CPL Brown crouched alertly behind his Land Warrior Modular Weapon System/Enhanced Crew Served Weapon (ECSW). It was the middle of the night, with Beginning Morning Nautical Twilight still hours away. His teammate, PFC Jones, sat to his left with his ammunition close at hand, absent-mindedly staring into the darkness. Their position on the perimeter of 1-7 Infantry looked down a dirt road that wound into the hills, villages and forests of a country far from home.

The enemy was using a blend of information, unconventional and conventional warfare in attempts to keep U.S. forces off balance and the U.S. population at home discouraged. Brown's Soldier Information System (SIS) was strapped to his body armor. It provided information in both visual and audible forms inside his helmet. The system was based on the hand-held Joint Tactical Radio System. It had an embedded Global Positioning System (GPS) and informed all friendly forces of Brown's position while keeping Brown aware of his buddies' locations.

Earlier, Brown had filled out the series of pull-down menus that ensured his status as an ECSW team was correctly reflected in the Joint Blue Force Situational Awareness, (JBFSA) system that fed the User Defined Operational Picture (UDOP). He had also filled in his information requirements, noting that enemy mechanized forces were his first priority information request. His ECSW had its laser range finder mounted on the weapon. It interfaced with the SIS by a wireless interface. The team also had VIPER binoculars with laser range finder, again using wireless interface to the SIS. When the enemy was spotted, Brown could paint the enemy with his ECSW or the VIPER laser range finder, verify the information in the pre-formatted message in his helmet's heads-up display, and then forward it to headquarters.

The information would be sent automatically to any user that met the location or type of information requirement through the network-fires function. Brown didn't understand how Warrior Information Net-Tactical, or WIN-T, did all this, and didn't care. He just knew he liked knowing what was going on.

Brown stared intently into the dark. Hours earlier, he had received a warning that enemy formations were moving out of a mountainous area 20 kilometers away, heading toward U.S. forces. But at this point, it was not a threat to him. He had indicated in his information request that he was to be notified of any enemy formations within two kilometers of his location. It was this request that now triggered a faint chiming sound in his left ear. Brown activated his heads-up display on his helmet, and received the report that enemy mechanized forces had been scattered by U.S. air forces, aviation and Non Line of Sight (NLOS) fires, and that isolated enemy formations were working their way through compartmented terrain and forests and a small number of enemy infantry fighting vehicles were coming down the road toward him. Brown acknowledged the information, and nudged Jones in the ribs.

Earlier they had used their laser range finder to build their range card in the SIS, as did the other weapon systems on the perimeter. They knew exactly where they could engage, and the networked fires program in the SIS had built a complete picture of the perimeter, covering the dead spaces with NLOS and Beyond Line of Sight (BLOS) fires. This preparation proved valuable as Brown observed three infantry fighting vehicles through his helmet's night-vision device. They stopped at the edge of a gully 400 meters to his front. Brown pointed his ECSW at the enemy vehicles, activated the laser range finder, and observed the GPS one-meter accurate grid of the enemy vehicles, which he transmitted to his headquarters.

Within seconds, through the network-fires function in the SIS, every weapon that could engage the target was cued, slewed onto the target using their laser range finder, and ready to engage. In many cases, ECSW teams could barely see the target. But they knew they were oriented correctly to engage the enemy. The Fire Control System (FCS) crews had already calculated firing coordinates for a BLOS engagement, and a nearby FCS-Cannon section lay onto the grid with Excalibur GPS-guided munitions, ensuring target hit with only a few rounds.

In about two minutes from Brown sending the target, all units and positions that could engage the target had reported ready to fire. The target had been cleared as enemy through JBFSA and the SIS, and company headquarters had designated the firing units to engage the target. On cue, four rounds from FCS simultaneously impacted on the three enemy fighting vehicles, destroying them and their crews. Two FCS-mounted combat systems moved out of the darkness to the left flank of the enemy to finish the engagement. All the ECSW crews on the perimeter saw this on their SIS display, ensuring there was no chance of a friendly fire incident. The SIS (crew) emitted a warning sound and put the weapon on safe any time it was pointed at a grid listed as friendly in the JBFSA system. As the engagement ended, company supply forwarded the consolidated munitions expenditure report, based on the firing counts from each weapon's onboard sensor, to move an exact amount of munitions forward ...

— Glen Collins

BEYOND BLUE FORCE TRACKING

"Every warrior wants to know three simple things … Where am I? Where's my buddy? Where's the enemy?"

— Gen. Gordon Sullivan (USA, Ret.)

BEYOND BLUE FORCE TRACKING ...

PRECISION WARFARE!

By Glen Collins

Joint Blue Force Situational Awareness (note 1) is critical to answering the questions posed by General Sullivan and it provides the means for the information-enabled networked warfare scenario described on the previous page. By providing the "common grid" for all forces, GPS puts the battlefield on a numerical and geometric basis, and allows for efficient operations in virtually any area of military activity.

The system shares friendly locations provided by GPS with other elements, answering the questions of "Where am I?," and "Where's my buddy?" When the system's location is extended through the use of a laser range finder or other accurate sensor, then GPS-accurate Red-force Tracking is able to answer the third question, "Where's the enemy?"

A JBFSA system consists of four components:

1. A device for providing location (Global Positioning System)
2. A communications system to move grid locations back and forth (Joint Tactical Radio System)
3. Databases to store the locations
4. A display system — Global Command and Control System (GSSC) User Defined Operational Picture (UDOP)

The technology that provides these elements is not new. The location is provided by the GPS. With the fielding of GPS III circa 2010, pinpoint accuracies are to be expected. Communications can be provided by any communications pathway. However, the joint tactical radio system will have a GPS receiver and will move communications through terrestrial or Space links as needed.

The database software (e.g. Microsoft Access or Oracle) that stores user locations and information is also well established. Much of the work in implementing JBFSA rests in the fusion of the different systems' information into the UDOP. Currently, the Air Force has fielded the Hook-112 and tested the Combat Survivor Evader Locator, and the Army has fielded the FBCB2, the Grenadier Brat/MTX and the Movement Tracking System.

There are also several commercial systems used by the services (Figure 2). None of these systems feed directly into the UDOP, although some can be manually integrated. Without Joint Blue Force Situational Awareness (JBFSA), a joint UDOP is not possible.

Today's JBFSA technologies provide some limitations that future technologies will improve. GPS II's three to five meter Spherical Error Probability (SEP) provided today will be reduced to one meter with the fielding of GPS III.

The communications architecture in the Global Information Grid, or GIG, which includes the Warfighter Information Network-Tactical (WIN-T) and Joint Tactical Radio System, will provide seamless movement of data anywhere on the battlefield or wherever needed, giving a seamless JBFSA system.

The database and UDOP are mature technologies able to deliver full capabilities for a JBFSA system. Finally, the basic terrain data used to populate the UDOP and upon which we track our forces is currently at Digital Terrain Elevation Data (DTED) three or four. With the fielding of the Space-Based Radar constellation in 2012, the UDOP will use DTED level-5, giving high-resolution terrain data to one-meter accuracy. This is important to tactical operations and fire control calculations. These technological advances are not necessary to implement a JBFSA system, but they do improve it. There are currently no technical limitations to implementing JBFSA and Precision Warfare in the services.

The U.S. Army Space and Missile Defense Command's Battle Lab in Colorado Springs, Colo., is currently conducting the JBFSA Advanced Concept Technology

> Rather than refighting the last great war … we should instead ask, "Given an emerging technology, how can we fight war more rationally?"
>
> — J.F.C. Fuller

Demonstration (ACTD) under the charter of U.S. Joint Forces Command, the lead for JBFSA and U.S. Strategic Command. The Battle Lab is also working in close coordination with the Army G-6.

The primary purpose of this effort is to demonstrate the ability to fuse together the various Blue-Force Tracking (BFT) systems currently fielded into the UDOP. It appears the most challenging aspect of achieving JBFSA is fusing the "stove-pipe" systems used today to provide the UDOP, and designing an efficient database system that makes information available efficiently and effectively to conserve precious bandwidth in order to enhance battlefield victory. As this work progresses, the question that U.S Joint Forces Command must now ask is, "Now that we have achieved JBFSA, how will our joint and service CONOPS be affected?"

What does JBFSA enable? Precision … in everything we do. The JBFSA basis is a grid. This series of numbers provides an exact location of any asset, and gives insights on activities based on movement and terrain. The range and direction from one grid to another is easily calculated by any computer or calculator, and is based on simple geometry, the Pythagorean Theorem.

- The difference between two grid locations is calculated by using the Pythagorean Theorem A2 + B2 = C2

Knowing exactly where things are allows us to manage forces, fires, information, and logistics in a much improved manner.

Any review of military history and the battles fought will uncover numerous examples where maneuver forces were in the wrong place, losing valuable time to continue their mission, incurred friendly fire casualties from both direct or indirect fires, or where forces were incorrectly massed (too much or too little) to achieve the effects we desired. To compensate for this lack of precise understanding of our location and as well the enemy location, we devised complicated maneuver graphics, such as boundaries, fire support coordination measures, and free-fire zones — all for the purpose of ensuring that we didn't kill each other, and that we had sufficient forces to control terrain and defeat the enemy.

With JBFSA, maneuver and fire support graphics will be less necessary, as we will know exactly where forces are located. Once the enemy is located, and since all sensors in the battlespace will provide precise "common grid" locations, we can better calculate the fires and forces required to defeat that enemy. The information acquired by any one sensor can then be delivered to users based on precise locations and Requests for Information, enabling decision superiority.

Finally, as forces move in the battlespace and consume classes of supply, logistics requirements can be better calculated, and delivered to the right user at the right time and location. The integration of GPS-delivered precision into maneuver, fires, information and logistics is the basis for future precision warfare.

Thesis: Given we know exactly where each of our assets are located (due to JBFSA), how will that knowledge change the manner in which we conduct military operations?

Precision Maneuver

The Army has developed a pathway to achieve an objective Future Army. Enabled by decision superiority over the enemy, the Future Army will not use maneuver graphics as in the past, and will not "maneuver to contact" but rather "maneuver out of contact" and engage the enemy at a time and place of our choosing with effects from the FCS and stand-off joint fires. JBFSA is essential to the conduct of non-contiguous distributed operations as is currently being done in Iraq and Afghanistan, and planned routinely for the Future Army of 2010.

Precision Maneuver is a major change from the movement and placement of forces used in past wars. Army forces in Operation Iraqi Freedom used JBFSA and non-contiguous operations on a limited basis. Over the last year, the Army patched together a JBFSA system using Force XXI Battle Command

(See Blue Force, page 18)

Beyond JBFSA ... Joint CONOPS

Knowing where your forces are located is only the beginning. Now that you know ... what can you do better?

Precision Maneuver

– Basis of network-centric warfare
– Based on JBFSA and DTED-5 digital terrain
– More agile movement in the battlespace
– Enables more efficient massing and economy of force decisions
– Increased situational understanding of Joint and coalition force dispositions and enhanced combat ID
– Better focus of engagement, information, and logistics support
– The right force … at the right time … at the right place!

Precision Engagement

– "Common Grid" and basis of networked-fires and network-centric warfare
– Based on JBFSA and DTED-5, combined with an integrated laser-range finder (LRF), embedded into weapons and platforms
– Accurate to one meter with fielding of GPS III
– LRF extends grid location to distant objects (terrain and blue/red forces)
– Precision networked agnostic sensors allow target engagement at any range
– Combat ID accomplished by querying JBFSA database (reduced incidence of fratricide)
– Air and missile attack capability established
– Enables networking of direct fire weapons
– The right effect … at the right time … on the right target!

Precision Information

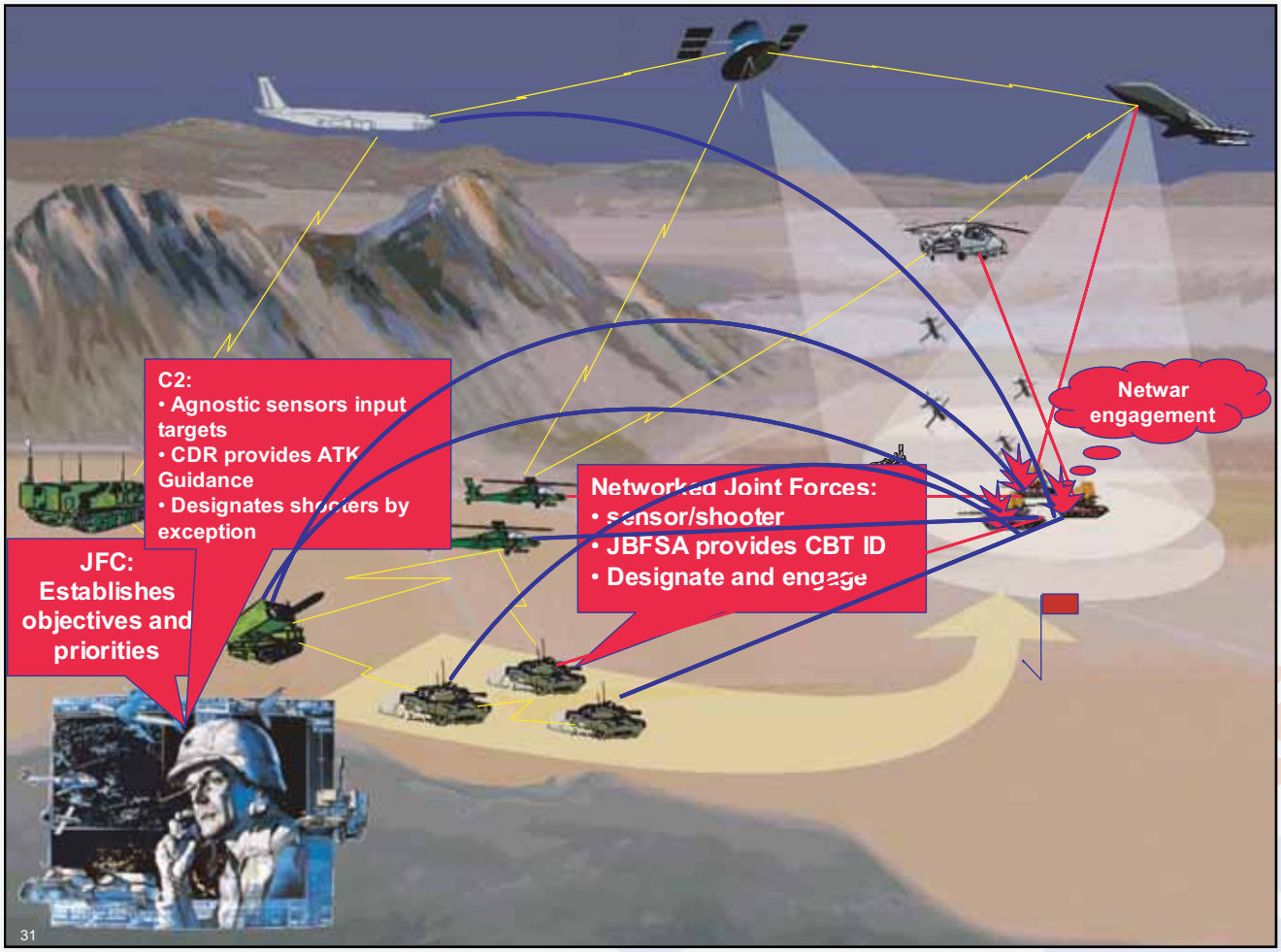
– Basis of network-centric warfare
– Based on JBFSA and DTED-5 digital terrain, stored in a distributed network of databases (based on NGA databases)
– Users (at every level to the individual combat platform) define their information needs in the JBFSA databases
– Every piece of information (blue and red) is "pushed" to users based upon the grid location and user-defined information requirements
– The right information … at the right time … to the right customer!

Precision Logistics

– Basis of network-centric warfare
– Based on JBFSA and DTED-5 digital terrain combined with barcode tagging of supplies
– Option of embedded logistics or user-defined logistic requests
– Logistics forces tracked same as maneuver
– Lesser requirement for LPI/LPD and secure comms
– The right support … at the right time … to the right customer!

Precision Warfare

– Basis of network-centric warfare
– Enabled by JBFSA + DTED-5 digital terrain + LRF
– A "revolution in military affairs?"



Blue Force ... from Page 15

Brigade and Below (FBCB2) and commercial satellite communication that allowed commanders at brigade and higher levels to know exactly where maneuver formations were located, allowing for more efficient integration of fires, information and logistics.

This early JBFSA system did not incorporate JBFSA to the lowest levels of all Army forces, and did not tie together fires, information and logistics into an integrated precision warfare C2 system.

Precision Engagement

The Army has always understood the importance of precision direct fires. Well aimed, semi-automatic fire and near sniper-quality marksmanship is a trademark of today's American soldier. The M1 Abrams tank is the best in history with first-round kill at ranges of just over three kilometers.

The Army also knows that the majority of missed targets for indirect fires are attributable to the simple fact that historically our observers often do not know exactly where they are, and therefore can't locate the enemy any better.

Air Force and Navy aviation have also discovered the efficiency of precision bombing. Starting with laser-guided bombs in Vietnam and building to today's GPS guided bombs and cruise missiles, single-round effects on target have allowed significant improvements in the number of targets that can be engaged from a single platform, and greatly improved logistic support.

The Army is beginning this move to precision engagement in its indirect fire systems with SADARM, Excalibur, and GPS-guided MLRS rockets.

The basis of precision fires is extremely simple. First, GPS provides the "common grid" for all fires. The observer/sensor and the firing platform are precisely located through GPS, and the locations shared in the C2 system through the JBFSA system. The observer/sensor locates a target, and either through the sensor technology or LRF, transfers the GPS grid onto the target, using a polar-plot method (range and deflection).

The target grid is then sent to the firing platform, which calculates the firing data for dumb munitions, and/or enters the target grid into the missile or round for smart munitions.

In the case of smart munitions, they must receive GPS updates while in flight, and using these updates they simply guide themselves onto the target grid. This process is range independent for smart munitions.

The least controllable variable in the ballistic equation is meteorological variables such as air density and winds, which can be accounted for by a single-round observed registration where the observer uses the LRF to determine the "did hit" data of the observation round, allowing second round fire-for-effect engagement, but not precision, even with dumb rounds. This is true for any

sort of delivered munitions, air or ground, direct or indirect.

Networked fires — direct and indirect

JBFSA is also the critical enabler of networked fires. Knowing precisely where each firing unit is in relation to the enemy allows for the C2 system and decision makers to efficiently determine which assets should engage a target, with the potential for all systems within range to have firing solutions calculated and ready to engage within moments, and with a minimum of commands.

By combining LRFs with JBFSA, and integrated into the firing platform, we can designate, cue and slew a firing system on a target without the need for human involvement during engagement. The firing platform knows where it is. The target grid is sent to the platform (cue), a range and deflection are calculated, and the firing device is oriented on to the target (slew).

The LRF engages the target to determine if the direct line to the target is clear (using the range function) and orients upward over the target to clear the ballistic pathway of the munition (direct fire). The target is engaged, and re-engaged with the LRF to determine movement.

If not moving, the sensor that acquired the target or sensors on the firing platform determines BDA, and the need for further engagement. This system would allow for robotic firing platforms, allowing a single human to control "swarms" of firing platforms.

Potential for long-range missile engagement

JBFSA, combined with global networks of ground, air, and Space sensors, provides the opportunity for a revolution in military affairs through engagement of an enemy by long-range fires delivered through the air, sea and Space.

Once a sensor acquires a target, accurate to GPS and inherent sensor error, a missile can guide itself on to the target independent of the range. The only limitation in range to a target is the amount of fuel in the missile, meaning there is no limitation.

The USAF is currently developing long-range attack systems, such as conventional ballistic missiles and the Common Aerospace Vehicle (CAV), which launch from the United States and can engage a target anywhere on earth in a matter of minutes to hours. This portends significant changes in future force structure, bringing into question the need for long-range bombers and Carrier Battle Groups for the attack of many types of fixed targets.

Precision Information

Today we use a push-pull information system that is often criticized for failures in both dynamics. Users forward Requests For Information (RFI) and Priority Intelligence Requirements (PIR) which are often vague, represent an amalgamation of numerous subordinate users, and are generally not precise by type information, location or timeliness.

The intelligence community does its best to push information forward to the customer using a process called TPED, or Tasking, Processing, Exploitation, and Dissemination that too often gets the wrong information to the wrong user. Using the JBFSA location tag, with database oriented RFI and PIR we can precisely deliver the right information at the right time to the right customer. It requires the communications bandwidth to move the information, and the databases to populate with information.

The user starts the process by logging into the JBFSA database(s), and through pull-down menus annotates the type information he needs by type, location, and timeliness. From then on, any time a piece of information is developed it is checked against these criteria and sent automatically to the user.

The only challenge in the delivery of Precision Information is the design of the database architecture to ensure redundancy of information storage, and efficient movement of information.

Precision Logistics

Although most of this discussion of JBFSA has focused on battlespace forces, the efficiency gained by logisticians knowing exactly where supply items are located is no less profound. The logistics community has already begun implementation of JBFSA of logistics operations through In-transit Visibility and Movement Tracking systems. All the same, principals and components of JBFSA discussed above apply to logistics.

Using bar code technology linked to a JBFSA system, logisticians are able to accurately plan production and movement of supplies, ensuring with a greater certitude the delivery of the right stuff to the right place at the right time. JBFSA, combined with the overall command and control system, gives the ability to compile supply usage more efficiently, to include calculating fuel use based on movement.

On-board sensors built into the Future Combat System and other new combat systems will provide automatic updates of maintenance status and supply usage, using the same communications paths, databases and displays as described earlier.

Summary

The services have engaged to make JBFSA a reality, and to varying degrees have accomplished answering the questions of "Where am I?" and "Where's my buddy?" Now is the time to ask the next question "What's beyond JBFSA?" which will enable the answer to "Where's the enemy?" and lead us down the path to Precision Warfare.

Notes:

1. Joint Blue Force Situational Awareness (JBFSA) is the "Knowledge of the position and status of our own forces (including a Space, air, ground and sea picture/track) to smartly employ them and/or protect them from hostile attack or fratricide"

Glen Collins left 26 years of Army service as a colonel in December 2003, and was one of the first FA40, Army Space Operations Officers. His last positions were as SMDC's Director of the Force Development and Integration Center, and served in Operation IRAQI FREEDOM from March to August 2003.