Distributed Interactive Simulation (DIS): An Overview Of The System And Its Potential Uses

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ABSTRACT

The Distributed Interactive Simulation (DIS) concept, since its inception, has been defined into three separate but distinct areas of service.

- Viewing of data in the real-time environment.
- Multiple range viewing and usage of"real-time data."
- Problems with the sharing of information through DIS.

This paper will discuss the DIS concept and some of the various methods available to display this data to users of the system.

KEY WORDS

Distributed Interactive Simulation (DIS), Simulations, Large Scale Integrated Networking

INTRODUCTION

One of the emerging capabilities of real-time simulation is the ability to create large virtual worlds in which many subjects can interact. These simulations are being done by electronically linking individual simulations and simulators into a virtual problem solving world. As described by the DIS Steering Committee [l], the creation of such virtual worlds makes possible:

- Training of large scale forces in a realistic environment
- Planning and rehearsal of operational missions
- Development of new tactics and concepts of operation
- Testing of the efficacy of new systems very early in their development cycles

The movement to create these large virtual worlds is called Advance Distributed Simulation (ADS). Almost every major simulation being procured today will become part of ADS. The leaders of this effort are the Advance Project Research Agency (ARPA), Joint Warfighting Center (JWFC), Defense Modeling and Simulation Office (DMSO), the Simulation Training and Instrumentation Command (STRICOM) of the Army, and the Federal Aviation Administration (FAA).

To make such ADS capabilities a reality, a standards infrastructure was established to make the individual simulations operable. Standards are needed in the areas of interfacing, communications, representation of the virtual environment, management, security, and performance measurement. In 1989 a small group of individuals within the defense community organized a series of workshops. At the March 1994 workshop over 1100 people attended. The goal of which was to create and enhance the standards that are used to support the ADS movement. This support movement is called Distributed Interactive Simulation (DIS).

VIEWING OF DATA IN THE REAL-TIME ENVIRONMENT

There are several methods of viewing this DIS data in real-time. They are:

Plan View Display (PVD) (sometimes called-God's Eye View (GEV)) - This is normally a top-down two-dimensional view of an area of interest. It may include a map underlay showing physical or political boundaries. This map can be statically displayed, when the view-plan does not change, or it can be recalled from a database. Each entity, a single device like an aircraft or radar site, is represented by an icon. As data is received, about the state of the entity, the viewer and icon is updated. The display represents the relative position on the earth and will typically display all entities in that area or space regardless of the altitude above or below sea level.

If the update rate is slow, the icon may jump about roughly from place to place. The appearance of the display can be improved by updating the icon position more frequently. Network bandwidth limitations may prevent the simulation from transmitting position data frequently enough to make the icon appear to move smoothly. "Dead reckoning" is used to increase the update rate without using more bandwidth. The display and the simulation both use the same algorithm to predict the position of the icon. The simulation only transmits a new icon position across the network when the simulation determines that the dead reckoning position differs noticeably from the correct position.

A PVD is usually a low cost device. A single unit typically costs less then $50,000 depending on the range of capability and computer power. Adding to this cost is a database that contains or generates the map underlay. The cost of this underlay if externally obtained, is typically $500 to $1,500 per copy. Some systems support the use of a scanner which can reduce the cost of digitizing the maps. If a high volume of map underlays are to be produced, serious consideration should be given to obtaining and using the scanner to reduce the life-cycle costs of the PVD.

<u>Viewport</u> - This is a three-dimensional display much like what an image generator would produce for a flight simulator. Several implementations exist with variations of capability. All share the capability of allowing the user to view the virtual space from some vantage point with a cartoon-like image generated in real-time.

There are typically three features that can be found in a Viewport:

> Attached (or tethered) operation -- This mode allows the user to attach to an entity as it moves through the virtual space. As the entity moves through space, the view of the user also changes. The user may or may not choose to keep the entity within his field-of-view and can normally adjust the eye-point, or aspect-of-view, on any axis. This permits the user to look at a wingman, see what might be chasing the entity, or simply browse the country side. This can be done with any entity in the virtual space.
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> Cockpit view -- This permits the user to share the eye-point of the entity pilot or driver. The user will see what the entity operator or pilot sees. This differs from the attached mode in that the point-of-view is always inside the entity' s cockpit or point of operation.
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> Stealth mode -- This mode permits the user to fly through the virtual space undetected. This would allow him to fly to a point at "warp" speed, pick a point of interest, and then hover to view the action without becoming a part of the scenario. This dynamic mode permits a level of flexibility beyond what an entity can do. He can fly through tree lines, mountains, and other obstructions or go underwater or into outer space. In this mode the user can also eliminate visibility restrictions that may occur in the virtual world.

Like the PVD, the Viewport device typically costs less then $50,000, and increases to millions of dollars depending on level of detail, number of entities it is capable of supporting, and the range of capabilities that the user can select from. Additional costs include the support of moving objects or other animated activities. This cost increases with the need to insure that your data base includes all models that must be displayed. Otherwise, a generic model will be used to represent the entity. Also, the terrain database is a key part of the database. Much like a Scene Image Generator, the Viewport device must represent entities as they would appear in the real world (on the side of a mountain, near a beachhead, above a city, etc.)

The Scene Image Generator (IG) uses the traditional method of viewing the dynamic real-time world, or virtual world in a simulator. It is restricted to the actual entity and the field of view supported by the IG constructed. There is a tremendous need for standardized images. It is a waste of resources to have to redesign the image of an F-16 fighter jet every time it is ported to a new platform. Existing data bases do not use a common format, without regard to the platform, that the image is to be displayed on. Some work has been done in the area of a "standard interchange format" but there is nothing currently available that has made a major breakthrough. The industry tends to oppose this standard interchange format since this would reduce the need for regeneration of terrain models and object images for each platform.

A Network Interface Unit (NIU) is required to connect a simulator to an entity in the virtual world. This is the device that tracks, filters, dead reckons, and generates entities. Locations with the proper display equipment have the ability to show an entity as it is in relation to the rest of the virtual world. If the entity is moving, then that entity must state this fact to the rest of the network so all other display equipment can show the entity's movement. This is done through a data structure called a Protocol Data Unit (PDU). Each entity, that is part of the virtual world, must emit a PDU at a predetermined minimum rate. This rate varies and is defined by the exercise participants.

There are ten PDUs currently defined by the DIS standard [2] :

- Entity State PDU
- Fire PDU
- Detonation PDU
- Service Request PDU
- Resupply Offer PDU
- Resupply Received PDU
- Resupply Cancel PDU
- Repair Complete PDU

- Repair Response PDU
- Collision PDU

Each PDU contains enough information to allow all the participants of the simulation to identify the issuing entity, the valid time and the purpose of this PDU. The Entity State PDU is unique in that it also contains information about the entity's location and its XYZ velocity in relation to the rest of the simulated world. The other PDUs describe specific events that will affect the overall simulation.

MULTIPLE RANGE VIEWING AND USAGE OF "REAL-TIME DATA"

The integration of a range into a virtual DIS simulation can be beneficial if the solution being provided is appropriate to a training mission or engineering study that encompass other entities. By "connecting" a simulated weapon system to the network, which is likewise connected to an actual airplane, the pilot can control the weapon system as if it were an actual unit. Because of the fact that the size of the network or distance between two points is unimportant, it is conceivable that the manufacturer of an untried weapon system could "fly" his product on an airplane that is sitting on a taxi way. This combined airplane/weapon system could then conduct tests against an actual training range located on the other side of the country. The results of this simulated flight test could then be monitored at yet a fourth location by the "flight test engineers." The restrictions of time and space are no longer as important as when everything had to be done in the real and physical world. In the current, physically restricted world, large sums of money are spent to ensure that resources (engineers, observers, weapon systems, airplanes, etc.) are moved to remote test sites to conduct evaluation tests. Then if an unforeseen problem occurs (an observer's wife goes into labor and he must fly home, or a 50¢ framit fails and the test airplane is grounded) valuable range time is wasted and must be rescheduled. But in a DIS networked test, as previously described, the requirement to ensure that the airplane is flight-worthy is unimportant. (Fortunately DIS will never be able to substitute or simulate the support of a husband during the child-bearing process.)

Compliance with DIS is sometimes specified in new system acquisitions where it may not be appropriate. It is sometimes also applied without an understanding of what else is required to make the whole system work. One example could be a major range instrumentation program, where policy makers have required the new system to be DIS compliant, but does not produce a DIS data product. Extreme care will have to be taken to ensure that DIS does not become a, "They've got it and we want it too." desire. Only time will tell as to how effective the virtual situation can be in solving both the training and engineering problems.

PROBLEMS WITH THE SHARING OF INFORMATION THROUGH DIS

The ability to do joint training is supported in the DIS concept. You could have multiple virtual entities from geographically dispersed locations appear in a common space. Other entities such as those generated in a fully or semi-automated simulation can also appear in that space. If that space was a real location, such as a training or test range, then the virtual and computer generated entities could coexist.

One major problem exists here. Than is how to send information about a virtual entity to an onboard system? Also, how does the real object on the range share itself with the rest of the world, and how does this real object become aware of the virtual world's interactions. The simulated entity information would have to be uplinked to an airplane's 1553 bus to be displayed on its display consoles. Hence a new, enhanced, or extended capability is required on the range. Some ranges have discussed embedded capabilities for training. This will require new definitions, and most likely, new equipment for the range to be DIS compliant.

The principal domain for DIS is human-in-the-loop interaction with simulation and a synthetic environment. Admittedly, DIS is not appropriate for certain hardware-in-the-loop, high-fidelity, engineering applications. Some examples that would not be suited are simulations that study techniques, problems or exchanges that need no human interactions.

However, when the time comes to consider the human-in-the-loop ramifications, and to view the system as an organic whole, then the situation is right for the use of DIS, both as an experimental and problem solving tool. Using DIS coupled with high-fidelity simulations is particularly useful in the "Test & Evaluation" and system acquisition arenas. The high fidelity simulation community also needs to understand the benefits that DIS can bring because of it's effort. They can gain a more complete and accurate understanding of how the candidate high performance weapon system and sensor subsystem fit into the total human-in-the-loop system and into the force structure as a whole. The implementation of DIS may well require different models to test system performance than those models currently used for high-fidelity component investigations with models that conform to the architecture, protocols, databases, and timing of DIS, yet still retain the key functions of the subsystem under investigation.

SUMMARY

Computer models of human performance and behavior will, for the foreseeable future, be poor substitutes for actual human behavior. No computer simulation can act like a human being better then a real person. The key selling point for DIS is this ability to bring accurate human activity into the picture to interact with all considered systems. This allows everyone involved to gain a better understanding of a simulation and to apply this newfound knowledge to engineering and real-world solutions. Engineering development, personnel training, equipment upgrades and flight test are but a few of the many things that will be made better because of the use of DIS.

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