# SILS MRAT: A Shipboard Integration of Logistics Systems And Mission Readiness Analysis Tool

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## ABSTRACT

SILS (Shipboard Integration of Logistics Systems) is an umbrella program initiated and sponsored by Dr. Phillip Abraham in the Logistics Directorate of the U.S. Office of Naval Research (ONR). The SILS vision is a system of systems that brings together shipboard and shore based data and information sources in a single integrated environment. SILS MRAT (Mission Readiness Analysis Tool) is a high-level shipboard component of SILS, which applies intelligent agent technology to the near real time decision support needs of commanding officers, department heads, and key operations & maintenance personnel. This tool demonstrates the capability of a system architecture to integrate current, and future software applications and information systems within a single decision framework, reducing system interoperability problems and minimizing the disruption caused by software application changes. It will provide a prototype "readiness node" at the unit level designed to serve as the basis for hierarchical fleet operational and maintenance decision support and readiness evaluation systems. The toolkit consists of a set of loosely coupled, user customizable, client-side components including: scheduling, status reporting, readiness assessment, problem resolution, and agent interface. SILS MRAT will function in a collaborative environment using a shared set of distributable server-side components: object server, agent engine, interface engine, recall engine, and a common ontology. This system will provide the basis for battle group and force level readiness decision support necessary to meet today's changing naval force operations. The effective integration of coalition forces in modern naval forces will demand greater interoperability, mission integration, and material support by U.S. and foreign navies.

## KEY WORDS

Decision Support, Logistics Network, Information Management, Knowledge Management, Software Agent

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## 1. INTRODUCTION

**Functional Introduction by Chris Neff**

*"The security environment of today and tomorrow will be characterized by uncertainty, chaos, surprise, and conflict … naval forces must exploit the power of information to seize the advantage over potential adversaries, and must be postured, through technological advances, changes in organizational structures of forces, and experimentation with innovative concepts of operations, to sustain and advance broad competitive* advantage*."(England etal 2002)* [1]

Modern military actions require the effective management of assigned assets, and the ability to obtain adequate resources to operate and maintain them. Within the Department of the Navy, there are numerous stovepipe organizations focusing on various elements of the resource process each with a limited understanding of the end-to-end logistics process or, more importantly limited access to meaningful information. In order to ensure that appropriate funding is available, necessary contracts are in place, repair and maintenance facilities are properly staffed

and outfitted, transportation networks are robust, and personnel are adequately trained; an effective information management system must be available to decision makers.

The events of this past year have highlighted the critical need for the timely integration of information and effective knowledge management in a post-911 climate. The U.S. DOD's strategic vision is documented in the QDR and Joint Vision (JV) 2010/2020, which recognizes our changing global environment and emphasizes the need for information superiority, while ensuring operational interoperability among the military services and our allies. The department's future focus on the operational concepts of: – dominant maneuver, precision engagement, full-dimension protection, and focused logistics – should allow combined military forces to achieve full-spectrum global dominance. U.S. Naval Forces continue to conduct inter-operations with our Pacific Rim neighbors from Japan, Korea, Canada, and Australia; as a vital element of regional stability. In recent years China, Korea, India, Pakistan, Indonesia, and the Persian Gulf States have challenged this regional stability. Stability cannot be achieved without fully operational unit availability anywhere, anytime; capable of responding to varied situations and scenarios. Focused Logistics is a critical component of total operational readiness.

The realignment and consolidation of stakeholders and intelligent information and knowledge management will be essential in the planning and development of the logistics requirements to support sustainable DOD and coalition force operations. In order to meet the challenge of change naval forces must be able to sustain a long-term, forward deployed presence. Within the U.S. Pacific Fleet this can mean supporting deployed forces through the discipline of sea-based logistics with a full spectrum of battle force replenishment, operational logistics, weapons handling, force support, maintenance, and infrastructure from logistics bases over 14,000 NM away. These disciplines include the challenges of: conducting re-supply in sea state 3 conditions, Total Asset Visibility (TAV), providing logistics information to operators, safe knowledgeable weapons handling, stock positioning, transportation, re-supply, and predictive maintenance actions.

The area of logistics brings together the disciplines of staffing, training, warehousing, inventory management, transportation, procurement, repair, and maintenance. While most requirements can be satisfied by financial resources, there may be some instances where all the resources in the world will not allow actions to be taken within the desired timeframe. Therefore, it is essential that effective information and knowledge management systems be available to meet the demands of the complex logistics requirements necessary to sustain high levels of mission readiness with limited funding and personnel.

**Technical Introduction by Michael Zang**

The majority of substantial software systems currently in use can be classified as multi-user data processing systems based on the client server paradigm. These systems have been very successful as computers excel at data processing tasks and they address the need to share data between the users responsible for the various input and output (processing) tasks. In many ways, these systems have been too successful. Humans have become overwhelmed by both the amount of data they produce, and the amount of data they must be feed in order to provide results.

Software system development is currently in the midst of a major transition from stand-alone, albeit multi-user, stovepipe systems to distributed, network centric systems of interoperable systems. This revolution is driven by the needs to share data across the traditional functional boundaries of an enterprise to enhance operational efficiency, and by the increasing trend to utilize a collaborative cross-discipline approach to problem solving. This development has allowed subsets of the output of one or more system's to augment the input to another system. It has also allowed many more people access to the output of each individual system; thereby, increasing the data overload problem.

This problem will fuel a new revolution, currently in its infancy, towards information centric software systems. Information centric systems utilize a well-defined system specific ontology developed independently from the technology employed to implement the system and the optimizations required to provide adequate system performance. The system ontology provides classified, structured data, rich in context providing relationships and thoroughly grounded in the vocabulary of the target domain; thereby, elevating the system's data to the level of information that is capable of providing some level of understanding to the software agents that access it. Information centric systems allow for the development of intelligent software agents that can apply model based reasoning to provide additional processing, filtering, and alerting mechanisms to significantly reduce the data overload phenomenon [2].

The transition to information centric systems highlights a major problem with the current approach to network centric system design. The plethora of currently available middleware technology that has fueled the ongoing transition to network centric systems only addresses the interfaces between systems at the level of individual data elements (physical level) and does not deal with the logical translation of information between system; thereby, requiring the development of costly, hard coded and inflexible translators for each individual interface. In practice, these types of interfaces are exceedingly difficult to maintain in light of system updates and configuration

changes and may still entail much use of tedious human intervention to verify their outputs.

The SILS MRAT project addresses this issue by proposing that the interfaces between systems should be elevated to the level of information centric systems themselves designated as interface engines. This in turn leads to a system of systems architecture that groups collections of systems that need to regularly exchange information into loosely coupled federations whose central hub consists of an interface engine that is configured to address the specific needs of the federation.

This concept views the interface engine as just another system which allows one to layer a hierarchy on this system of systems architecture where higher level federations may include as systems zero or more interoperability servers typically from lower level federations. Within the defense domain, one could envision the proposed system of systems hierarchy following along the lines of existing unit hierarchies within the individual services with a the top level of the hierarchy operating at the level of the joint chiefs of staff, and commander in chief. Of course, crossties between the individual units and services at the lower levels of the hierarchy may also exist. The end state of this vision is a single, albeit large and distributed, system of systems that incorporates the entire information infrastructure of the DOD. This system of systems would be tailored to meet the specific needs of user communities at all levels, by utilizing systems specifically developed to meet their needs, and would be adaptable to change due to the extremely loose coupling between systems.

In addition to the standalone information centric interface engine that is initially targeted to integrate logistics systems aboard ship, an information centric agent based decision support system capable of exploiting the capabilities of the interface engine is under concurrent development. This system is targeted to aid a ship commanding officer and senior enlisted personnel in the area of mission readiness analysis and has been instrumental in the process of identifying interface engine requirements to drive forward the development process. Since the interface engine does not have a significant user interface component and the existing logistics systems it is working to integrate do not yet take advantage of its capabilities, the mission readiness analysis tool is necessary to provide inspiring demonstrations of the interface engine indirectly through the capabilities it provides to it. The mission readiness domain is ideally suited to this purpose, as it requires an integration of the logistical and operational information resident in multiple existing information systems that are functionally and spatially dispersed throughout the ship.

## 2. BACKGROUND

**Functional Background by Chris Neff**

*"For the past 20 years the U.S. military services have suffered under the limitations of stove-piped computer software applications that function as discrete entities within a fragmented data-processing environment. Lack of interoperability has been identified by numerous think tanks, advisory boards, and studies, as the primary information systems problem." (Pohl 2001)* [3]

In his paper "Information-Centric Decision-Support Systems: A Blueprint for 'Interoperability'", Dr Jens Pohl highlights the importance of creating a decision support collaborative environment where computers can focus on the functions that they perform best, and humans can cooperate in the decision process with the requisite knowledge to optimize the solutions. Better decisions can be made once the human computer partnership has been established and organizations have progressed to an environment of Business Intelligence, which brings together effective, computer-assisted (agent), information management and knowledge building [3].

In an Information-Centric environment, it is possible to create an architecture that will enable data-centric applications, like many of the U.S. Navy legacy systems to information centric systems through translators (Figure 1). This has the obvious advantage of transforming data-centric systems, developed though the numerous stovepipe software applications, without the need to standardize data elements across the user community. As Pohl points out, existing legacy applications have been developed and deployed at enormous investment. Their value is linked to the critical functions they perform, and the savings in lost time and productivity, which will occur as these functions migrate to the new decision support environment. Finally, new information centric systems provided under the umbrella of Enterprise Resource Planning (ERP) will require process and software changes to integrate with residual information management systems.

This resulted in the Department's focus on the need to move toward an Enterprise Resource Planning (ERP) solution used by many of the leading global corporations to standardize business processes, application software, and facilitate a change management process. The cornerstone of the ERP process was the migration of numerous legacy information systems to standard applications using common data elements across all business applications. Current estimates are that the ERP process will take 8-10 years to complete and will cost the Navy in excess of $1.8Billion. Although ERP offers the opportunity to bring data together in a common environment, it lacks the ability to identify information that could be valuable to a human-computer partnership.

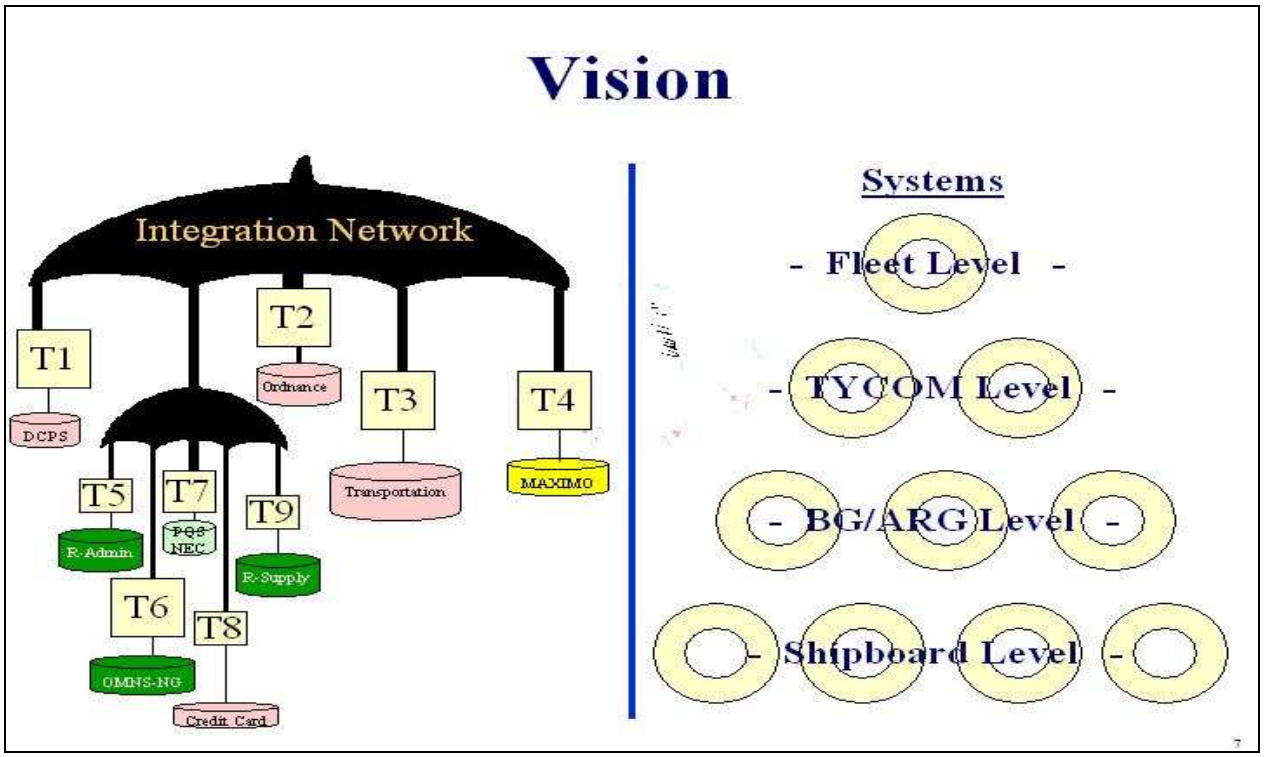


Figure 1 Logistics Information Integration Vision

More important is the amount of time that it would take and the number of legacy system owners that will be required to willingly participate in the transition/migration process. Michael Isikoff in his Newsweek article of May 2002 observed "So much intelligence comes in, rumor, hearsay, disinformation, so little of it more than trash: once in a blue moon an agent-prospector may get lucky. But even then an agent's warning is likely to be dismissed as what Condoleeza Rice last week called "chatter" …there's always too much information" (Isikoff May 2002) [4]. Likewise, Fareed Zakaria made the following observation: "No one person at the FBI had responsibility for strategic analysis, connecting the dots" (Zakaria May 2002) [5].

Intelligent decision support agents can help resolve both of these concerns. Agents can be created to access legacy applications and link common data elements together. The development of these agents can reduce the amount of time required to enhance the knowledge level of the users and extend the value of legacy systems.

Figure 1 depicts a series of translators and agents extracting data from various logistics legacy applications. The larger umbrella on the left conceptualizes the ability of integration networks to be developed in a manner, which would allow them to function with other networks. From a fleet perspective, the development of system of networks would allow all layers of an organization to extract the same source data and convert it to decision support tools that would meet diverse mission requirements, responsibilities, and perspectives.

**Technical Background by Michael Zang**

The SILS Mission Readiness Analysis (SILS MRA) Program consists of two distinct information centric systems: the SILS Interface Engine (SILS IE) and the SILS Mission Readiness Analysis Toolkit (SILS MRAT). SILS IE is responsible for providing interoperability services to select groupings of systems, which will be referred to as a federation. SILS MRAT is responsible for leveraging the services provided by SILS IE in order to provide the ship captain, department heads, and senior enlisted personnel with tools to support mission readiness analysis. Both of these systems are based on the same fundamental concepts and can be characterized as agent based, distributed, information centric systems.

At the top level SILS MRAT is comprised of; a collaborative, distributed, object-serving communication facility that houses a collection of executable domain object models, an agent engine that houses a collection of collaborative agent federations, and a suite of application tools that provide end-user interfaces to the system.

The SILS Mission Readiness Analysis Toolkit (MRAT) is a software package developed by CDM Technologies, Inc. that is based on the Integrated Cooperative Decision Model (ICDM). ICDM consists of an underlying architecture, fundamental design criteria, development

tools, and processes for creating agent-based decision-support systems. The underlying architecture provides a set of high-level application-independent subsystems and the mechanisms to support collaborative interaction among them. These generic subsystems can be quickly tailored to produce an application specific architecture and implementation utilizing the ICDM development tools. The initial development of ICDM was undertaken by the Collaborative Agent Design Research Center (CADRC) at California Polytechnic State University, San Luis Obispo. Based on a three-tier architecture, ICDM incorporates technologies, such as distributed-object servers and inference engines, to provide a collaborative environment for agent-based decision-support systems that provides both developmental efficiency and architectural extensibility.

The agents employed by ICDM are software processes, components, or modules that have the ability to perceive the external environment and autonomously act on it in collaboration with other agents. Agents act in a manner conducive to achieving the individual and collective goals of the system and its users. The external environment in which an agent is situated is both bounded and defined by the ontology the agent employs to interact with it. The ontology provides a vocabulary to describe the external environment that is constrained in accordance with the underlying principles operating in the environment, such as the physical laws that constrain our own environment. The ontology allows agents to express their specific interests in an environment, communicate their thoughts about it, specify actions on it, and record knowledge about it.

The level of perceived agent intelligence is coupled to and bounded by the specialized depth (number of concepts) and richness (number of associations) of the ontology [6]. The ICDM framework employs standardized Unified Modeling Language (UML) to formally specify all the types of things (conceptual and physical), within the target domain, and the types of relationships (conceptual and physical) between them. The ICDM Toolkit Code Generation Utilities operate on this specification to implement a distributed ontological framework for the specific architectural configuration(s) and platform(s) targeted for deployment. The generated ontological framework provides an enabling foundation upon which the rest of the application is implemented.

ICDM based software employs two major categories of agents: subscription based and rule based. Subscription based agents are individual processes or components that operate at the architectural level of the system. Rule based agents correspond to modules within an expert system shell environment each of which contain a rule set targeted to encode a particular area of expertise within the application domain. Both categories of agent are proactive in that they automatically act in response to changes in the virtual representation of the external environment and therefore do not have to be explicitly told to act as is done in traditional procedural paradigms.

Subscription based agents use the standardized Common Object Request Broker Architecture (CORBA) services that ICDM provides along with a proprietary subscription service to register their individual interests within the domain. The ICDM Subscription Service alerts individual subscribers to changes in the collection of distributed objects used to represent the domain by pushing the changes to the corresponding subscriber. This capability allows the individual subscribers (agents) to collaboratively interact without any prior knowledge of each other in an efficient and scalable fashion.

Subscription based agents may in turn contain rule-based agents that operate in modules within the parent process or component. Rule based agents utilize specialized declarative languages to precisely specify a state in the external environment and the action that should be performed when the specified state is observed. They work at a much lower level of granularity than that employed by subscription-based agents. This level of granularity requires specialized data structures and algorithms to efficiently match on the states of the external environment. To date the required level of efficiency is only found in Rete Algorithm based expert system shells. The traditional problem with expert system shells is that they are stand-alone development environments that don't interoperate with the general-purpose environments required for graphical user interface (GUI) development or for relational database interaction.

Interoperability with expert system shell environments is a core technological feature of ICDM based applications. This interoperability is provided through proprietary adaptations to existing expert system shell environments that enable them to seamlessly operate as plug-in clients to the distributed ICDM Object Serving Communication Facility that houses the virtual representation of the external environment.

SILS IE is a communications manager interacting equivalently with a variety of data-centric and information-centric systems, including SILS MRAT. It is capable of efficiently exchanging objects among various ontologies. In addition to routinely extracting and transforming data objects from simpler, passive systems, SILS IE must be responsive to complex queries from sophisticated, interactive systems. In this sense, SILS IE must be able to handle publish and subscribe activities, accommodating client requests for data and/or information refreshed on a time or event driven basis.

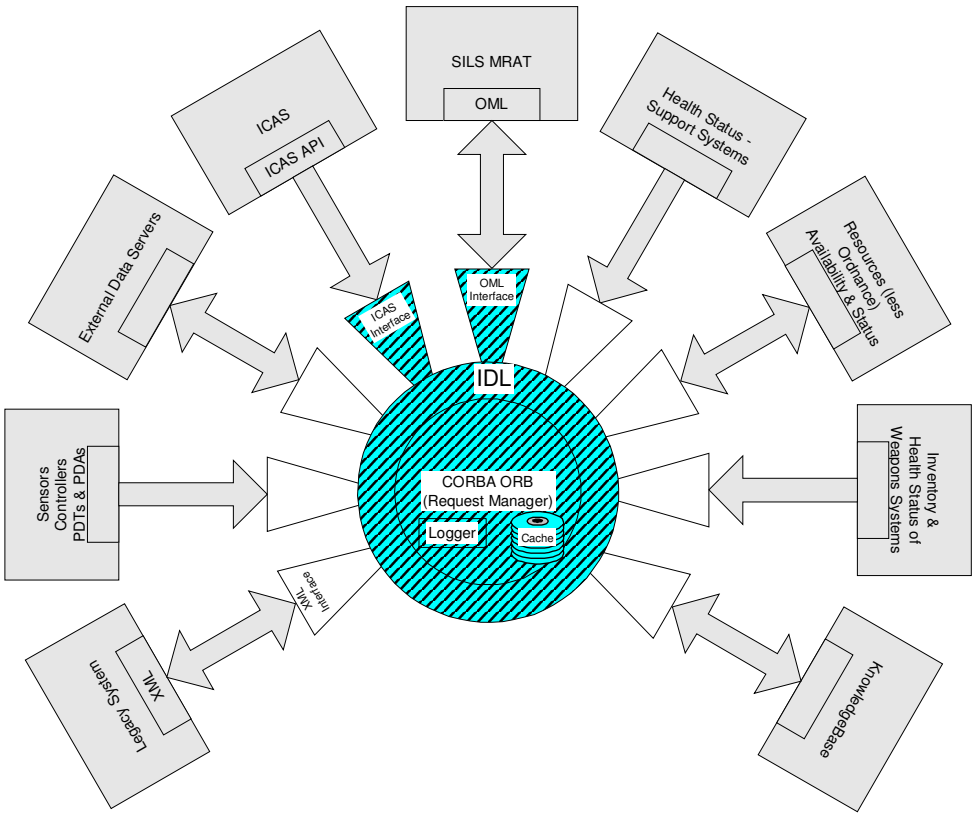


Figure 2 SILS Interface Engine

As depicted in Figure 2, SILS IE lies at the center of the diagram. The outermost of the concentric rings describing SILS IE contains a series of keystone shaped elements representing the individual interface modules specific to a given ontology and its related system(s). It is within the individual, specialized interfaces (keystones) that communications with each system are translated to and from terms intelligible to their defining ontology.

Internal to the outer ring of interface elements lies the SILS IE ontology. All internal operations are conducted exclusively within the context of the SILS IE ontology. This ontology defines all the information of common interest to the entire federation as opposed to the specialized interests of the individual systems that are participating in it, and defines the interrelated logical constructs associated with interoperating systems and the services provided by the interface engine. No translation or reformatting of data and information is applied within the core of SILS IE. All supporting functions of SILS IE, such as scheduling, communications monitoring, task management, object caching, transaction logging, etc., are performed within the central core.

In brief, this approach provides the following advantages over the interoperability approaches typically employed today.

1. Only one interface is required per system rather than the number of participating systems less one.
2. Runtime interpretation of System Interface Ontologies and the associated mappings provides the flexibility to adapt to changes in the and eases configuration management
3. Information Centric design allows for the creation of intelligent agents that can reason on interoperability issues to better deal with issues such as system degradation, latency of information, and data inconsistencies.
4. Provides seamless interface to legacy and follow-on applications.

## 3. OPERATIONAL CONCEPT

SILS MRAT will integrate significant logistics components into a decision aid for the Captain and other key decision-makers. The system will support planning and allocation of scarce mission resources; scheduling and integration of readiness-related activities; identification of opportunity costs; and provision of distributed situation awareness between the ship's Captain and his officers. One of the key features in this area is the recognition that readiness capability may change based on date and time. Accordingly, SILS MRAT will allow the user to move forward in date and time to assess future capability and condition. This information-based

shipboard decision aid will act as the umbrella integrator (through the services provided by SILS IE) for principal data systems contributing to mission readiness.

Among the most important decisions, a Captain makes, are those, which determine the ship's readiness to accomplish the missions it is assigned. His responsibilities include planning, allocating ship resources, requesting & justifying external resources, supervising activities, and continually assessing the ship's status to insure adequate levels of readiness are attained and maintained.

The value of decision support tools varies depending on the ships operational cycle. During pre-deployment "work up", while still under the Type Commander control, the principal role of decision support is planning the resource allocation to support the primary and alternative missions of the ship. This usually leads to a command decision to accept shortfalls and/or to use some form of consequence analysis as support and justification in a request for external assistance. In as much as it is designed to be a distributed system, it may prove feasible to use SILS MRAT as a means of submitting these requests with inherent justifications and illustrations.

Once the ship deploys to an operating area, the situation may change significantly. External assistance is likely to be more restricted and subject to extended delays. Under these circumstances, it is vital to accurately characterize the elements involved in shifting resources and weigh the consequences of the shift in a timely manner. This is a principal responsibility of command.

Ships can be judged to be fully mission capable – ready to perform all elements of the mission adequately – or mission capable with exceptions. An exception results from one or more tasks that cannot currently be performed to standard. Assessing the resources associated with reaching an acceptable performance level in the deficient areas, highlighting the potential to "under resource" another mission area, and identifying consequences in terms of the mission are the focus of SILS MRAT.

A mission can consist of phases and alternative methods of execution of each phase. Decision support assistance can be applied to mission phase planning and execution. Each phase of the cycle may vary with respect to requirements and when resources may be utilized. Requirements by phase can be broken down into the four key readiness factors of: personnel, training, supply, and material condition/maintenance. Each of these requirements should be identified to system readiness elements and availability by phase.

SILS MRAT will link resources-to-tasks-to-mission elements during the formal resource planning and readiness work-up process, by first linking tasks to nominally required resources and then linking these to mission elements.

To illustrate this point, a supply requirement decision support advisor could consider the availability of an on-board asset and compare the requirement to the anticipated phase of the requirement. The advisor should have access to various options and advise the decision-maker of the anticipated implications of each option. Options could include obtaining from an external source, repairing it locally (onboard), or deferring the action. Each of these options have risk levels and positives and negatives aspects.

During work up prior to deployment, the decision process is more formal, more deliberate, and without the urgency that exists once the ship deploys. Additionally, in a non-deployed status, the ship might have been able to wait for a particular repair while deployed any delay would seriously impact the mission and therefore be viewed as unacceptable. It is important to note that operational commanders have certain expectations of unit readiness once the ship is arrives "in-theater". The SILS MRAT decision support tool will be capable of nominating "best of feasible options". The options available to a deployed ship usually differ significantly from those available in port. SILS MRAT will characterize the risk in trading off performance in one or more mission elements through a shift of resources to improve performance elsewhere. This may be done by characterizing the risk in terms of the effect that the resource shift exerts on the tasks associated with that particular mission element. This task-resource connection is a fundamental relationship within SILS MRAT.

SILS MRAT will maintain this analysis and decision support during all mission phases. When requested by the user, the system will have the capability to initiate alerts and provide advice based on condition assessments. The Captain will be able to ask SILS MRAT for a feasibility assessment of a specified course of action.

## 4. FUNCTIONAL OVERVIEW

SILS Mission Readiness Assessment (MRA) represents a decision aid for all decision-makers from commanding officer to senior work center personnel. SILS MRA supports planning and allocation of ship level mission resources and identification of changes in readiness status. More specifically SILS MRA:

- Provides agent based shipboard decision support to the commanding officer and senior enlisted personnel

- Allows shipboard users to view and develop the operational schedule and relate tasks to their necessary resources
- Provides shipboard users with agent generated alerts and change notifications in response to changes in the readiness status
- Allows shipboard users to customize and extend the status reporting features and mechanisms
- Integrates with existing shipboard information, control, and monitoring systems

SILS MRAT will demonstrate the contributions that a collaborative decision support system can make in assessing ship readiness by integrating information across individual ship information systems and personnel. In concept, SILS MRAT receives: the personnel, maintenance, logistics, supply, and engineering readiness aspects the ship. Information sources include inputs from key personnel, ship performance characteristics, usage data of various types, and Captain's instructions; as well as external information to the ship such as the environmental conditions, the ship's mission, and availability of logistical support and supply.

Intelligent agents using a hierarchal representation of the ship as a system of systems manipulate this information. As mission discrepancies and/or potential failures are noted, the agents generate alerts, implication statements, and projections. While these outputs will often identify a specific problem within a particular system, the system will interpret the incoming information and then apply it broadly to support decision-making concerning a mission assessment of the ship's readiness. The current SILS MRAT agents under development are:

- **Mission Capability** – Identifies high-level problems that affect the ship's overall ability to perform a mission.
- **Training and Performance** – Identifies training and performance deficiencies.
- **Combat Systems** – Monitors the health of the ship's combat systems.
- **HM&E Systems** – Monitors the health of the ship's hull, mechanical and electrical systems.
- **Navigation and Communication** – Monitors the health of the ship's navigation and communication systems.
- **Damage Control** – Monitors the damage status of the ship and the health of the ship's damage control systems.
- **Supply** – Monitors the supply status of the ship.
- **Personnel** – Monitors the manning status of the crew.
- **Environment** – Monitors the external physical environment for the conditions that may affect the mission.
- **Environmental Protection** – Monitors the impact of operations for consistency with environmental regulations.
- **Rules of Engagement** – Monitors operations for compliance with published rules of engagement
- **Interface** – Monitors the health of interfacing decision support and information systems.

Top-level Mission Readiness assessments are presented with symbols providing immediate visibility of a ships readiness status biased by mission type. The symbols are as follows:

**Fully Mission Capable** - All major equipment and systems are fully capable of performing all required functions without reservations.

**Mission Capable** – All major equipment and systems are capable of performing all required functions with some reservations.

**Marginally Mission Capable** – All major equipment and systems are capable of performing all required functions with major reservations.

**Not Mission Capable in Selected Areas** – Capable of performing selected major functions in a primary mission area.

**Not Mission Capable** – Major discrepancies exist in one or more key functional areas, making the ship incapable of accomplishing a primary mission.

The SILS MRAT interface is composed of several user configurable panels and tool bars as depicted in Figure 3. These panels contain views of ship status and readiness conditions and provide alerts, messages, and notifications to ship officers. The interface is designed to facilitate rapid assessment of problem conditions and aids in the decision making process by exposing inter related links caused by seemingly disparate problems and providing facilities to assist in the development of appropriate courses of actions. SILS MRAT also provides the personnel of a ship with the tools to schedule and report ship activities, events, and department status.

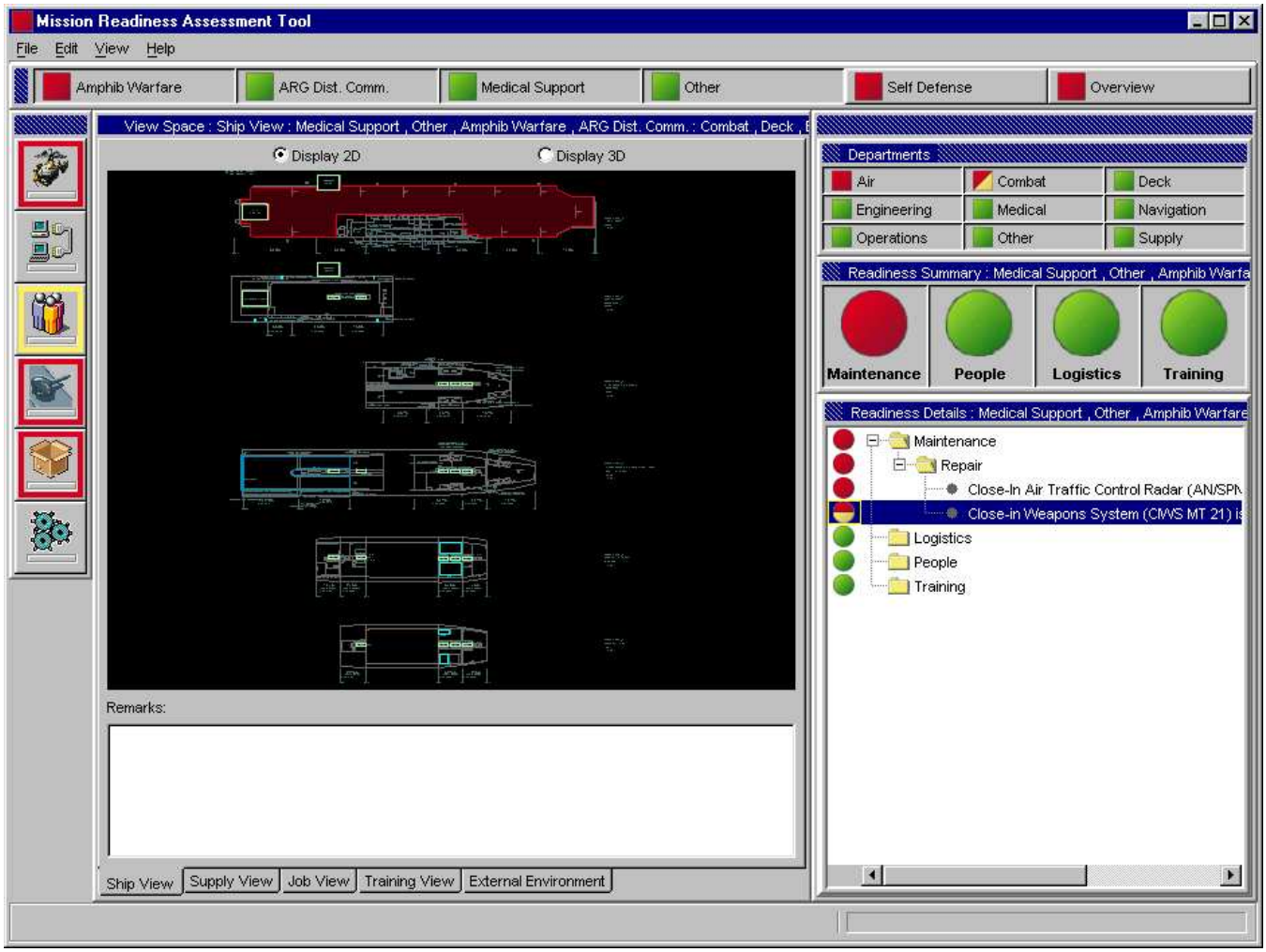


Figure 3 SILS MRAT User Interface

## 5. CONCLUSION

Today's demand for meaningful and valuable information will not allow us to wait for the information owner to provide us with the information. We need user centric tools that will allow access to information when required. From a technological perspective, there is no longer a need to rely on stovepipe systems and organizations to pass data and information to the user community. The advent of software agents provides us with the opportunity to intelligently integrate data and information. In order to expedite the information and knowledge management process we must exploit our pockets of innovation and develop a strategic blueprint for intelligent information management.

SILS MRAT and SILS IE are characteristic of a new breed of systems that utilize distributed system technology and information Centric design to allow for the creation of intelligent agents that can reason on mission readiness and interoperability issues, in this case, to better deal with issues such as system degradation, latency of information, and data inconsistencies. SILS MRA brings together, in a common tabletop, the disparate information systems that have been delivered to fleet units without consideration for the necessary data and information integration.

## 6. ACKNOWLEDGEMENTS

SILS is an idea developed by Dr. Philip Abraham at the Office of Naval Research and manifested in this funded project as an analysis and demonstration of decision support systems and agent based software for enhancing ship readiness and system interoperability. CDM Technologies, Inc. is responsible for the SILS Mission Readiness Assessment Tool (MRAT). MANTECH Advanced Systems International, Inc. is responsible for providing the SILS Interface Engine (SILS IE).

The system was developed after extensive interviews and meetings with three PACFLT units: USS Fletcher, USS Comstock and USS Peleliu. The knowledge acquired during these visits was instrumental in the design of SILS MRAT. The support and assistance of the respective commanding officers and their crew were invaluable in

the current system development. In order to gain a better understanding of the decision aids desired by other levels of the organizational chain; the team has also held extensive discussions with key fleet personnel on the COMPACFLT, COMNAVSURFPAC, and COMTHIRDFLT staffs. To ensure a fleet readiness focus is retained, Mr. Chris Neff continues to coordinate with other PACFLT and Navy Organizations and functions as the COMPACFLT representative.

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Mike Zang is a Senior Software Engineer at CDM Technologies, Inc. He currently provides technical leadership for the Mission Readiness Analysis Toolkit of the ONR sponsored Shipboard Integration of Logistics program and consults on a number of other concurrent projects at the center. Mike began his career at the research center as a core developer on the ICODES project then went on to be the technical leader and principle system architect for the ONR sponsored maritime logistics projects: CIAT, COACH, and OTIS. He introduced the use of case base reasoning at the center and is currently working in collaboration with the NRL's Intelligent Decision Aids Group, a part of the Navy Center for Applied Research in Artificial Intelligence, to extend this technology for the mutual benefit of both organizations. Mike's primary interests are in applied artificial intelligence and ontology development.


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Chris Neff has served as the principal logistics program analyst for the U.S. Pacific Fleet since May 1999. During this period, he has been responsible for identifying material, services, information management needs and resources necessary to support the Pacific Fleet's Aircraft Carriers, Surface ships, and Submarines. He has also provided both functional and technical support to fleet support agencies in order to increase information accuracy, streamline processes, and enhance decision support. He has provided the Office of Naval Research and associated contractors with logistics-related process improvement ideas and placed emphasis on those areas that will provide the greatest value. Prior to assuming his current position, Mr. Neff served as the principal Base Operating Support (BOS) program analyst for facilities, equipment and base support services throughout the Pacific Fleet area of responsibility from Nevada to the Indian Ocean.

Mr. Neff enlisted in the U.S. Navy in 1969, achieved the rank of E-5 prior to being selected for the Navy's Enlisted Scientific Education Program (NESEP), where he earned a Bachelor of Engineering degree in Computer Science at the University of New Mexico. In 1975, he was commissioned and assumed duties as the Electronic Material Officer on the Pacific Fleet Frigate USS Davidson subsequently became Supply Officer on the San Diego-based USS O'Callahan and obtained a Masters degree in Business. His 21 year Naval Career included assignments as Accounting Officer, Financial Management Officer, Financial Systems Project Director, Fleet Budget Officer, and Comptroller on the staffs of the Commander, U.S. Surface Force Pacific Fleet, Chief of Naval Operations, Officer of the Navy Comptroller, the Pacific Fleet Commander, and Commander Naval Logistics Command, Pacific.


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