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A PLAYER SUPPORT SYSTEM FOR AN INTERACTIVE THEATER-LEVEL WAR GAME

An interactive simulation of naval campaigns, called the Naval Strategic Warfare Simulation, is being developed at APL. Command and control elements are modeled within the simulation by the interactions of players simulating the functions of a naval theater command center. The players are supported by a minicomputer subsystem that provides them with a capability analogous to the information management system of a theater command center. This article describes the architecture and features of the Player Support Facility and outlines its role in the simulation.

BACKGROUND

The Naval Strategic Warfare Simulation is an automated simulation of naval campaigns having theater-wide scope. It is being developed to support planning and analyses conducted by the Office of Chief of Naval Operations. The simulation generates survival and mission effectiveness data for marginal and comparative analyses of weapons requirements, employment doctrines, and naval strategies.

It is operated in an interactive mode by users who assume the roles of theater command center decision makers for each of the opposing sides in a conflict. These are the "players" in the war game, and it is through their roles and actions that the elements of command and control are modeled as an integral part of the simulation.

The simulation uses the IBM 3033 computer system at APL; player interaction occurs at a Player Support Facility at the Pentagon via a telecommunications link.

A basic antisubmarine warfare simulation was built and tested in 1980.[1] In the fall of 1980, APL initiated an effort to upgrade the minicomputer system at the Player Support Facility to expand the scope of player actions, to include more than single player roles for each side, and to support not only antisubmarine warfare modeling but the full complement of naval operations associated with a campaign. In April 1982, a new interactive player system was incorporated into the simulation.

Player Roles

The war game involves two opposing sides, each having a set of players that directs its forces. Players assume any of three different roles — primary, supporting, or secondary — that are defined by the scope of a player's command responsibility. Primary players perform functions similar to those of theater commanders. Supporting players perform staff functions assigned to the primary player. They have direct contact with the primary player and have access to the same information available to him. Supporting players manage theater-wide resources, such as strategic submarine operations or allied naval forces, giving orders at the discretion of the primary player. Secondary players perform functions similar to those of on-scene commanders, such as force dispositions, air operations, and antisubmarine warfare. The secondary player, subordinate to the primary player, has a unique information set. He is subject to orders of the primary player communicated through the communications processes in the simulation; he also reports to the primary player through the same processes.

In addition, an umpire may be present to manage the war game and to provide information external to the simulation, such as intelligence gathered by neutrals or Montreux Convention declarations.[2]

SYSTEM ARCHITECTURE OF THE PLAYER SUPPORT FACILITY

A Player Support Facility consists of a minicomputer system and applications software to implement a full range of player functions and to interface those functions to other processes in the simulation. The minicomputer system consists of a DEC PDP-11, which can support up to five player stations like the one depicted in Fig. 1. The Naval Strategic Warfare Simulation System currently includes two Player Support Facilities. One, located at the Pentagon, uses a PDP-11/34 and is the production facility for running the simulation. An alternate facility, using a PDP-11/60, is located at APL and is primarily for system development.

Continued development of the Naval Strategic Warfare Simulation will encompass various system configurations of the Player Support Facility and simultaneous use of both facilities in the simulation. This development will include:

1. One satellite computer system supporting three player stations (Red and Blue primary players and an umpire),

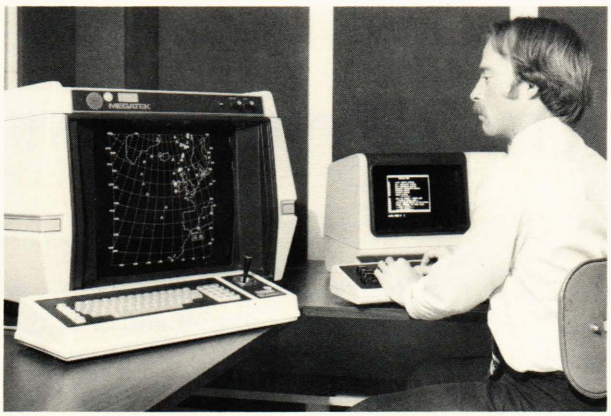

Figure 1 — A player station consists of a graphics terminal and an alphanumeric terminal. The graphics displays are generally geographic and are selected by tableau entries on the terminal function pad (the 15 keys on the right of the keyboard). The player builds composite displays by overlaying combinations of plots of friendly forces, enemy contacts, facilities, and other theater geographic features. Components of a composite display are removed by a second entry on the same key. The alphanumeric terminal is also table-driven, the player selecting the desired display, order, or decision aid from the appropriate menu.

2. One satellite computer system supporting five player stations (Red and Blue primary players, two Blue secondary or supporting players, and an umpire),
3. Two satellite computer systems supporting up to 10 player stations.

Player Station Description.

A player station consists of two display terminals as illustrated in Fig. 1. A graphics terminal provides the geographic positions of both friendly forces and enemy contacts. An alphanumeric terminal provides textual information in the form of reports from friendly forces and summaries of data such as contact reports and unit status. The players interact with the simulation through their alphanumeric terminals by issuing orders to their forces directing actions such as mission assignments, contact investigation, and defense condition changes. A number of tactical decision aids — special functions to enable the player to analyze the data from the simulation and the impact of potential decisions — have been implemented for both the graphics and alphanumeric terminals. A detailed description of player interactions is included in the discussion of software architecture.

Player Support System Software.

A software architecture was designed to accommodate each player function with a single computer program or task. The architecture is realized within the context of RSX-11M, the standard real-time operating system for PDP-11 computers. Real-time systems are often used for process control applications such as manufacturing or laboratory experiments. Viewing the player system as a real-time system is an approach that has the primary advantage of implementing each player function with a simple program requiring only a few of the satellite computer's resources. The major obstacle in design of real-time systems is overcoming contention for the same resources by multiple tasks. Contention problems are minimized here because much of the time spent by the player is idle time for the computer. If contention for memory or a particular file arises, the delay in resolving that contention generally is not noticeable to the players.

The player-system architecture for the Naval Strategic Warfare Simulation is a three-level hierarchy of tasks as depicted in Fig. 2. The high-level tasks (levels 1 and 2) are executive programs that coordinate interaction among the third-level functions, the players, and other processes in the simulation. In structural terms, the task pool at the third level consists of individual programs that perform mainly single functions within the system. Third-level tasks can also be categorized by the type of function they perform.

Data base maintenance tasks are generally initiated from the reports processor. They maintain historical data such as contact history files and unit position and intended movement.

Picture creation tasks build graphics displays and save the resultant displays in files on disk for recall on player request. The pictures are initiated in several different ways. Those for the unit status and contact displays are initiated by the player's graphics executive after a new set of reports is received from the simulation model. If the player selects a different background map, new unit and contact pictures can also be generated. Background maps are initiated from the alpha executive or are run in an off-line mode in which the other player system tasks are inactive. Other picture-building tasks generating displays of ocean depth contours, pack-ice boundaries, acoustic regions, airfields, and ports are executed off-line with optional access through the graphics executive.

Picture display tasks load picture files into the player's graphics processor for display on the graphics terminal. Those tasks operate only on displays that have already been generated by a picture creation task. Structuring the system so that building and displaying pictures are separate tasks resulted in a very flexible and responsive player graphics capability. There are 45 different graphics displays available at a player station — three for each of the 15 special function keys on a graphics terminal keyboard.

The alpha display tasks generate summaries from the player's data base and display them on the VT-100 terminal. Each alpha task also creates a file for an optional printed copy of the summaries.

Order generation tasks build the player's orders file for subsequent transmission to the simulation model. They are initiated by the alpha executive in response to the selection by the player of the appropriate item from an orders menu. Some orders tasks check the orders files of allied players to prevent the generation of conflicting orders. All orders tasks

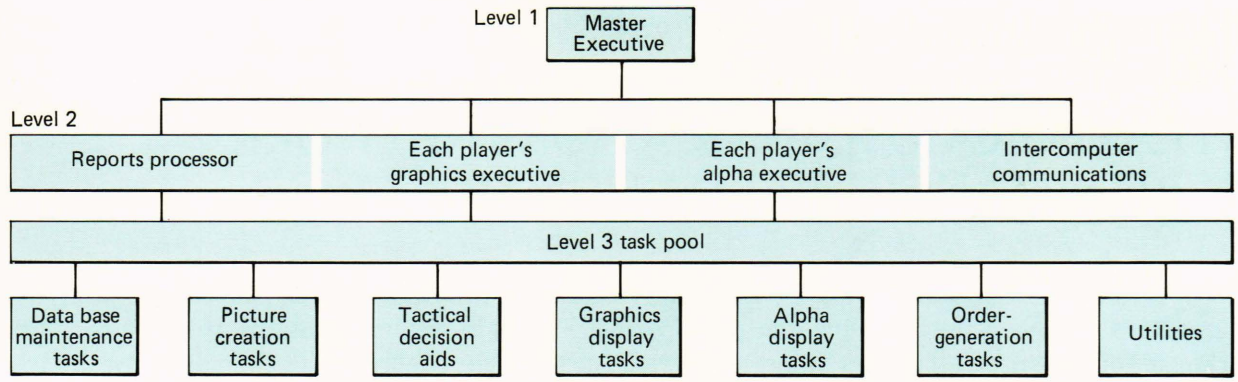

Figure 2 — The player support software system is a hierarchy with the third level tasks generally performing a single player function. The player executive tasks are table-driven so that player functions or roles can easily be altered by simply changing the table of available player functions. The Master Executive coordinates intercomputer telecommunications, reports processing, and the individual player executives.

have validity checks and help functions that are available to guide the player through the orders composition process.

Tactical decision aids that assist the player in making his decisions can be either graphic or alphanumeric. Examples are the display of a unit's position and intended movement or the calculation of probability of detection for a given sonobuoy pattern. Utility tasks are generally reserved for the umpire, enabling him to configure the display system, perform backup functions, and initiate or reestablish playing sessions.

Player Support System Data Base

Quick display generation is accomplished through careful structuring of the player system data base. Unit and contact data for each player are maintained in direct access files with single records that contain all the information pertinent to summary displays. For position and intended movement, and for contact track displays, individual files are maintained for the particular unit or contact. Access to all unit information uses an index structure so that data on individual units can be quickly accessed through the unit's name. To access groups of units, address indicator groups are defined. This enables a player to issue force orders (such as a defense condition change) easily to any selected subset of his forces.

DEVELOPMENT PROCESS

Because of the evolutionary nature of both military systems and missions, the simulation is expected to require modification from time to time in order to remain consistent with the world it simulates. Therefore, APL has established a system architecture philosophy and development process for the Naval Strategic Warfare Simulation to support recurrent modifications both to the simulation model and to the player support facility in an orderly, efficient, and well-documented manner.

The development process is inherently related to the modularity of the system architecture and encompasses three phases:

1. Architectural specification,
2. Prototype building and evaluation,
3. Implementation.

Configuration control throughout development is maintained by progressive refinements in documentation that are associated with each phase.

The basic development document is the system change proposal, which is both a configuration control device and the source document for all permanent system documentation. When approved, it becomes the architectural specification for a structural module of the system. Hence, each module affected by the modification of a general Naval Strategic Warfare Simulation system capability will be addressed by the system change proposal. This document governs development activities and is kept current so that it accurately describes the system element that is operational when implementation is completed. Thus, the documentation generated by the development process is itself modular and is characterized by the accuracy and completeness needed to support continued response to simulation requirements.

REFERENCE and NOTE

[1]L. R. Gieszl and J. W. Marrow, "Development of an Interactive Warfare Simulator," *Johns Hopkins APL Tech. Dig.* **1**, 52-54 (1980).

[2]The Montreux Convention of June 20, 1936, governs the procedures for the transit of merchant and war vessels through the Bosporus and the Dardanelles.

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