LIBRASCOPE'S INTELLIGENT NEW DEVELOPMENT ASSISTANT (LINDA) – A MODULAR DISTRIBUTED TESTBED

SYSTEM USES

Analysis and Development

- Force Level System Concepts
- New Combat Systems Concepts
- System Requirements and Specification
- Tactics
- Decision Aids
- Algorithms and Models

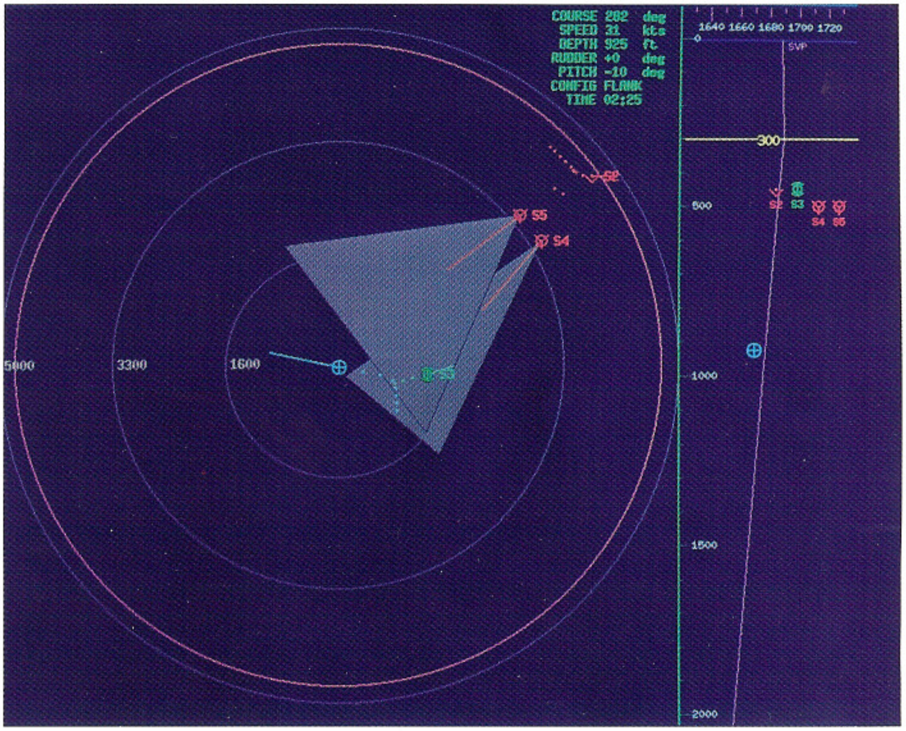
Training

- On-shore
- On-board ship
- Against Intelligent Adversaries

Real-Time Engagement

- Tactical Recommendations

AUV/UUV Command and Control



SYSTEM FEATURES

- User-friendly Graphical Interface
- Full Engagement Simulation
- Real-time Control of Engagement Simulation
- Smart Threat Modeling
- Automated Tactical Planning and Control
- Modularity and Portability

LORAL
Librascope

LINDA SYSTEM DESCRIPTION

Librascope's Intelligent New Development Assistant (LINDA) is a modular combat system development testbed. The testbed provides a convenient and cost-effective environment for prototyping Naval Combat Systems components, concepts, and algorithms. The testbed has a distributed architecture which can be hosted on a single computer or run on multiple computers tied together with Ethernet. Other hardware that supports Ethernet can be easily linked with LINDA.

LINDA has an open architecture that can be readily extended or modified. A core system provides the basic system infrastructure and services. The system can be extended (System Extensions) with software modules to provide additional interfaces, and development or data analysis tools. Applications that are under development or testing are integrated into LINDA in the same manner as system extensions.

Core System

The Core System testbed consists of a System Control process, an acoustic Engagement Simulator, and a Data Server/Archiver. System Control provides convenient and consistent control of system operation and system configuration management from a single location.

The Engagement Simulator models the external world. Full engagement simulation includes sensing, detecting, target motion analysis, and contact classification. Multiple objects with different characteristics can be modeled within a single simulation: surface ships, submarines, torpedoes, etc. Due to its extensible object-oriented design, models can be replaced or modified independently. Dynamic computer resource allocation avoids hard coded limits on the simulation; the rate of simulation execution is user controlled.

The Data Server/Archiver provides transparent management of the communication channels between the Engagement Simulator and other modules. Services such as message queuing, data recording and retrieval, replay of archived simulations, and communication diagnostics are provided.

System Extensions

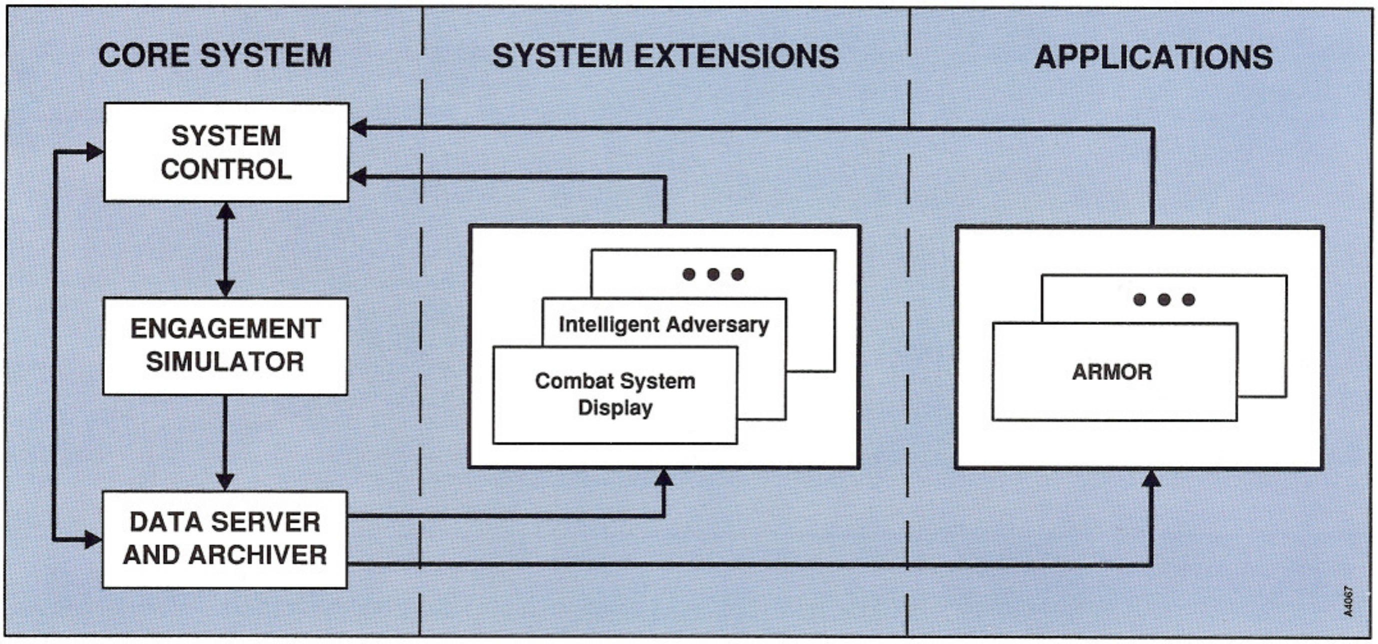
Several development and analysis tools are already available as System Extensions, more are under development, and others can be added by LINDA system users.

The Combat System Display has been developed to provide a graphical user interface which allows the user to control the system and observe its behavior. Advanced graphics and audio feedback provide multiple ways to monitor the simulation. The interface is highly interactive, making it easy to understand and learn. The interface is implemented using Motif and can be readily customized; displays can be distributed among multiple screens or workstations. Multiple copies of the interface software can be run simultaneously to allow different users to interact with different ships in the same engagement.

An Intelligent Adversary provides intelligent behavior to simulated threats, making performance analysis and training more realistic. Employing Librascope-developed automated planning and control technology, it automatically monitors the tactical situation and self-activates to generate and execute plans.

Applications

LINDA has been used to develop the Attack Response Mission-Oriented Reasoner (ARMOR), a tactical decision aid which is subsequently described. It is currently being used in other application development efforts.



AUTOMATED PLANNING AND CONTROL SYSTEM

- **Automatic situation assessment and threat alertment**
- **Real-time tactics recommendations**
- **Automatic execution of recommendations**
- **Explanations provided by user-friendly graphical display**
- **Interactive queries and explanations**
- **Adaptable to different tasks**

Automated planning is a process of automatically generating courses of action to solve problems. Automated planning is useful wherever complex tradeoffs must be made, reaction times are short, or large volumes of information exist - situations which are common in modern day tactical command centers.

Librascope's strategy for developing planning systems is to build a generic core technology and extend it for specific applications. Applications share a planning kernel, but have separate knowledge-bases. The planning kernel provides hooks for external interface modules and for application specific extensions (e.g., algorithms, databases, rule-based systems, etc.). Its main function is to construct plans that meet specified requirements. In addition, it has a facility for interleaving plan construction with plan execution. Being data-driven (changes in the external world drive plan construction and plan execution processes), it is self-contained and does not need external control.

The system design is a hybrid architecture of Artificial Intelligence (AI) technologies that address different aspects of the planning problem using the techniques most suitable to resolving each, rather than trying to use a single technology to address all of them. The system provides an open architecture to provide for growth, modification, and integration.

The development of practical, viable decision aid technologies must also include an integrated approach that addresses not only AI technology and domain knowledge, but software and systems engineering issues and operational considerations as well. Consequently, we are concerned with both the quality and reliability of the plans generated, and with the quality and reliability of the software system that provides them. Software engineering considerations such as verifiability, maintainability, and computer resource management are integral parts of our approach.

To address the tradeoff between an understandable knowledge representation and efficient implementation, we have developed a high level language named Tactical Planning Language (TPLan). TPLan is problem domain-oriented and natural for Naval officers to use. A compiler provides the mapping between TPLan and the underlying knowledge and control structure so that both comprehensibility (needed for verification, modification and expansion) and run-time efficiency are achieved. Formal syntax and semantics are used for representing plans undergoing construction.

The automated planning and control system's ability to develop and execute plans in response to changing situations gives it many potential uses. This general purpose planning technology has been used to develop the Intelligent Adversary, which controls simulated threats in the LINDA system. The Intelligent Adversary can be used to provide a training environment or a tactics analysis tool. The ARMOR decision aid was built by extending the technology to provide real-time torpedo defense recommendations. Examples of other potential applications include: (1) approach and attack planning, (2) damage control, and (3) signature management.

Increasingly sophisticated threats and austere budgets mean building more capable combat systems that can be operated by smaller crews. Decision aids that support task automation are essential for meeting this challenge.

ARMOR: ATTACK RESPONSE MISSION-ORIENTED REASONER

The Attack Response Mission Oriented Reasoner (ARMOR) is an automated decision aid that provides tactical advice to the command decision team of a submarine in case of torpedo attack. It is one of Librascope's Artificial Intelligence-based decision aids developed using the LINDA system.

ARMOR is a self-activating system and is capable of completely autonomous operation, executing the recommendations as they are generated. ARMOR continuously monitors the tactical situation using combat system data, detecting and evaluating threats automatically. ARMOR initiates planning or re-planning when it determines that planning is required.

ARMOR can also operate in a semi-automatic mode, requiring operator consent before beginning the execution of recommendations. In the advice-only mode, recommendations are displayed, but the operator must perform any required actions. ARMOR displays recommendations together with explanations in graphical form. The displays can be queried interactively to provide more detailed information. Recommendation displays are provided in all modes of operation.

The primary value of this work to the U.S. Navy is to increase ship survivability by increasing the probability of defeating torpedo attacks by recommending more effective plans, and by reducing the probability of defense failure due to human errors of commission or omission. The defense of submarines from torpedo attack is a task that has become increasingly difficult for combat system operators to carry out in the stressful environment of modern combat, due to the international proliferation of advanced ASW technology.

For additional information, write or telephone:
Loral Librascope, 833 Sonora Ave., Glendale, California 91201-2433
Telephone 818-244-6541 • FAX: 818-502-7298 • TELEX 215620

LORAL
Librascope

A9792BD-0598 Issued: 3/92