IDA DOCUMENT D-1686

DISTRIBUTED JANUS OVERVIEW

Annotated Briefing

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Advanced Research Projects Agency

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PREFACE

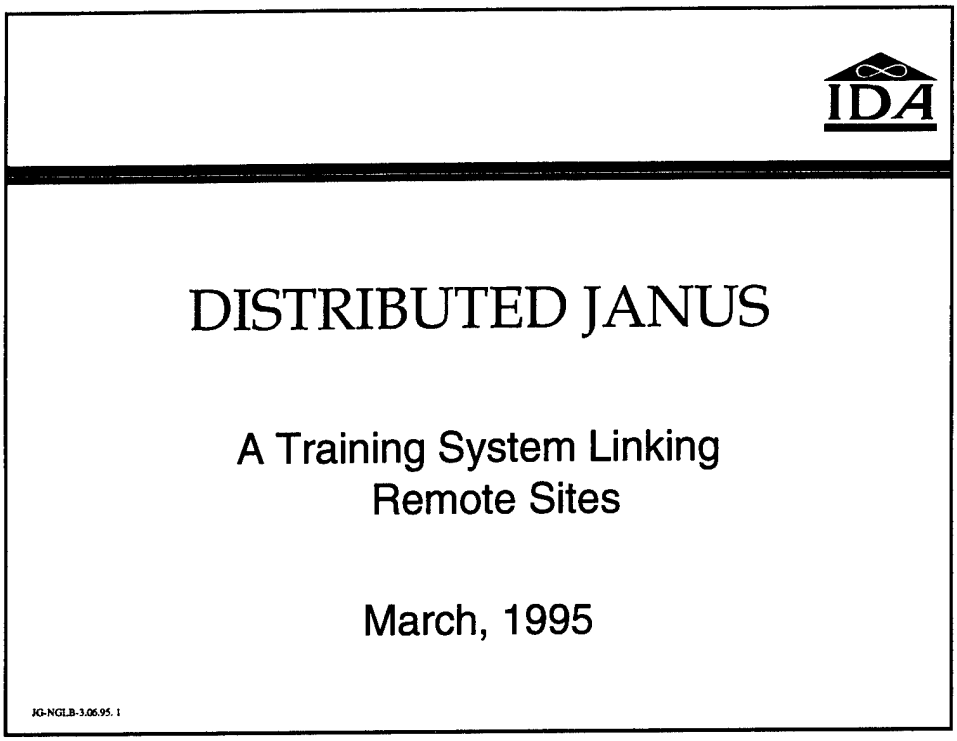
This annotated briefing provides an overview of the Distributed Janus training system developed at the Institute for Defense Analyses at the behest of the Advanced Research Projects Agency. The goal of the development was to enhance training for National Guard brigades.

The effort benefited from guidance provided by the review panel during the design phases of this effort: Lt. Gen. Frederic J. Brown (USA, Ret) and Lt. Gen. Willard W. Scott, Jr., (USA Ret), and Mr. Joseph W. Stahl and Dr. Richard J. Ivanetich of IDA.

INTRODUCTION

Distributed Janus is a computerized training system developed by the Institute for Defense Analyses under the sponsorship of the Advanced Research Projects Agency. This paper provides an overview of the effort by means of an annotated briefing that covers the origins of the system, discusses its architecture, highlights the main development efforts and addresses possible future directions. One other document provides appropriate details.

IDA Document D-1626 contains a system administrator's manual, an operator's manual, a user's manual, a modified version of the Janus exportable training document and other installation and user information.



Distributed Janus is a system development effort undertaken by the Institute for Defense Analyses for the Advanced Research Projects Agency. Its objective was to create a training system for the National Guard that would emphasize battle staff synchronization and link brigade and battalion armories into a single, coordinated command post exercise.

The project ran from March 1993 through March 1995. Efforts ranged from simulation design and development, and network creation, to determination of infrastructure requirements, installation and on-site support. This briefing summarizes that project and the system that was developed and delivered to ARPA.

The personnel who were most involved in the effort were: Jeffrey H. Grotte, Merle Roberson and Willard Christenson, of IDA, and Kathy Daley, Kenneth Craig and Katerina Samita, of Appia Associates, Inc., a subcontractor to IDA.

Initial Motivation

- Desert Shield/Storm after-action reports suggested National Guard training shortfalls
  - » Individual skill proficiency, especially in combat support and combat service support
  - » brigade and battalion staff synchronization
- FY92 DoD Appropriations Bill earmarked funds for "advanced technology training for National Guard roundout brigades"

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The initial impetus for the development of Distributed Janus came from Congress. Concerns raised about the readiness of National Guard units to participate in Southwest Asia operations led to Congress earmarking funds to enhance National Guard training using advanced electronics and simulation. This led to ARPA's Project SIMITAR — Simulation In Training for Advanced Readiness.

ARPA Response

- ARPA: Project SIMITAR (Simulation In Training for Advanced Readiness)
  - » Increase content and quality of training
  - » Compress time required for training
  - » Shift training from field to home
  - » Connect training institutions to armories
  - » Use advanced technologies and consumer electronics
- SIMITAR funds a variety of developments, including
  - » S2 trainer
  - » Reconfigurable simulator
  - » Maintenance Trainer
  - » **Distributed Janus**

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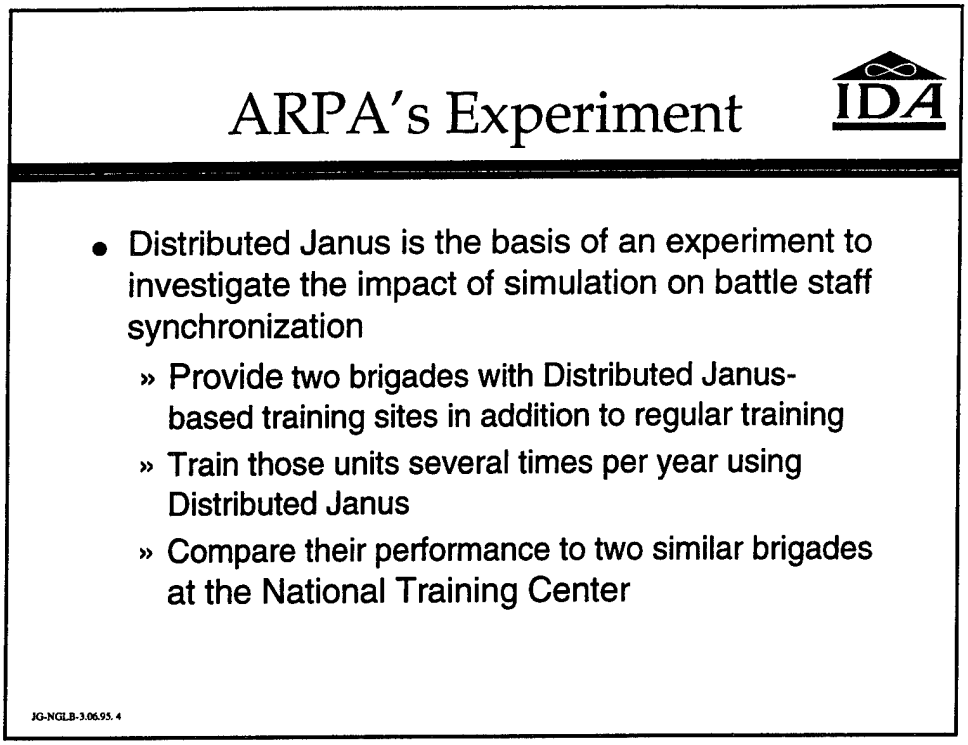
SIMITAR emphasizes bringing training to each unit's home armory. This eliminates burdensome travel time that is often associated with unit training, thus making available more actual training time over a weekend. A locally available system also could be used by personnel in evenings or at odd hours not necessarily associated with formal training.

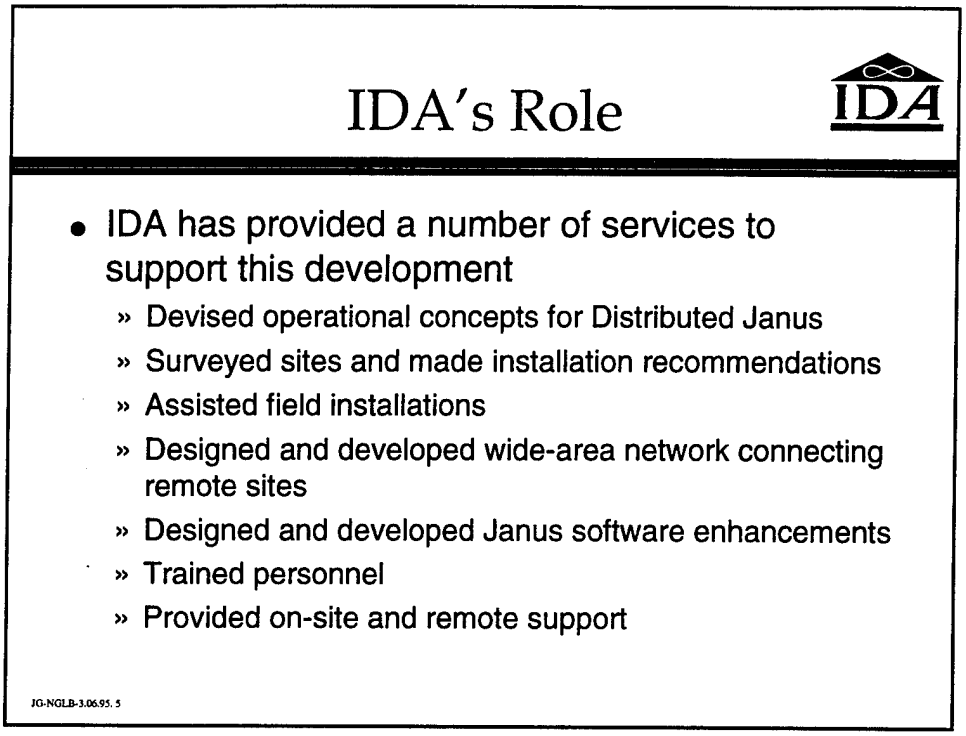
Providing electronic links with other sites allows two or more sites to train together, and also allows dedicated training activities to provide direct support. For example, an expert OPFOR cell could be linked with a National Guard maneuver battalion to provide doctrinally correct opposition without that battalion having to import that capability or develop it in house.

There are a number of separate developments that have been funded, including personal computer-based training systems, and an inexpensive reconfigurable simulator to connect to the distributed simulation internet. IDA's contribution is the development of Distributed Janus.



Distributed Janus has been developed in the context of an experiment to assess the impact of distributed simulation on battle staff synchronization training. ARPA has selected two National Guard brigades to receive Distributed Janus — the 116th Armored Brigade headquartered in Boise, Idaho, and the 48th Mechanized Infantry Brigade headquartered in Macon, Georgia. Brigade headquarters and subordinate battalions will receive suites of hardware and the associated software and will supplement their regular training with Distributed Janus until their rotations at the National Training Center in the 1996-1997 time frame. Their performance there will be compared to the performance of two similar brigades that have not received the system to see what kind of difference this type of at-home computer-based training might have. The Army Research Institute will do the comparisons.

While there are clearly too many variables in this experiment to produce any type of quantified measure of the impact of Distributed Janus, it is hoped that enough information, even if anecdotal, can be gathered to support the contention that this type of training makes a difference.

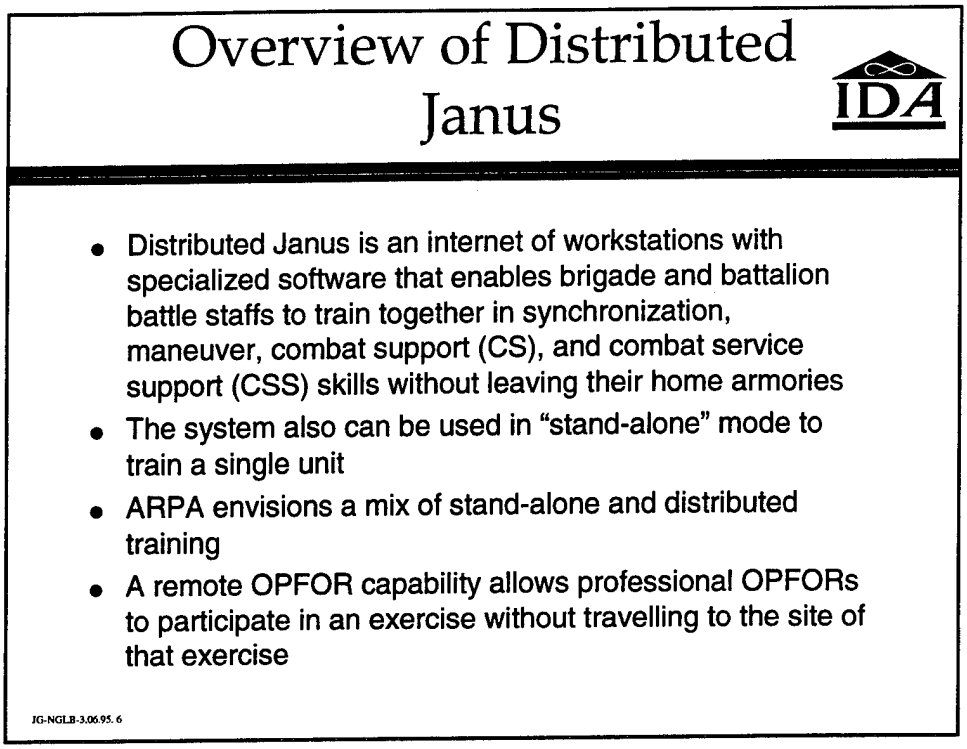


IDA's role in this effort has been primarily that of software developer. However, because of the innovative nature of this effort, our contribution has gone beyond simply writing code. Indeed, since there were no clearly defined requirement for the system, IDA had to design a strawman operational concept for the system, both in terms of what it needed to do and how it would be implemented in the armories. This required us to visit all the involved armories to determine what was needed in terms of infrastructure enhancement to support the equipment, and to return to inspect many of the sites after these improvements were made.

We also determined what was needed to implement the "distributed" component of Distributed Janus. This included development of a mechanism to utilize commercial telephone lines to create a wide-area network, as well as the software to operate that wide-area network and manage files in a user-friendly way.

There also were some changes that needed to be made to the Janus model itself to support ARPA's concept. We designed and implemented those as well.

Finally, there were a variety of miscellaneous activities we had to carry out, such as providing training for personnel that ARPA had retained to develop training scenarios, administer the systems, and manage databases. We also provided occasional on-site and telephone support to assist with the implementation of the system.



Each brigade and battalion armory received a suite of equipment linked together in a local-area network. These local-area networks are connected in a wide-area network, permitting distributed training. Each local-area network, however, can drive a stand-alone exercise within its own armory. Indeed, the training plan that ARPA has developed includes frequent stand-alone exercises (perhaps training each site twice per year) with one or two distributed exercises per brigade.

In addition to linking the armories of each brigade, each maneuver battalion can be linked to an OPFOR cell located somewhere else for stand-alone or distributed use. This relieves the brigades of supplying their own OPFOR (although they can do so if they wish) or of requiring full-time OPFOR personnel (who are supplied by the 35th Infantry Division at Ft. Leavenworth) to travel to the armories to support exercises.

Distributed Janus Hardware

- Each site has the following hardware
  - » 1 Hewlett Packard 715/50 workstation, runs Distributed Janus
  - » 20 Sun Classic workstations: display for interactors
  - » 1 ethernetwork
  - » 1 or more modem phone lines
  - » 4 or more dedicated voice phone lines: simulates brigade comm networks

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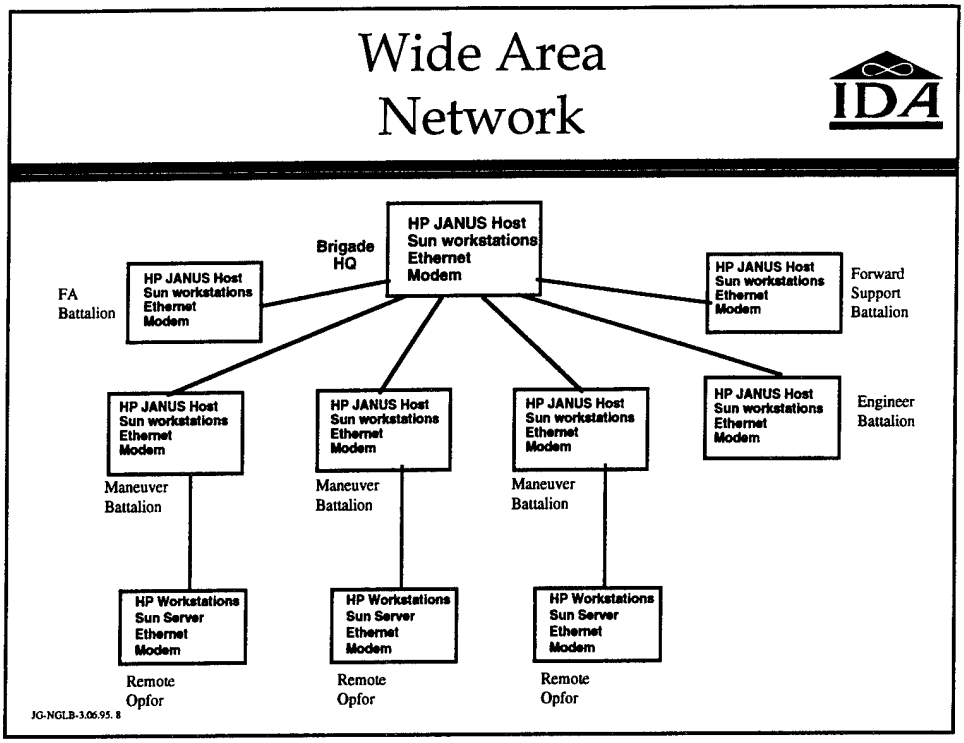
Each brigade and battalion armory received a substantial suite of computer hardware. A Hewlett Packard 715/50 serves as the Distributed Janus host. Here is where the program actually runs. The Sun workstations are used as displays. They are less expensive and less capable, but do relatively little processing. These workstations are connected into an ethernet. A suite of equipment for an individual site costs approximately $250,000.

One of the Suns is assigned the function of network server and also is the link to the wide-area network. The remainder of the Suns can be used as interactor workstations, each showing different assets.

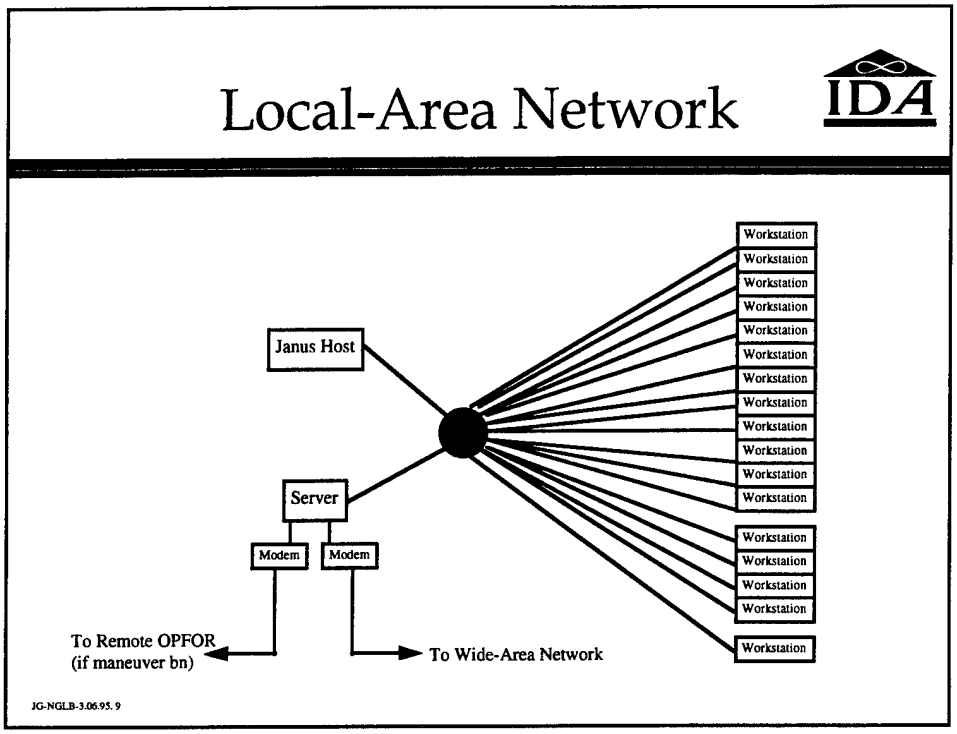
Ordinary commercial phone lines provide a data link between armories and, through the use of conference calls, simulate brigade-level communications networks. Intraunit communications are done using field telephones and radios that are already on hand.



A brigade's subordinate battalions' local-area networks are connected to each other through a star-shaped wide-area network with the brigade server providing connection to all the sites. Each connection includes one data line and four voice lines. The data lines are currently commercial telephone lines, with the servers communicating over 14,400 bps modems using PPP protocols.

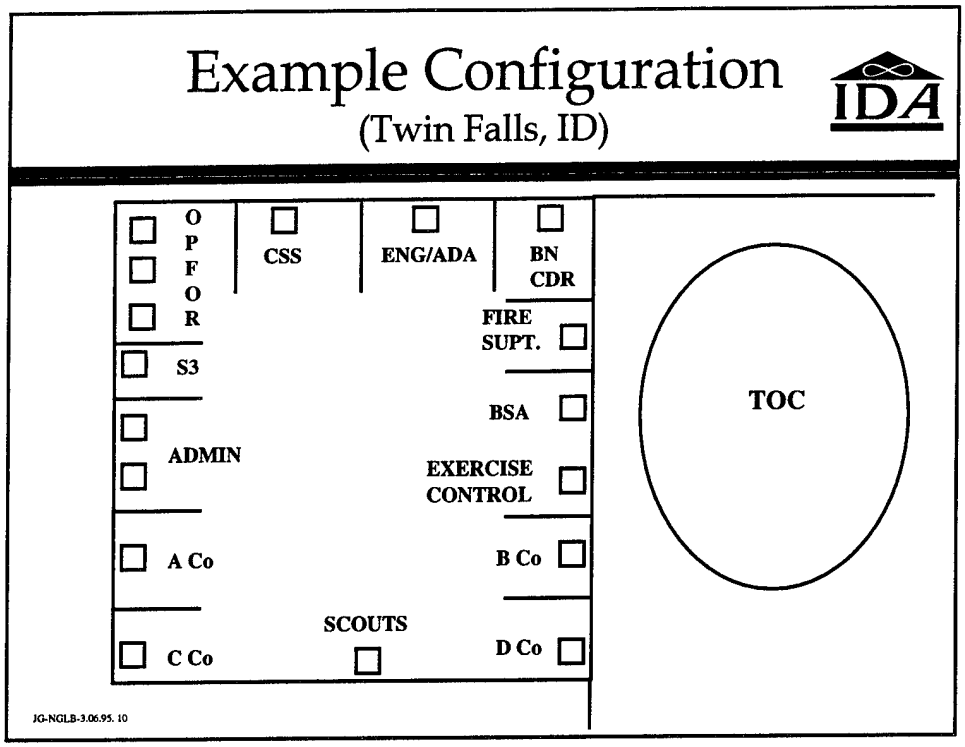
A workstation at a particular site is not restricted to connections with its local host computer. Workstations can be connected through the wide-area network to a different host computer when that serves the purposes of the training exercise. For example, a workstation at the Field Artillery battalion could be connected to the host at one of the maneuver battalions to simulate the fire support element normally provided to that battalion. That workstation would be able to share the maneuver battalion's view of the battle. The limited bandwidth of the modem phone lines limits the degree to which such interconnections can be made, however.

Late in the development of Distributed Janus, ARPA requested a capability to connect the maneuver battalions to OPFOR cells located at a distance from the Idaho and Georgia brigades. IDA has provided that capability, again using telephone lines. An OPFOR cell has a small suite of equipment comprising a modem connected to a Sun Classic server, which is connected through ethernet to two Hewlett Packard workstations. Unlike the other Hewlett Packards in this system, these Hewlett Packards serve only as displays and are connected through the phone lines to the maneuver battalion's host. The number of workstations that can be used at an OPFOR cell is limited by the bandwidth of the phone lines. A greater number of workstations would exhibit excessively long response time to user actions.



At each unit armory, the local-area network is an ethernet operating off a central set of ethernet hubs. The number of workstations connected to the hub is determined by the requirements of the training exercise. Also connected to the hubs is the Janus host and the Sun server.

If this is a brigade armory, the server is connected to six modems, which communicate to the six battalions. If this is a battalion armory, the server is connected to one modem to communicate to the brigade system and, if a maneuver battalion, a second modem that can communicate with the remote OPFOR, if desired.



This slide illustrates how the system is set up for an actual exercise in Twin Falls, Idaho. The drill floor is occupied by the Tactical Operations Center, set up in 577 command vehicles and connected to the simulation area by field telephone. In the simulation area, workstations are dedicated to maneuver company operations, a scout platoon, the brigade S3, fire support, the battalion commander, engineering and air defense artillery, and combat service support. There also is a workstation devoted to brigade support with reserve forces (BSA in the above diagram) as well as workstations for the OPFOR and administrative functions, such as running the system and creating after action slides. The exercise control workstation displays a CONWOR screen, which is a Janus utility that presents a real-time view of the entire battle for use by the exercise controllers.

Software Enhancements

- Distributed Janus began with the Army's Janus model--IDA added two categories of software enhancement
  - » Software to facilitate its operation in distributed mode (collectively known as "Agent") and
  - » Modifications to Janus itself to improve the training experience

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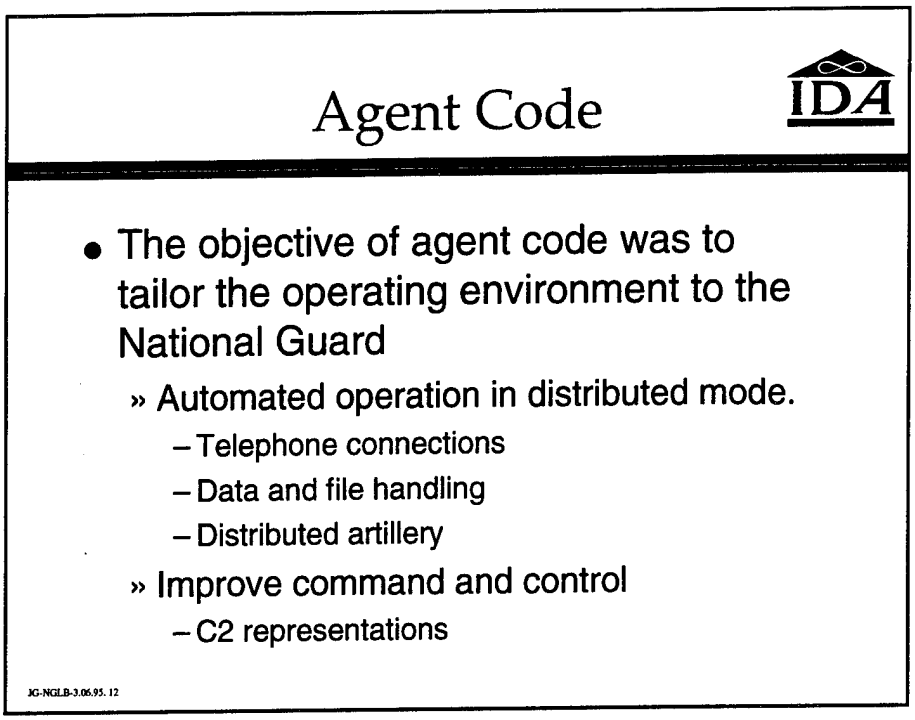
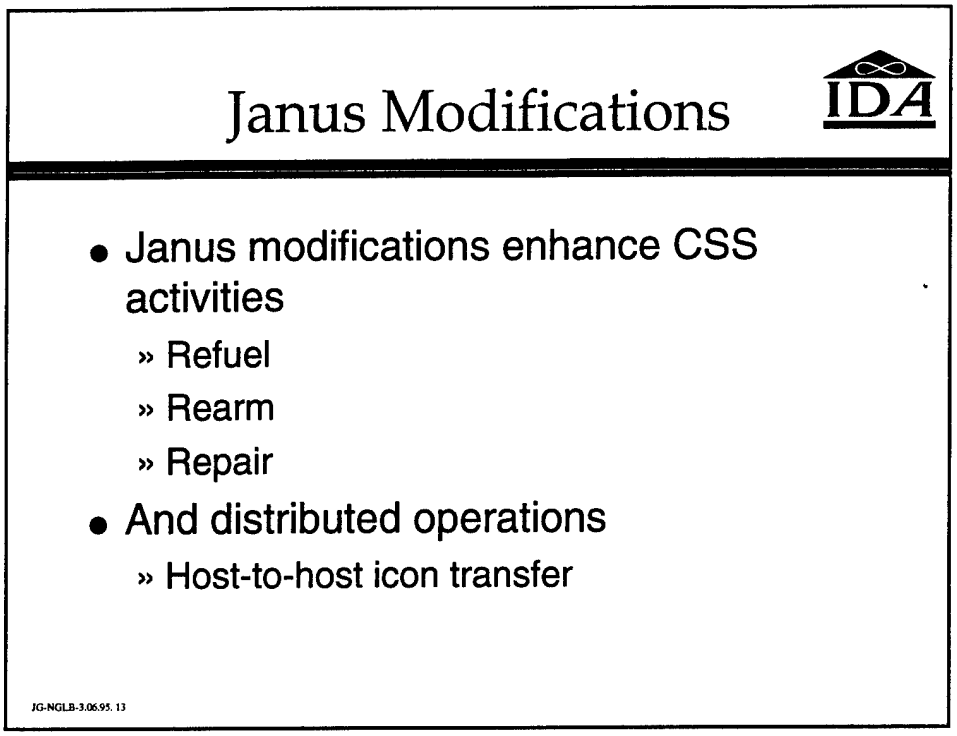
Two types of software enhancements were added to the Army's Janus model to enhance its applicability to the Guard. The first is code that is not part of the Janus model but adapts its operation to this training mission. The second is code that modifies the Janus model itself to increase its functionality. All these enhancements were directed toward supporting the underlying objective of enhancing brigade and battalion battle staff synchronization training.



IDA created a number of capabilities to satisfy what we perceived as National Guard requirements. The first of these was to simplify as much as possible distributed operation, recognizing that the personnel who would be operating this system would not be UNIX experts. As an example, a distributed exercise is easily initiated through the choice of a menu item at any one of the host machines. Software automatically makes the necessary phone calls, initiates Distributed Janus at the other sites with the proper scenario, synchronizes the game clocks, and ensures the clocks stay in synchronization. There also is a mechanism to ensure that artillery fired at one host appears at all others, since indirect fire can cover broad expanses of the battlefield.

Another initiative was to enhance command and control play in an exercise involving widely separated facilities and many workstations. Using the e-mail capabilities resident on the workstations, IDA created a number of templates to allow users to send electronic representations of frag orders, situation reports, and other forms of communications. Moreover, the simulation itself can send e-mail to workstations to report damaged vehicles, casualties and other information that can be used to exercise combat service support functions (in the Army's version of Janus, vehicles are either undamaged or destroyed; there are no wounded).



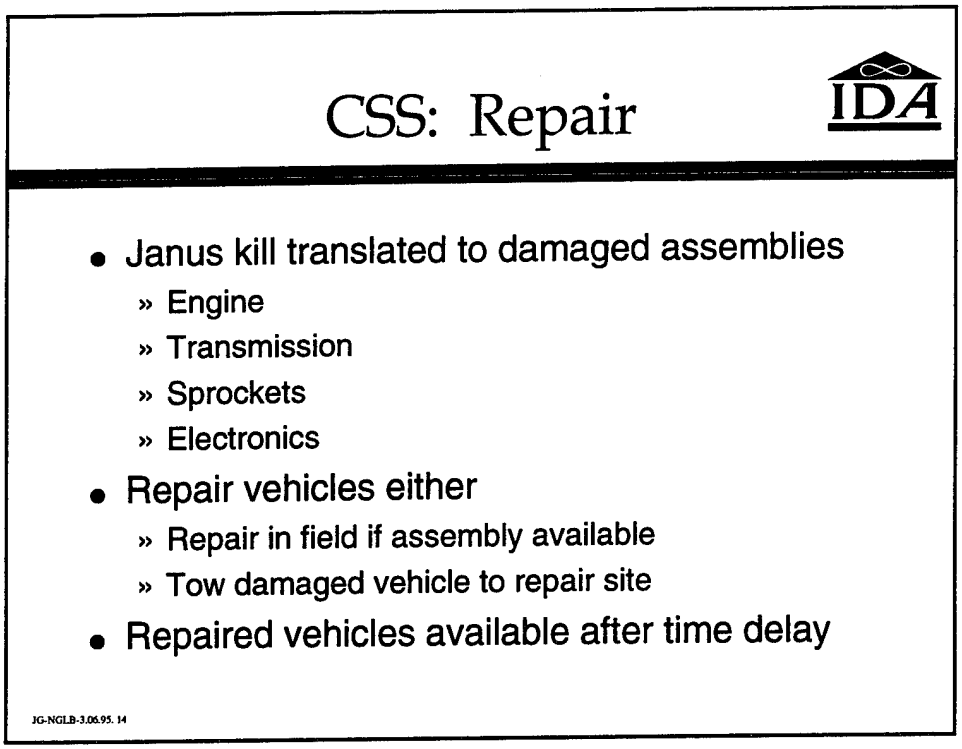
A distributed exercise involves six battalions: three maneuver battalions, an artillery battalion, an engineer battalion, and a forward support battalion. Unless attention is paid to the functions of these latter two units in the software, scenario, and training plan, it is very easy to focus too much on the maneuver units. Distributed Janus has some software enhancements that encourage increased combat service support participation.

Several improvements have been made to increase refueling activities. Controllers have been given the capability to download fuel from vehicles at the beginning of or during an exercise, making fuel shortages occur earlier than they would in the natural course of simulated combat (Janus normally begins with all vehicles containing a full load of consumables). Also, the ability to refuel logistics vehicles from other logistics vehicles has been added, as well as the ability to conduct "hot refuel" — refueling in which a group of combat vehicles is filled to a constant percentage, rather than topped off in a first-come-first-served manner.

Rearming activities can be increased by a mechanism similar to that mentioned above, where controllers can remove munitions from a combat vehicle, making rearming functions occur earlier in a scenario.

We also have added some prototype repair capability to the system. This is discussed more fully on the next slide.

Finally, we have changed the model to accommodate distributed operation by allowing host-to-host transfer of vehicles and by allowing controllers to move those vehicles at will around the battlefield, simulating reassignment of vehicles from one unit to another.



ARPA asked us to identify desirable CSS enhancements. Discussions with CASCOM and TRAC-Lee personnel identified several areas where new capabilities would greatly increase the training content of Distributed Janus for forward support battalions. Because ARPA could not fund all these enhancements, we have chosen to implement a prototype repair capability so that initial investigations into the value of CSS enhancements could be made.

All kills in Janus/Army are catastrophic kills. We have changed this so that some kills are translated into damage to certain key components: engines, transmissions, sprockets or wheels, and electronics. Vehicles with damage to these components can be repaired and returned to combat if appropriate actions are taken. These actions require that a repair vehicle be brought to the vicinity of the damaged vehicle. If the repair vehicle has an appropriate repair part, the damaged vehicle can be repaired in the field. This is simulated by a time delay which freezes the repair vehicle in place for a certain period, after which it is available to conduct additional repairs and a vehicle of the type repaired becomes available for reassignment by controllers. If the repair vehicle does not have the correct replacement assembly, it can tow the damaged vehicle to a predesignated repair location where, after a suitable time delay, the repaired vehicle becomes available for reassignment.

Additional Utilities

- After action review
  - » Simultaneous presentation at all locations
- Distributed scenario editor
  - » Minimize human error in unit assignments

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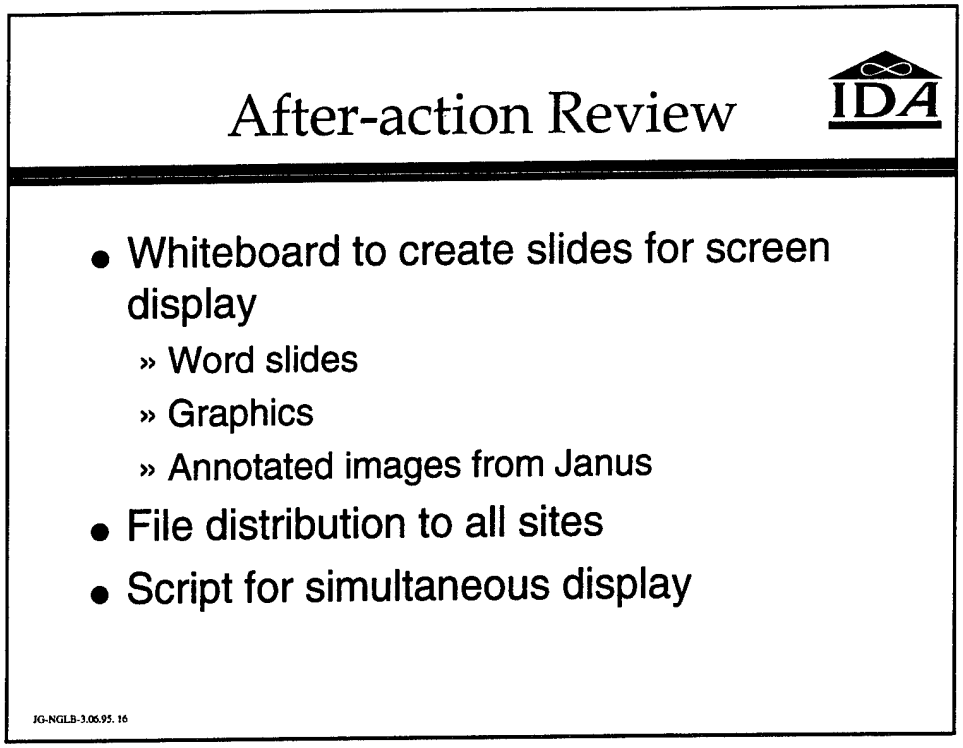
As supplied by the Army, the basic Janus model comes with a number of data and scenario development utilities. We needed to develop two more utilities to accommodate the distributed nature of the system.

The first utility allows a brigade commander to conduct a simultaneous presentation at all sites; the second is useful for developing distributed scenarios. More will be said about these utilities in the next two slides.



The after-action process of a distributed exercise involves not only reviews within each armory, but also information passed down from brigade headquarters to subordinate battalions. Because of the limited bandwidth of the telephone connections, approaches such as teleconferencing will not work. To facilitate this process, IDA installed — on each brigade headquarters — host commercial "whiteboard" software that allows the brigade staff to create word slides as well as annotated images from Distributed Janus screens or replay utilities. This set of slides can be sent electronically to each battalion host so that, when a brigade after-action review is initiated, these slides can be presented simultaneously at all sites (controlled from the brigade host). Voice communication can be provided over one of the telephone conference calls that simulate the brigade communications during the exercise.

Distributed Editor

- A distributed scenario involves 7 Janus scenarios--one on each host
- Each host scenario potentially has all brigade assets (to account for vehicle transfers)
- Each scenario must present only that unit's assets, with the others "parked" offscreen
- The distributed editor simplifies the process of ensuring assets appear on, at most, one host

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Creating a distributed scenario can be accomplished using the standard Janus utilities, but careful accounting is needed to ensure that the right forces appear on the appropriate unit screens. We have created a utility to do this accounting, which eliminates the errors that might arise by having forces appear twice.

Implementation

- Distributed Janus equipment & software has been installed in Idaho and Georgia armories
- ARPA has hired system and database administrators to support both brigades
- Ft. Knox Reserve Component Virtual Training Program has produced maneuver battalion scenarios; is working on brigade scenarios
- Training has begun
  - » Albany, GA--10 December 1994
  - » Twin Falls, ID--28 January 1995

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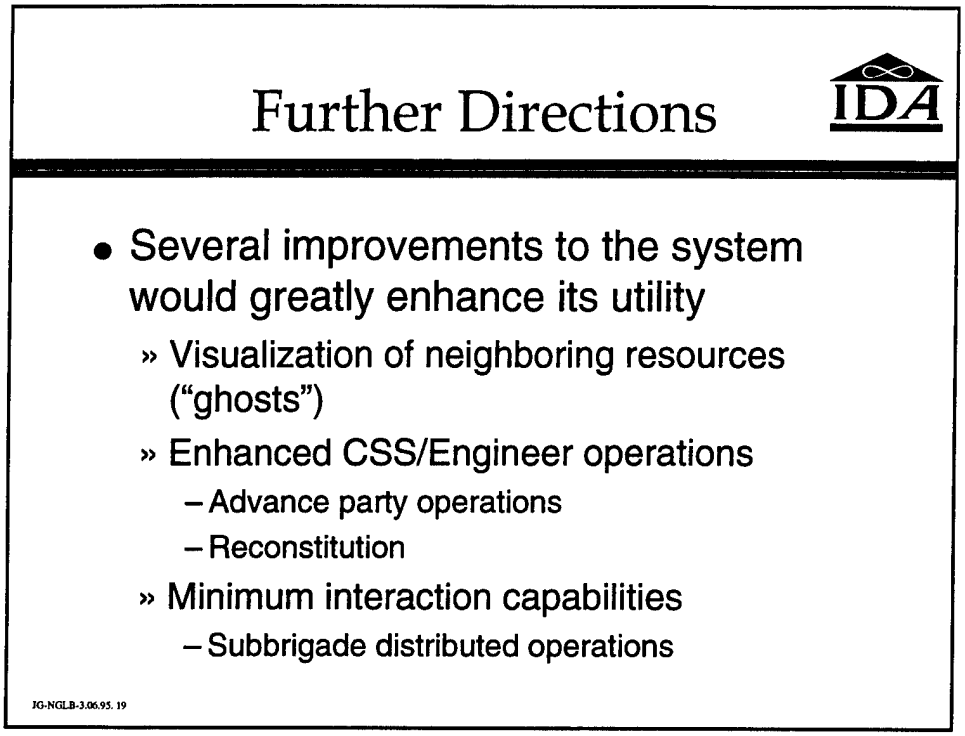
Distributed Janus has been installed in the two brigades and an infrastructure is in place to support it. This infrastructure includes contract support to assist with system administration and database and scenario maintenance. Scenarios are developed at Ft. Knox. So far, four stand-alone maneuver battalion scenarios have been developed and brigade scenarios are under development. Distributed scenarios have not yet been assigned for development.

Standalone training has begun in both states. Exercises will occur at various maneuver battalion locations approximately monthly throughout the remainder of this year. It is not certain at this time when non-maneuver battalion or distributed exercises will commence.

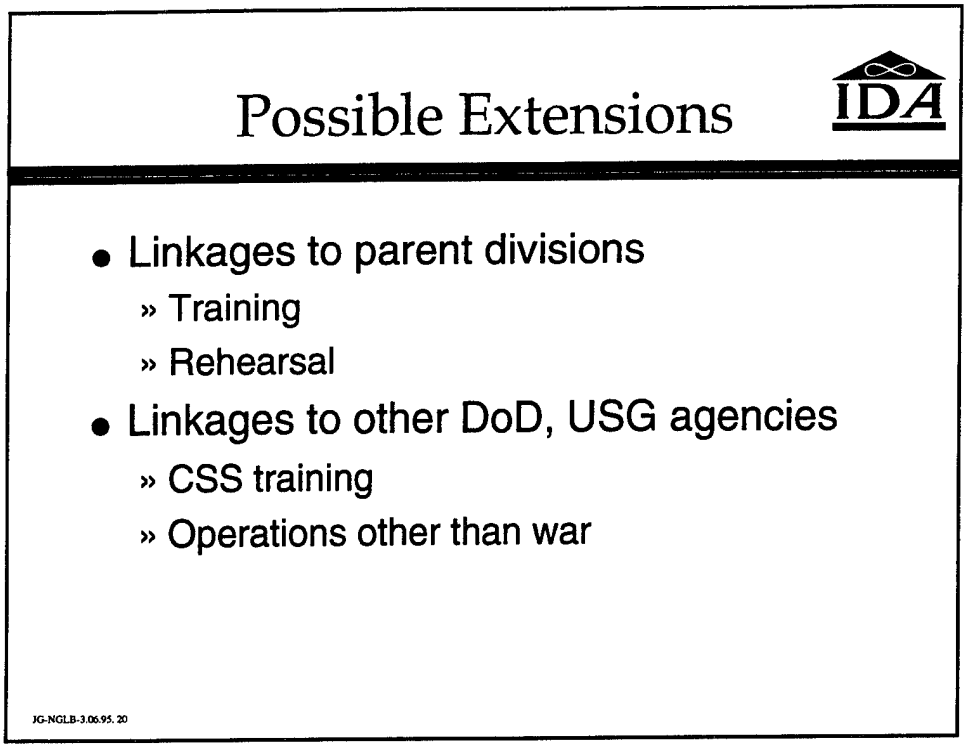


In the course of our work, we identified several improvements that would greatly enhance the utility of Distributed Janus as a training system.

The first of these would permit assets being used in one unit's scenario to be seen, and to interact, on all other units' hosts. The shorthand term we use for this capability is "ghosts." Currently, each unit can see and interact with only its own assets. This imposes several unrealistic constraints on exercises. Passage of lines, reinforcement, and support for neighboring units cannot be accomplished without artificially transferring control of some assets. Similarly, CSS assets must be transferred to maneuver units to refuel or repair combat vehicles. Adding ghost capability eliminates these artificialities.

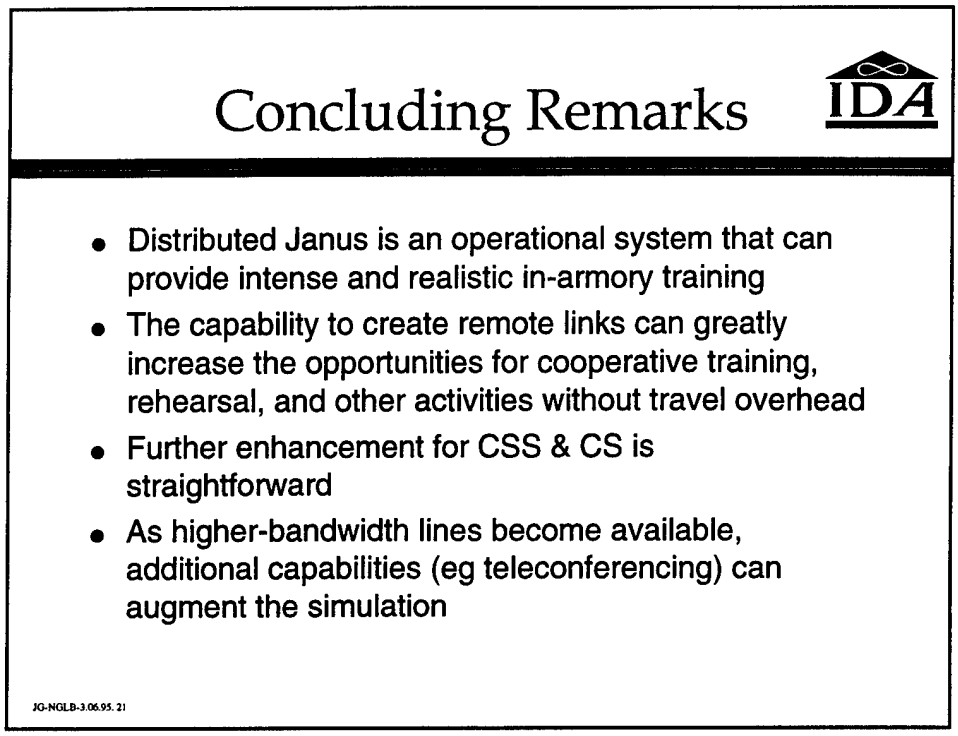
The second major enhancement would be to further add CSS capabilities. Further efforts directed toward advance party operations — construction of obstacles, prepared positions, river crossings, refueling and maintenance points — would increase the participation of engineering and forward support staffs. Enabling reconstitution activities — repair and redistribution of assets — would also go further toward exercising these staffs.

Finally, a capability to enable partial distributed operations, with non-participating units replaced by a skeleton staff of interactors making adjustments to a prepared scenario, would provide training opportunities between standalone and fully distributed (perhaps to enable remedial training following a distributed exercise, or to provide combat activities to exercise non-maneuver battalions). This has been under consideration throughout the development, although there has been no final determination of the degree of automation of the nonparticipating units necessary to make this capability both useful and feasible.



Distributed Janus was originally designed to link battalions together for simultaneous staff training. As the development progressed, it became clear that a useful addition would be to provide links to OPFOR cells. Other useful linkages can be easily conceived, such as linkages to parent divisions for training or, prior to mobilization, for rehearsal. This is even more attractive when one considers the possibility of using variants of Janus which are geared more toward urban environments (for peacekeeping/enforcement or disaster relief) or toward nuclear, biological, or chemical warfare (for training against WMD proliferators).

Additional connections can be envisioned. For peacekeeping or disaster relief, other government agencies could be linked with responsible units. For example, FEMA could coordinate with an operational unit to exchange graphics, test alternative courses of action, evaluate support requirements, and so forth.



Using computers to bring together widely scattered participants into a coordinated exercise is currently receiving much attention in the U.S. and elsewhere. The focus ranges from individual weapons, as in SIMNET, to entire theaters, as in the Synthetic Theater of War. Our focus has been on the brigade and battalion. Early experiences with Distributed Janus validate the notion that bringing simulation into armories is an effective and efficient way of enhancing the training of National Guard troops. Although distributed exercises have yet to be conducted, it is apparent that, with the explosion of communications networking now taking place in the U.S., training systems such as Distributed Janus will one day be commonplace. This development effort has taken several major steps in that direction: the network software has been created, a concept of operations articulated, and equipment and communications lines installed in the field.

There is more work to be done, particularly in enhancing CSS and CS functionality. That work probably should wait for experience with the distributed system to focus efforts on the greatest needs.

Greater utility also is possible as higher bandwidth lines become commonplace. The workstations used for Distributed Janus are easily upgraded to provide video and voice exchange. This will further increase the potential for computer-assisted exercises at the armory level.

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13. ABSTRACT ***(Maximum 200 words)***

Distributed Janus is a computerized training system for National Guard brigade and battalion battle staffs developed by the Institute for Defense Analyses under the sponsorship of the Advanced Research Projects Agency. A key feature of the system is that it can link together brigade and subordinate battalion armories over conventional telephone lines to support a distributed battle staff CPX, eliminating the requirement to assemble the staffs at a single location. This document is an annotated briefing.

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