Fateful Lightning

Perspectives on IT in Defense Transformation

ITAA

Digitizing the Battlefield

Towards the Objective Force

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In 1994, the Army formulated a hypothesis—that "digitization of the battlefield"—the incorporation of an information system into each combat platform, and the linking together of all of these information systems into a tactical internet—would result in a significant improvement to the fighting effectiveness of the combat team.

They were looking for increases in force effectiveness of very significant magnitude—e.g., much more than could result from simply upgrading weapons systems. Some force-on-force modeling had indicated that potential weapons/platform upgrades could increase the effectiveness of the heavy force, for example, by 30% to 40%. Could digitization deliver significantly more? Could it do so across the entire force, not just for the heavy force?

It was recognized that if their hypothesis proved correct—and if the engineering world could deliver the required products—the existence of the new digitized battlefield information infrastructure would enable significant changes to their business processes (e.g., doctrine, tactics, organization, equipment counts per fighting unit, etc.). That is, to realize the full benefits of digitization might require doing more than just equipping the force with the digitization equipment.

The Army therefore conducted a systematic experimentation process—one that considered all aspects of the problem (technology, personnel, training, tactics-techniques-and-procedures, organizational structure, etc.), and various echelons and scales.

The experiment design included several significant features:

- Up to tactically-significant scale (true representation of complex, combined-arms task forces). Simulation was used extensively, but it was determined that field experiments should include large force packages, so as to provide data to calibrate future simulations, and to enable discovery learning through the field experiments.
- Lots of unscripted combat actions during the experiments - assess the interaction between commander initiative and the new technologies.
- Use of the National Training Center and the After-Action-Review process—measure the outcomes in terms that made sense for the Army.
- Detailed instrumentation and data collection—continue learning long after a particular exercise concluded.

This experiment process has created an information system determined to be effective and suitable for warfighters. For example, in a 1998 test, two battalions of a single brigade fought against each other in several days of free-play exercise. The battalions were equipped and trained essentially identically . . . except that one battalion had the prototype digitization equipment, and the other didn't.

Loss-exchange ratios were consistently 3-to-1 to 4-to-1 in favor of the digitized battalion.

A TRADOC analysis around the same time indicated that a digitized force would achieve fighting power more than twice that of a force similarly equipped but not digitized.

These are the level of benefits for which the Army was looking. While not as capable as that needed for the Objective Force, it showed the promise and feasibility of the concept, and provided a great deal of tangible basis for future decisions.

I had the privilege of serving as the prime contractor's program manager for this period, and therefore had the opportunity to live through much of this process. The following summarizes some of the key lessons that have come out of this experience:

- We started modestly, concentrating at first on achieving blue force tracking (situational awareness) and just a few other capabilities. This is not to understate the technical challenges involved, which were considerable. But this narrow initial focus allowed us to separate the variables of perceived benefits and issues. The clarity resulting from the narrow focus also contributed to building and retaining organizational focus and commitment.
- The digitized battlefield was from the first conceived as significantly "horizontal" and joint—it involved the entire land combat team (e.g., armor, infantry, artillery, air defense, combat service support, etc.—no branch was left out), fixed-wing close-air support, ISR up to the National asset level, etc. This involved about 50 platform types, even for the first experiment. All of the platform PM had opinions and concerns, and needed to protect the essential characteristics of their platform, e.g., combat performance, safety, etc.
- There was a lot of discovery learning throughout the process concerning capabilities:
- We were able to create and disseminate an effective, accurate and timely blue force picture, even across a large, dispersed, and joint combat team. We even found ways to reduce the vulnerability of the blue picture to GPS jamming. Creation and dissemination of the red picture is much more subtle, with much debate about how to balance timeliness and accuracy, completeness and simplicity, and knowledge and security. Partial answers have been found to all of these issues, but this is an area where improvement will be required in the future. Two examples should be cited of where revolutionary improvements have already been implemented: (a) collection, coordination, and automatic dissemination of SPOT reports, making this valuable source of information available not only across the combat team on the ground, but potentially to higher-echelon processing centers; (b) the integration of unmanned air vehicles (UAVs) with imaging payloads into a complete and highly-automated CONOPS, with near-instant dissemination across the entire combat team of UAV product in a form comprehensible to all users, closed-loop tasking of the UAV, and improved ability to coordinate UAV movement both with respect to information collection goals and with respect to knowledge of the enemy air defense threat.
- We quickly determined that the actual operational units were every bit as interested in what we could accomplish with automation of logistics, supply, and status reporting as they were in what we could accomplish for maneuver and battle command. Preliminary "long mission threads" that connect individual platforms to status summaries and supply-management systems have proven their value, although significant technical improvements remain to be accomplished.
- One of the powerful reasons often cited for enterprises to invest in infrastructure is that novel uses, not foreseen in advance, are found once the infrastructure is created and deployed. This is certainly true of digitization. One example that has stuck in my mind was watching a brigade use the system to manage a nighttime river crossing. The commander's staff used the blue picture and the movement-management tools to get the brigade across the river in about one third of the time it would normally take, and told me that they were able to remain less vulnerable (mostly via dispersion)

The FBCB2 touchscreen displays in color the location of friendly and enemy forces, providing soldiers and commanders with near-real-time battlefield information.

during that reduced time interval.

One of the concerns from the very beginning was how to provide value once a combat team was actually in contact with any enemy force; it was widely accepted that digitization would help our forces maneuver to obtain tactical advantage, but there was reluctance to believe that the information could be assimilated while in actual close combat. Innovative tactics-techniques-and-procedures have largely solved this problem, providing insight into achieving effective C2 messaging and timely red picture update on-the-move, without diverting the combat team in contact from their combat tasks.

Much energy was invested in considering the appropriate manner to achieve the large-scale horizontal interoperability; as noted above, even the initial experiments involved more than 50 platform types, plus dismounted soldiers and mobile tactical operations centers. In the end, we opted for having a common implementation on every platform, rather than letting each platform develop their own implementation against a set of specifications. This was in some ways uncomfortable for some of the platform PMs, but saved immense amounts of time and money because we were able to make the interface from the digitization equipment to the platform much simpler than the interface from the platform to the network. We were thereby able to avoid a huge (e.g., on the order of 50-factorial) integration problem.

Very significant progress was made in a number of networking technology areas, but much more remains to be accomplished. Key examples include:

We found in both existing systems, and our system in its earliest version, that the complexity of network administration led to administrative errors, which in turn led to less-than-desired network availability. This caused us to put a lot of emphasis on automating network engineering, configuration, and administration.

■ One of our concerns from the very beginning was scaling; that is, would the network start to show inconsistent connectivity and/or increases in the percentage of available bandwidth used for administrative purposes (as opposed to mission purposes) as it got larger. This was a major focus of our modeling efforts, and also of our laboratory measurements.

■ We were able to provide quality-of-service (against various definitions of quality) without having to allocate unacceptable percentages of the total communications capacity, but in some senses the solution took too much advantage of radio-specific characteristics. In the future, more generalized solutions will be required.

The TRW-developed FBCB2 software, which can be installed on platforms ranging from tanks to aircraft, ultimately will provide command and control and situational awareness to users on tens of thousands of Army vehicles.

■ The network became so reliable ("data communications are now more reliable than voice communications" was a user comment after one recent test) that it creates an opportunity to use the network to address system-level administrative goals, in addition to system-level mission goals. It also creates an opportunity to look at using the data network for voice communications.

■ We created what we call a "force-structure-aware network", that is, the network knows something about the users it is serving. We believe that this will lead to significant benefits to users, and also reduce the complexity of software applications. For example, users do not need to address most messages—the network understands the role within the combat team of the message creator, and the reporting relationships within the team, and can figure out (a very large percentage of the time) who (one or more) is the intended recipient. An example is a call-for-fire; the network knows which fire-support elements/fire direction centers support which geographic areas and which subsets of the force structure. Another example is status roll-ups (operational, supply, personnel, etc.) that automatically match the constantly-changing force structure and unit task organization. A third example is facilitating the creation of software applications that can correctly summarize the force at any echelon (we call this "collapse/expand", e.g., depict companies rather than platforms on the display, etc.). This is a complex problem, as in real-life there are often cross-attached units (ambulance, engineering vehicle, etc.) that are moved frequently and on short notice between tactical units. By using the force-structure-aware network's knowledge of the current unit task organization, accurate data can always be provided to the applications.

The Army directed a compressed schedule for the first phases of digitization; this schedule, 2 to 3 times shorter than a conventional approach, was considered necessary in order to build and maintain momentum.

The Army leadership realized that not all of the desired schedule compression could come out of the contractor—the Army, too, would also have to improve its own process timelines. Knowing that this would be uncomfortable for the Army organizations involved, the Chief of Staff himself took the initiative to build consensus amongst all of the stakeholders to implement the necessary improvements.

In my view, one of the critical items was an agreement to streamline decision-making (e.g., between PEOs), often requiring their staffs to operate together in one pass, rather than in sequence. The contractor PM was required to raise problems directly to the PEO if decisions were not timely.

Another valuable Army management initiative was TRADOC and FORSCOM concurrence to allow significant interaction by the contractor with operational units (the EXFOR, experimental force), in order to facilitate lessons-learned and discovery learning by both parties. This required the contractor to commit to strong coordination efforts with the PM, PEO, and TSM, so as to obtain these benefits without bypassing the oversight and guidance roles of these organizations. This also required significant commitment from the operational units involved.

This was followed by a regular process of coordination amongst the stakeholders. Great focus was maintained over a long period of time on achieving the schedule while still creating a breakthrough capability. The schedule was achieved, and far from breaking the system, the pressure and collaboration required engendered a significant sense of teamwork.

The Chief of Staff maintained a high level of personal involvement throughout this process, over a period of several years. I believe that this was instrumental in maintaining institutional focus and creating consensus.

Into the Future—On to the Objective Force

There are still many areas where additional improvements, even breakthroughs, are needed. For example, we have done significant research into having the planning process draw continuously upon situational awareness (SA). This involves using the SA data to initialize any given planning cycle, but even more productively, involves the use of SA automatically to monitor a plan and highlight recent events that have created problems or opportunities with a plan. But at present, this is still a research topic, not a fielded capability.

I cited some revolutionary improvements that have already been made in creating and disseminating the red picture. Future improvements will certainly involve better matching between the types of information produced by sensor systems and the types of information needed by decision-makers.

There is a lot of benefit that could be derived by having more logistics data reporting, and system management in general, "piggy-backing" on the digitization data network.

There are serious issues remaining to be solved in order to extend the capabilities and benefits described in this paper to dismounted soldiers. Battery life is one issue, but in my view the key issue is communications.

Joint and allied interaction need to become much more sophisticated. For example, I mentioned above the integration of fixed-wing close-air-support aircraft into the digital battlefield, which improved targeting and reduced fratricide for those missions. But much more integration of the ground and air battlespace is needed. Some of this is starting, with linkages via Link-16 to AWACS and ABCCC ready for near-term implementation.

Interactions between sensors, deciders, the network, and weapons still need revolutionary improvements. One concept is "plug-and-fight", wherein any platform can join the network on-the-fly, register with the network (thereby telling the network what assets—sensors, weapons, etc.—it brings, and also get into a logistics-reporting scheme, etc.). When a decider "pulls the trigger", the network makes recommendations or decides which weapon is the most appropriate to use. This involves more robust and subtle weapons-target-pairing algorithms than are available at present, among other challenges.

The utility of mixtures of UAVs—from theater-wide to organic—is just being explored, including armed UAVs. The problem I call "N-to-1 tele-operation" remains, too—if the battlespace is going to be populated with a lot of remotely-operated platforms (air and ground), we probably cannot tolerate needing N people to operate each platform; we will need for 1 person to operate N platforms.

Much technical progress is still needed in the area of infrastructureless networks, especially their dynamic behavior. Current levels of network performance and availability suitable for the Internet are not adequate for warfighting.

Progress continues every day. For example, exciting new variants using small, on-the-move SATCOM transceivers are in use in the Balkans and other theaters today, providing more flexibility and better coverage for low-density deployments in rugged terrain. Digitization is in the field today, effectively supporting our armed forces.

The Objective Force is a vision of a more effective future. But it is a vision with genuine intellectual and analytic roots, derived from the Army's experimentation program; this experience shows that the Objective Force is feasible. I am proud to have led one important portion of this process. Now we must extract the appropriate lessons from the recent past and the present, and combine those lessons with new ideas to create the future Objective Force. Our nation needs nothing less.

About the Author

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Neil Siegel is Vice-President of Technology at TRW Systems. Prior to taking that assignment, he held a succession of leadership positions in TRW's Army and military businesses, including Vice-President and General Manager of TRW's Tactical Systems division, and TRW's Program Manager for the Army's Force XXI Battle Command Brigade-and-Below program.