls Colonel Thorpe.

But he persisted and expanded the scope of his studies to include



A networked warrior's view of the planet Simnet: An anonymous low-level NOE (nap-of-the-earth) scene is displayed in the early stage of a battle. The GE Compu-Scene® IV Visual Simulation System can depict terrain identical to anyplace on planet Earth, from Fort Knox to Red Square.

the Army after he was assigned to DARPA in 1981. Although today Colonel Thorpe customarily wears his Air Force fatigues and mirror-bright combat boots in a building where the civilians wear suits and officers wear dress uniforms, he confesses that at first he wasn't sure what an Army battalion was. (It typically comprises a headquarters company and four infantry companies or four artillery batteries, totaling about 700 soldiers.)

By January 1985, DARPA had built a plywood mockup tank simulator, but it was based on a canned, seven-minute videotape scenario and was by no means an interactive system. By October 1985, Colonel Thorpe's group was able to display a full simulator with crude interactive graphics at the annual Association of the US Army convention, and the program took off. The first two preproduction units were installed at Fort Knox in May 1986, and the tankers began serious training in tactics.

—Photo © BBN Systems and Technologies Corp.

Simnet uses BBN's real-time computer image generation system to simulate the view from many types of vehicles. Using depth buffers, the computer stores data relating to factors such as perspective and speed and adjusts them to produce appropriate visual images. Here, a helicopter simulation is being developed.

Sweeping the Competition

What put Simnet on the map was its success in preparing US teams for the Canadian Army Trophy competition in June of 1987. This is the top contest among NATO armored units, and the United States had suffered a string of embarrassingly poor finishes. That spring, US entrants used Simnet to recreate the Grafenwoehr range, going on to sweep the competition. One M1 platoon from the 8th Armored Cavalry achieved a record score among twenty-four participating platoons, and another finished third. "That got everybody's attention," Colonel Thorpe notes.

An early application of Simnet came in the Army's source selection from among two competitors for the Forward Area Air Defense System/Line of Sight-Heavy (FAADS/LOS-H) system. Trials were held at the artillery school at Fort Sill, Okla. "They needed somebody to shoot at," Colonel Thorpe says, so Simnet was expanded to include generic fixed- and rotary-wing CAS aircraft. Almost by default, this put Simnet in the thick of the Army's AirLand Battle concept of combined arms.

Today the system has been expanded throughout Army sites in CONUS and West Germany, but the principal installation is at the armored school at Fort Knox. It can train an entire battalion at a time. Expecting that Simnet will soon move from development to operational use, the Army's program manager for training devices (PM-TRADE) is circulating a draft request for proposals aimed at an initial procurement next year.

Colonel Thorpe estimates that the Army itself might want to procure as many as 5,000 of the $250,000-per-copy workstations, making it a potential billion-dollar program.

Colonel Thorpe concedes that his own service has shown scant interest in Simnet, though he contends that Simnet-type systems would be valuable in training pilots for high-flying reconnaissance aircraft and special missions such as those of the E-3 Airborne Warning and Control System (AWACS). Tactical air units, he adds, could also benefit. "They may find," he says, "that artillery is their best wing man because it takes out air defense."

The Navy, meanwhile, plans to join the Army in joint exercises this fall, says Colonel Thorpe. The idea is to use Simnet to "build an ocean" useful in training those conducting shore bombardment from ships or flying carrier aircraft on attack missions.

Some technical issues remain to be resolved. Simnet graphics are still crude, Colonel Thorpe concedes, much like looking through a dirty window or encountering bad weather. Another question concerns long-haul communications to link participants on a global basis. It would be cheaper and more efficient to train the CONUS-based and forward-deployed units together electronically rather than to move them to a single site. The question is whether performance will be degraded by the delays inherent in satellite communications. An alternative may be to use transatlantic fiber optic cables currently being installed. That, however, raises security questions.

Virtually Unbeatable Aggressors

As in all training of this type, there is the problem of the "red" aggressor forces. They do their work so often and thereby build up their warfighting expertise to such a high level that they become virtually unbeatable. It is generally agreed that training US forces in the

—Photo © BBN Systems and Technologies Corp.

The "tank" simulated here may be the quarry of the "helicopter" shown in the previous photo, even though the users may be at Simnet terminals hundreds of miles apart. Besides the actions of networked "enemy" forces, users must contend with random vehicle failures and other realistic hazards.

tactics of the enemy is desirable, but what if those tactics suddenly change?

These are some of the issues that were addressed during a proof-of-principle exercise conducted last March. Fort Knox provided a battalion-sized mechanized infantry task force, and Fort Rucker furnished helicopters as the blue team. USAF joined the competition for the first time with four A-10 pilots: Maj. Frank Countryman and Capt. Mark Lampe from the 45th Tactical Fighter Squadron, Grissom AFB, Ind.; Capt. James Cobb from the 355th TFS, Myrtle Beach, S. C.; and Capt. Jeff Miller from the 23d Tactical Fighter Wing, England AFB, La. BBN personnel in Cambridge were the red team. Additional support was provided by the other Simnet associate prime contractor, Perceptronics of California.

The battlefield was a fifty-by-seventy-five-kilometer piece of terrain at Fort Knox, complete with forests, streams, hills, buildings, and roads (an "Autobahn"). The area normally is used for real training exercises. The participants sat in mockups of crew stations that provide realistic sound (but no motion) and have all controls necessary for maneuvering and fighting. They communicated with each other via standard forty-channel FM radios.

As everybody fought the same battles, the intensity level escalated—and little wonder. Because there is no "reset" button on Simnet, a tank that gets hit is a tank that goes out of the competition. If an airfield is pocked, an A-10 pilot has to find another place to land. If a tank tries to cross an unfordable stream, it stays there until a simulated tow vehicle can pull it out. If it runs out of ammunition, it stops firing until another simulated vehicle resupplies it.

Random failures are built into the system to occur at the rate normally encountered in combat. A vehicle's transmission failure can put it out of operation for an hour, for example; a faulty battery or alternator can be replaced in thirty minutes.

Though active participants can see only that part of the battle observable from the windows of their vehicles (three and a half kilometers for the ground vehicles and seven kilometers for the CAS aircraft), the DARPA monitors can unobtrusively move anywhere on the battlefield to see how everybody is doing. Colonel Thorpe calls this his electronic "magic carpet," and he can hitch it to any vehicle or even to an incoming missile. Despite the crude graphics, the observer is quickly swept into the emotion of combat. Colonel Thorpe jokes that he has increased his vocabulary of profanity in this way.

Refining Combat Skills

Each exercise is videotaped as the fighting proceeds so it can be played back later for instruction in tactics. However, this system is not intended to teach anybody how to drive a tank or fly an airplane. All the participants are expected to know the basics already; they are supposed to use Simnet to refine their combat skills. Nor is Simnet intended to replace Reforgers or Red Flags, but rather to help personnel prepare for them.

"In order to fight, we have to be able to do the things we know we will have to do on the first day of a war," Colonel Thorpe says. "But nobody, anywhere, is able to practice them." On the electronic planet of Simnet, however, warriors can practice those skills every day.

The payoff could be great. All military training, whether in the field or in DARPA's glamorous new video arcade, is aimed at countering what many view as the single greatest challenge of warfare: overcoming uncertainty. As the German military philosopher Karl von Clausewitz put it in his landmark work, *On War*: "War is the province of uncertainty: Three-fourths of those things upon which action in war must be calculated are hidden more or less in the clouds of great uncertainty."

The purpose of Simnet is to help warriors prepare to cope with that uncertainty—with a bonus for the trainees: The "dead" soldiers can go home at night, have dinner with their families, and ponder ways to survive the next time. ■

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