Naval Battle Management Simulation with Concurrent GESBT on the Intel iPSC™

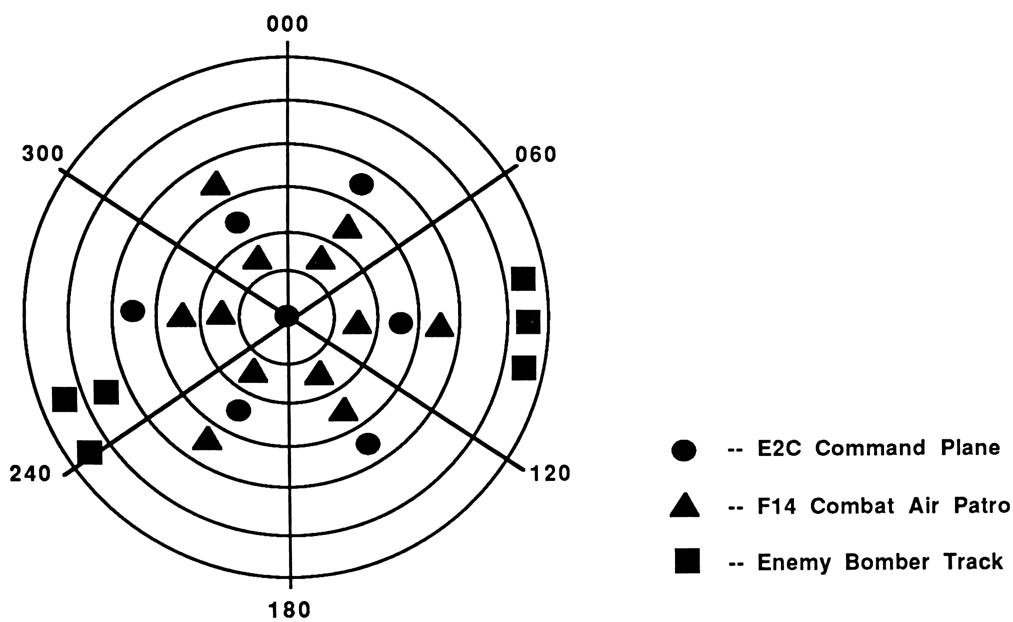
David Billstrom, Intel Scientific Computers
Michael Blanks, Science Applications Intenational Corporation

PROBLEM DESCRIPTION

This demonstration is a prototype of one part of a large-scale battle management simulation tool. Eventually the potential of a large-scale concurrent computer....the iPSC™....will be exploited by a multitude of communities of expert systems. This demonstration consists of one of these communities of expert systems. This hierarchy of expert systems may be appropriate for many large-scale expert systems applications, not just battle simulation.

The community of expert systems currently on the iPSC represents the battle management of an aircraft carrier battle group. The problem was deliberately chosen for its complexity. The complexity is due to the fact that the area covered by the battle group is too large for a single expert system to reasonably cover...as is the case with many potential expert system applications.

Therefore, the area about the battle group is divided into six sectors. An expert system conducts defense strategy for each sector, and communicates with the neighboring expert systems which conduct defense strategy for each of their sectors. An illustration of the graphic display of the defense sectors is shown below:



The area about the aircraft carrier group is divided into six sectors, each with 60° of the horizon and 600 miles radius from the ship. Each sector is commanded by a Naval E2C command plane. The defensive knowledge of the commander of each E2C aircraft is captured in a knowledge base. The knowledge base for each sector is identical. The knowledge base governs the defense of a sector but also communicates with other E2C commanders (knowledge bases) about threats and response strategy as well as borrowing combat air patrol aircraft (fighters) from those sectors. Threats are bombers, seeking to destroy the aircraft carrier and defense units are friendly fighter aircraft, each with a limited number of missiles.

THE SOLUTION

In the eventual simulation tool, many instances of the community of experts that represent the battle group will run on the iPSC. Each community will act on the exact same collection of enemy threats, but will use different defense strategies. Upon resolution of the simulated battle, each community will report back to a central monitor, which will record the relative success of the community against a set of threats. The central monitor reports which community answered the threat scenario in the optimal way. That particular defense strategy is then reported to the human battle commander.

The benefit of a simulation tool structured this way is the ability to run many different scenarios against the same situation at a speed much faster than real time. This offers the human a number of optimal choices before he or she needs to make the choice. A large-scale computer...such as the iPSC...offers the faster-than-real-time performance needed. A concurrent system offers a method to capture the knowledge used to execute a realistic simulation.

This type of large-scale simulation tool is not restricted to battle management, but could be applied in many areas such as complex factory assembly line planning, vehicular route planning, and biological life systems simulation.

IMPLEMENTATION USING CONCURRENT GESBT

Concurrent GESBT is a tool for building multiple, cooperating expert systems[1]. It allows expert systems to create other expert systems and move and copy objects among expert systems. The programmer determines which processor nodes of a concurrent computer receive the expert system.

The battle management simulation was mounted on the iPSC concurrent computer by building a single knowledge base for E2C defense strategy and then allocating six of these knowledge bases. Each of the knowledge bases was placed on a single node of the iPSC. This one-to-one mapping of knowledge bases to processor nodes was not required. Future versions would probably use only three processor for six knowledge bases. The mapping, under programmer control, is dependent on the structure of the problem. For the current community, each sector conducts defense strategies relatively independently. Therefore, each sector knowledge base is dedicated to a complete processor.

There are two other knowledge bases serving each E2C commander knowledge base. Both reside with the knowledge base they serve, on the same iPSC node. One provides expert knowledge about how to move objects in the sector, the other manages the sector-specific resources (planes and missiles).

Another knowledge base was created to track community-wide resources. This knowledge base holds the strategy of the central command, the aircraft carrier. Sector knowledge bases communicate with this resource knowledge base to report and ascertain the status of fighters. This knowledge base is allocated its own iPSC node. An eight iPSC node serves as the initializer for the entire simulation. After starting the other seven nodes, it waits for completion of the simulation.

For this implementation, the entire community of knowledge bases representing the aircraft carrier battle group was mounted on eight iPSC processor nodes. The community uses only a portion of the iPSC computational resources, because the intent is to install many of these communities at the same time on the iPSC in the near future.

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1. See SAIC publication Concurrent GESBT, August, 1986.