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Next Generation Technology for Simulation and Training

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Military simulation systems have always evolved along a path plowed by the availability of commercial technologies. The introduction of mini computers in the 1970's allowed this community to migrate board wargames onto these platforms to create the earliest constructive simulations. Maturing research into computer graphics and visualization in the 1980's enabled the creation of early virtual simulators. The inclusion of networking between commercial computers allowed us to create systems like SIMNET and networked flight simulators in the 1990's. These networked systems led to the challenges of interoperability that were addressed by DIS, ALSP, and HLA at the end of the century.

Our community sometimes creates its own custom technologies, but we are more often adopters of the latest technologies that are emerging in the commercial realm. Military systems can afford to spend more money on the applications of these technologies and usually create systems before many other commercial entities can afford them. As a result, it may appear that the simulation community is creating the base technologies, when in truth we are usually adopting new technologies from industry and academia, and then applying them vigorously to our problems.

When we look to the future we can see the next wave of technology upon which military simulations will be built. At the fringes of our community there are forward thinkers who are already pointing to the inevitability of these technologies and the impacts they will have on new applications. High Performance Computing, IT service architectures, and commercial game engines are presenting intriguing and powerful opportunities to our industry. The special-interest experiments that are being conducted with these right now will become the core of the next generation of systems over the next decade.

High Performance Computing

High Performance Computing (HPC) refers to a number of new hardware products that incorporate multiple computing elements into an integrated hardware platform. These include everything from the special purpose Cray supercomputers to the multi-core CPUs in every new laptop computer. In the near future, every device will have multiple CPUs embedded in it, which will enable applications to split all applications for parallel computation. Chip makers like Intel and AMD have made it clear that they intend to double the number of compute cores inside of a basic computer every year. Simple arithmetic indicates that the dual core processor that is standard in a consumer PC today will grow into 64 cores in just 5 years and may exceed 2,000 cores within 10 years. If this type of computation is available in consumer machines then how much more can be leveraged for military simulation and training? New simulation products that are started today must be created with the idea that they will be able to leverage the power of thousands of processors by the time the system is fielded. This presents a significant challenge to the companies and the individuals creating them. The previous generation of systems was designed with the annual doubling of the speed of a single CPU in mind. The annual doubling of the number of processors presents a more complex problem. Most programmers are not proficient at designing software for parallel computation. This is a skill that must become part of a basic education in computer science, and it must happen almost immediately. Because HPC refers to a wide variety of technologies, the available compute environment for our simulations will be very diverse. In addition to multi-core processors, we will have available compute clusters that bring together thousands of these multi-core CPUs. These clusters will also include graphics processing units as general purpose computation resources (GPGPU processing). Other vendors are creating specialized chips that provide improved performance in mathematics, physics, and artificial intelligence. These are designed to fit into personal computers or clusters as a co-processor in support of the multi-core CPUs described earlier. IBM and Sony have released the Cell processor which combines two general purpose CPUs and eight vector processors. At the fringes there are a number of other specialized chips like digital signal processors that have not traditionally been used in simulation processing, but which present significant power at low prices and may find a niche in this domain. When all of these are brought together into an affordable HPC, they present several orders of magnitude increases in processing as well as significant challenges in designing the next generation of simulation products.

IT Services

The IT community has created a service-based business that allows customers to connect to powerful applications from anywhere on the network and to run specialized software from a very thin client on the desktop. In some cases this client is as thin as a web page loaded in a browser, in others it is a light application that runs as a browser plug-in or standalone application. The key point is that complex IT applications can be accessed from almost any desktop computer and usually requires no special pre-configuration. Military simulations have typically relied on powerful, customized suites of hardware and software. This has limited our ability to extend simulation-based training to everyone in the military. We have relied on simulation centers with unique equipment and required that customers physically come to the center or to a satellite location that has similar unique equipment. IT services redefine the client/server relationship such that the customer receives a client that can be supported on a much larger set of computers. Simulation systems can take advantage of this same type of redesign to deliver training through a much lighter and more accessible interface. In the commercial world we have become accustomed to two-dimensional map displays on sites like Google Maps and Map Quest, and menu-based systems on thousands of other web sites. These are the primary types of user interfaces for most constructive simulations and for the control terminals in the live and virtual domains as well. A redesign of our current applications could enable our customers and trainees to use very unique, complex, and computationally heavy applications from any desktop because the heavy lifting is handled by server machines that that do not have to be collocated with the trainees. Though there remain some issues with dynamic updates of simulation data, these are minimal problems that can be tackled with research and ingenuity. We are in a position to apply commercial IT architectures to break our dependence on custom computer hardware and facilities at the client/customer end of the interface.

Game Technologies

For the last several years, the simulation community has been abuzz with ideas for using commercial computer games for military training and analysis. A number of very interesting experimental systems have been created and several applications have been fielded. As individual and small unit trainers these games offer a miniature version of the virtual trainers of the 1990's. They allow semi-immersion and collaborative play to soldiers who previously were unable to use simulation in their training. Computer game technologies offer a compelling environment, multiplayer capabilities, world-class visualization, cognitive stimulation, rapid scenario customization, and extreme portability. Many of the military's initial experiments have focused on the modification of a commercial game to create trainers. However, as we master these technologies and understand how they are valuable for our missions, we will be able to create training tools that specifically meet our needs, rather than being limited to the structure of the commercial products. Though there are questions about the modeling accuracy of a commercial game, there is nothing inherent in the technology that prevents military users from inserting the most detailed and validated models available. Our initial use of commercial games has been a necessary stepping stone on the path to a more mature and focuses use of game technologies for military purposes.

During the last quarter of the 20th century we saw a transformation of training based on our adoption of mini-computers and workstations, virtual reality and graphics devices, and networking. The first quarter of the 21st century is presenting us with a similar triad of technologies upon which to continue this transformation – high performance computing, computer games, and IT services. Though some readers find these technologies esoteric, they are no more esoteric than were 3D graphics to the first flight simulators to adopt them or than networking was at the beginning of the SIMNET project. We are clearly witnessing the seeds of the next generation of core military training technologies.

Author

Dr. Roger Smith is the Chief Scientist and CTO for U.S. Army Simulation, Training and Instrumentation. He is focused on bringing innovative technologies into Army training and testing events. His organization awards over $2.5 billion dollars in government contracts each year, primarily focused in simulation, training, and gaming technologies. He has published over 100 technical papers on gaming, simulation, and innovation. He has lectured at a number of universities on these topics and serves on the editorial boards of the *ACM Transactions on Modeling and Computer Simulation* and *IRI's Research Technology Management*. Dr. Smith holds degrees in Computer Science, Statistics, Mathematics, and Management.