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An American National Standard

Standard Guide for Implementation of a Fleet Management System Network[1]

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1. Scope

1.1 This guide provides an overview and guide for the selection and implementation by shipowners and operators of a Fleet Management System (FMS) network of computer services in a client/server architecture (see Fig. 1). The FMS is based upon a wide area enterprise network consisting of an unspecified number of Shipboard Information Technology Platforms (SITPs) and one or more shoreside Land-Based Information Technology Platforms (LITPs), which provides management services for the shipping enterprise. The FMS can be understood as a computer system comprised of one or more LITPs and one or more SITPs. It can be characterized as mission critical 24 × 365 (24 h/day, 365 days/year).

1.2 The SITP (see Fig. 1) provides a set of software services, including:

1.2.1 *Communications Services*, to communicate between vessels and with shore via multiple wireless communication technologies;

1.2.2 *Data Acquisition Services*, providing access to shipboard system data as required for use by other systems and management purposes; and,

1.2.3 *Executive Services*, providing software process administration and control.

1.2.4 In total, the SITP provides the capability for multiple shipboard computer systems to share data with each other and to communicate with shore-based management or other vessels or both.

1.3 The SITP is understood to consist of integrated hardware, software, a data repository, and standardized procedures, which provide the ability to send, receive, process, transfer, and store data or messages in digital form in a common mode from shipboard systems or administrative utilities or both, and from designated sources outside the network, for example, systems accessed through wireless communication services, such as satellite, VHF, HF, and so forth. Shipboard systems include navigational, machinery control and monitoring, cargo control, communications, and so forth. The SITP also will provide the capability for the remote administration and maintenance of associated computer systems aboard the vessel.

1.4 The SITP requires an underlying hardware and network infrastructure, including a shipboard computer local area network (LAN), file servers, workstations, wireless communications transceivers, cabling, other electronic and optical devices, video display units, keyboards, and so forth.

1.5 The SITP also requires underlying system software providing network operating system (NOS) services, DBMS services, and other system software.

1.6 There also is a layer of shipboard application systems, which are designed to capitalize on the FMS infrastructure to share data with other shipboard systems and management ashore. Those systems also would be able to capitalize on the remote management capabilities of the FMS.

1.7 The LITP is an asset that can exchange operating and administrative data from individual ships and maintain a DBMS to support fleet management and other maritime applications. The LITP will support data repositories, file servers, workstations or personal computers (PCs), and a communication hub providing connectivity to distributed satellite services, VHF (very high frequency), HF/MF (high frequency/medium frequency), and land lines. The DBMS makes possible the development of knowledge-based "decision aids" by providing the ability to retrieve, process, and analyze operational data.

1.8 This guide does not purport to address all the requirements for a SITP, which forms a path for data for direct control of the operation or condition of the vessel or the vessel subsystems.

1.9 In all cases, it shall be possible for all units of navigation equipment resident on the Navigation Equipment Bus to operate and display essential operating data independently of the FMS.

1.10 In all cases, it shall be possible for all units resident on the Control, Monitoring, and Alarm Bus to operate and display essential operating data independently of the FMS.

1.11 In all cases, it shall be possible for all units resident on the Communications Bus to operate and display essential operating data independently of the FMS.

[1] This guide is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of F25.05 on Computer Applications.

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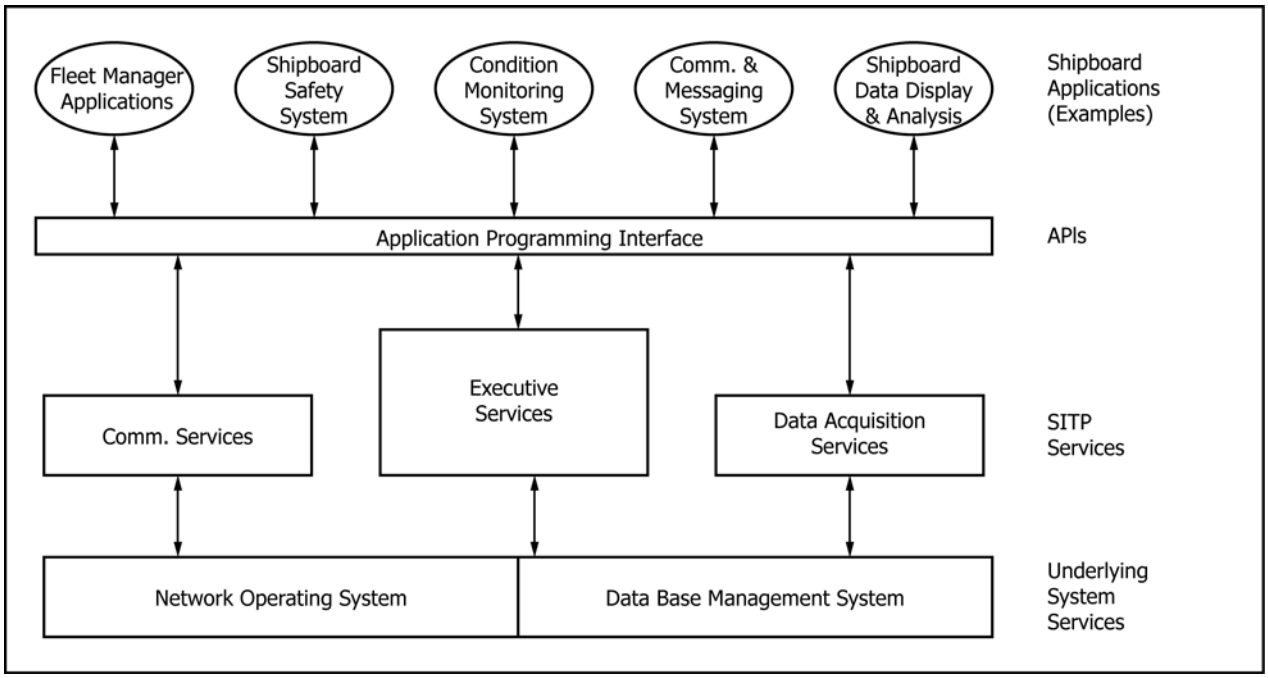

FIG. 1 Typical Architecture

1.12 Values shown in this guide are in SI units.

1.13 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E919 Specification for Software Documentation for a Computerized System (Discontinued 2000) (Withdrawn 2000)[3]

E1013 Terminology Relating to Computerized Systems (Withdrawn 2000)[3]

F1166 Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

F1757 Guide for Digital Communication Protocols for Computerized Systems

2.2 *ANSI Standards:*[4]

X3.172 Dictionary for Information Systems

X3.172a Dictionary for Information Systems (Computer Security Glossary)

2.3 *IEEE Standards:*[5]

IEEE 1028–1988(R1993) Standard for Software Review and Audit

IEEE 1012–1986(1992) Standard for Verification and Validation Plans

IEEE 45 Recommended Practice for Electrical Installations on Shipboard

IEEE 802 Standards for Local and Metropolitan Area Networks—Overview and Architecture

IEEE 802 Standards for Local and Metropolitan Area Networks—Interoperable LAN/MAN Security

IEEE 802.10e and 10f Supplements to IEEE 802.10

IEEE 1003

IEEE 1063 Standard for Software User Documentation

2.4 *IEC Documents:*[4]

IEC 50 International Electrotechnical Vocabulary (IEV)

IEC 92–504 Electrical Installations in Ships; Special Features–Control and Instrumentation

IEC 533 Electromagnetic Compatability of Electrical and Electronic Installations in Ships and of Mobile and Fixed Offshore Units

IEC 945 Maritime Navigation and Radiocommunication Equipment and Systems

IEC 1069 Industrial–Process Measurement and Control—Evaluation of System Properties for the Purpose of System Assessment, Part 1: General Considerations and Methodology; Part 2: Assessment Methodology

IEC 1162 Maritime Navigation and Radiocommunication Equipment and Systems—Digital Interfaces

IEC 1209 Integrated Bridge Systems (IBS) for Ships

2.5 *NMEA (National Marine Electronics Association) Standard:*[6]

NMEA 0183 Standard for Interfacing Electronic Marine Navigational Devices

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331, http://www.ieee.org.

[6] Available from the National Marine Electronics Association (NMEA) Seven Riggs Ave., Severna Park, MD 21146.

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of terms in this guide and described below are in accordance with Terminology E1013 and ANSI X3.172 and X3.172a.

3.1.2 *application program, n*—a computer program that performs a task related to the process being controlled rather than to the functioning of the computer itself.

3.1.3 *application programming interface (API), n*—an API is a set of rules for linking various software components of a network.

3.1.4 *automatic information system (AIS), n*— automatic distribution of a ship's voyage information to all interested parties, that is, other ships, port state, owner, and so forth.

3.1.5 *baseband network, n*—only one transmission can be on the network at any given time.

3.1.6 *black box test, n*—black box tests are based on the design specification and do not require a knowledge of the internal program structure.

3.1.7 *certification, n*—the process of formal approval, by an authority empowered to do so, of arrangements or systems for the reception, storage, or transmission of data and intelligence relative to the management, operation, or control of vessels.

3.1.8 *client server database engine, n*— a commercial data base management system serving as a repository for all critical ship operating and configuration information.

3.1.9 *computer program, n*—a set of ordered instructions that specify operations in a form suitable for execution by a digital computer.

3.1.10 *computer system, n*—a functional unit, consisting of one or more computers and associated software, that uses common storage for all or part of a program and also for all or part of the data necessary for the execution of the program.

3.1.11 *configuration manager, n*—utilities that determine the data to be collected, the processing and storage rules, the standard software functions that facilitate the interfaces between systems and the FMS process servers and other configuration parameters.

3.1.12 *data replicator/message processor, n*— a software module that is responsible for receiving, decoding, and storing communications and transmissions received from ships. This module also prepares data for transmission to a ship through the land-based communications hub.

3.1.13 *document management system, n*—an application that allows procedures manuals to be stored and accessed electronically on shipboard and to be updated electronically.

3.1.14 *electronic mail system, n*—a messaging and file transfer system for both ship and shore.

3.1.15 *fault tolerance, n*—the built-in capacity of a system to provide continued correct execution in the presence of a limited number of hardware of software faults.

3.1.16 *fleet management system (FMS), n*— a system of computer services in a client/server architecture, based on a wide area enterprise network consisting of an unspecified number of SITPs and the LITP. The FMS can be understood as a computer system comprised of one or many shipboard systems and one of many shoreside systems. It can be characterized as mission critical 24 × 365 (24 h/day, 365 days/year).

3.1.17 *independent, n*—independent as applied to two systems means that either system will operate with the failure of any part of the other system excluding the source of power.

3.1.18 *interface, n*—the interface attribute describes the methods and rules governing interaction between different entities.

3.1.19 *integration tests, n*—tests performed during the hardware/software integration process before computer system validation to verify compatibility.

3.1.20 *land-based communications hub, n*— a land-based computer system that provides uniform access to multiple maritime satellite services, as well as access to public telephone networks, e-mail, and the internet.

3.1.21 *local area network (LAN), n*—a network that connects computer systems resident in a small area. For purposes of this guide, the SITP is considered a shipboard LAN with access to similar shoreside and shipboard units through radio and satellite telecommunication services.

3.1.22 *MSAT*—satellite communications service covering North America

3.1.23 *multitasking, n*—the capability to handle more than one task at a time

3.1.24 *NAVTEX, n*—a system for the broadcast and automatic reception of maritime safety information by means of a narrow-band direct-printing telegraphy.

3.1.25 *network interface unit (NIU), n*—the network interface units (NIUs) provide for connection and message translation to enable data streams from systems, both hardware and software, which may use various standard and proprietary communication protocols to be stored and accessed in the FMS database in a standard format.

3.1.26 *ship information technology platform (computing), n*—an integrated system of software, hardware, communication links, and standardized procedures that provide the ability to collect, process, and store information in digital form.

3.1.27 *ship earth station, n*—a mobile earth station for maritime service located aboard a ship. Typically, a small lightweight terminal with omnidirectional antenna with interfaces for a personal computer or any other data terminal equipment for message generation and display, for example, Inmarsat C, or a steerable antenna mounted on a stabilized platform, for example, Inmarsat A and B and M.

3.1.28 *single failure criterion, n*—a criterion applied to a system such that it is capable of performing its safety task in the presence of any single failure.

3.1.29 *software, n*—programs, procedures, rules, and associated documentation pertaining to the operation of a computer system.

3.1.30 *software cycle*—the software cycle typically includes a requirements phase, a design phase, an implementation

phase, a test phase, an installation and checkout phase, and an operation and maintenance phase.

3.1.31 *validation*—the test and evaluation of the integrated computer system, hardware and software, to ensure compliance with the functional, performance, and interface requirements.

3.1.32 *verification, n*—the process to determine if the product of each phase of the digital computer system development process satisfies the requirements set by the previous phase.

3.1.33 *voyage data recorder (VDR), n*—a store of information, in a secure and retrievable form, concerning the position, movement, physical status, command, and control of a vessel over the period leading up to a marine casualty.

3.1.34 *white box test, n*—white box tests require a knowledge of the internal program structure and are based on the internal design specification.

3.1.35 *workstation, n*—a computer and associated visual display unit (monitor) configured as an I/O unit to perform certain tasks.

4. Significance and Use

4.1 Competent information management is essential for safe and productive operation and regulatory compliance. A short list of the functions affected includes decision aids for navigation, communications, ship handling, machinery control, cargo operations, maintenance and repair, personnel records, and environmental protection.

4.2 The shipbuilding and shipping industries have identified a need to develop comprehensive standards and guides for implementing computer-based shipboard data management systems.

4.3 The FMS may include single or multiple SITPs and single or multiple LITPs and provides the means to integrate shipboard and shoreside computer systems with multivendor connectivity, distributed processing, and electronic data interchange between noncompatible networks, computers, workstations, and peripherals and maintain databases, which promote safety of life at sea, protection of the environment, and operational efficiencies throughout the life cycle of the vessel/fleet. The FMS may incorporate satellite gateways to coastal communication hubs providing access to land-based networks, such as telephone lines, facsimile, e-mail, and expanded satellite services through land earth stations.

4.4 The SITP can be configured to provide the ship's control center with access to local control centers, such as for cargo operations, which may be located on the main deck.

4.5 This guide has provisions relevant to all components of the FMS platform including the ship earth station, interface devices for subsystems and administrative systems connected to or forming part of the network, communication services, and certain land-based facilities under the direct control of the ship's management.

4.6 It is the intent of this guide to provide guidelines for the design and implementation of open client/server architecture for computer and communication networks for shipboard and shore-based applications.

4.7 This guide is intended to assist vessel owners, designers, shipyards, equipment suppliers, and computer service providers in the development of contract technical specifications, which detail the services to be supported, performance required, and criteria for acceptance for specific FMS installations.

5. FMS Architecture

5.1 *Network Design*—There is an underlying computer network to support the FMS. The functions of the FMS enable a communication network that provides for the exchange of information between nodes or devices capable of transmitting or receiving information in the form of electronic or optical signals. The process is enabled by communication protocols, which define the rules that must be implemented in the hardware and software. The text of this guide is predicated on a network architecture conforming to the Open Systems Interconnection Reference Model (OSI/RM). See Guide F1757.

5.2 *Network Management:*

5.2.1 The FMS is based upon a wide area network (WAN) consisting of a number of LANs, which are dispersed geographically over large areas and are linked through wireless communications by bridges and gateway devices. The group responsible for managing the FMS will normally be located in the principal shoreside office. The primary task of the network management system is to oversee and report on the operation of the network, which may comprise products from many different vendors.

5.2.2 *Security*—A security function should be provided that is responsible for the following:

5.2.2.1 Data confidentiality;

5.2.2.2 Data integrity;

5.2.2.3 Data authentification; and,

5.2.2.4 Access control.

5.3 *Database Model*—Database maintenance and availability are key features of the FMS. Each SITP and the LITP will maintain separate databases. Each FMS site will incorporate a database management system, including replication capability, as part of each SITP and LITP installation.

6. Shipboard Information Technology Platform (SITP) Connectivity

6.1 A key objective of the SITP is to facilitate sharing of data among shipboard systems (see Fig. 2). The shipboard systems, which are candidates for connection to an SITP include, but are not limited to, the following:

6.1.1 *Shipboard Operating Systems*—Shipboard operating systems are active systems and may acquire information from sensors or databases and exercise control internally or transmit data for administrative purposes or for application in knowledge-based decision aid systems.

6.1.1.1 *Integrated Bridge System*—This system comprises the integrated bridge system bus, the navigation equipment bus, and the control, monitoring, and alarm bus.

6.1.1.2 *Integrated Bridge System Bus* —The integrated bridge system bus provides connectivity for the navigation

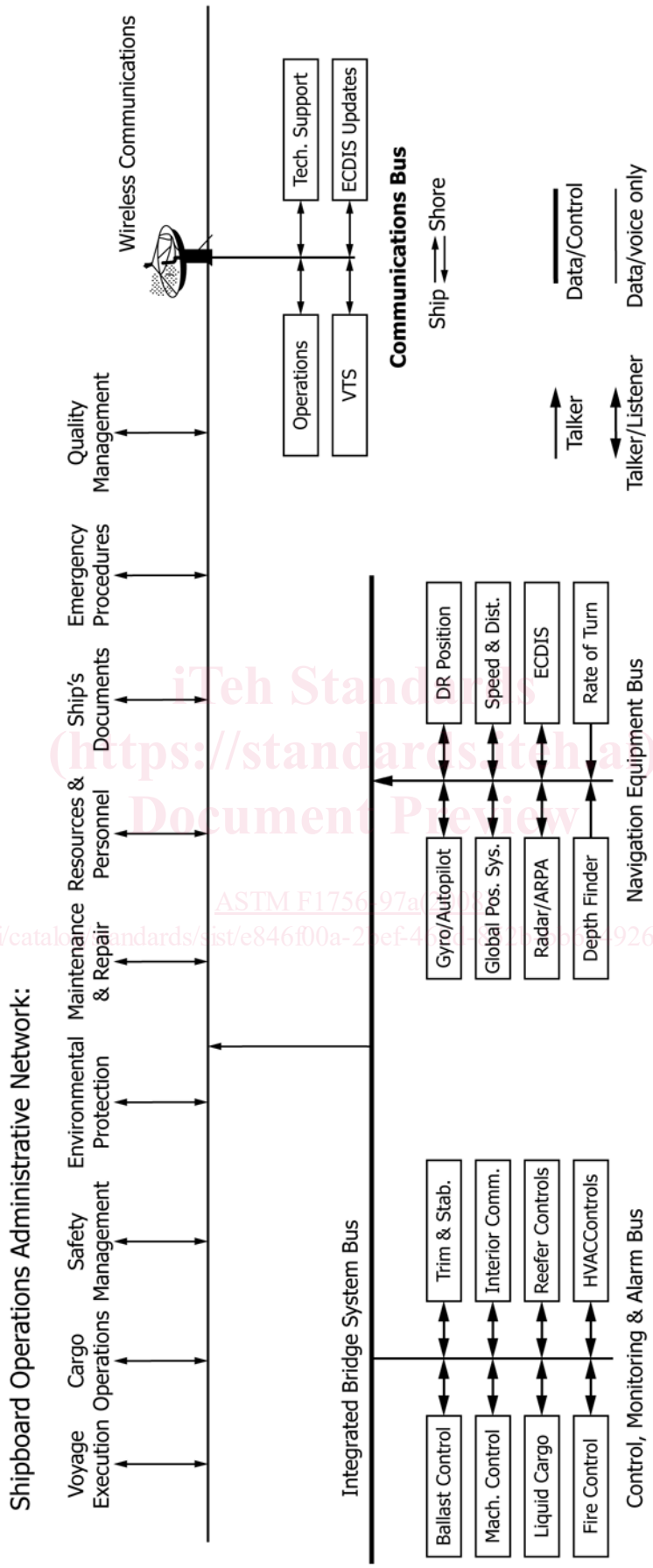

FIG. 2 SITP Data Flow (Typical)

equipment bus and the control, monitoring, and alarm bus and is a controlled gateway to the administrative network.

6.1.1.3 *Navigation Equipment Bus*—The navigation equipment bus provides systemwide connectivity for any or all of the following or any additional units associated with the navigation of the vessel: gyro compass/autopilot; global positioning system (GPS); dead reckoning (DR) navigation system; speed and distance indicator (Doppler log); sonic depth finder; electronic chart system (including, but not limited to, ECDIS); rate of turn indicator (ROTI); radar/ARPA (automatic radar plotting aids); radio direction finder; and voyage data recorder (VDR).

6.1.1.4 *Control, Monitoring, and Alarm Bus*—The control, monitoring, and alarm bus provides systemwide connectivity for any or all of the following or any additional units associated directly with control of the vessel: machinery control, monitoring, and alarm; liquid cargo control; inert gas control; ballast control; fire detection and alarm; loading (trim and stability; hull stress); internal communications; WT door and fire door controls; controls for refrigerated cargo; and HVAC controls.

6.1.2 *Communications Bus*—The communications bus provides connectivity for any or all of the following or any additional units providing communication facitilities on board the vessel: Inmarsat A, B, M; Inmarsat C; VHF radiotelephone; MF/HF SSB radiotelephone; cellular; and GMDSS (Global Maritime Distress Safety System–see Appendix X3).

6.1.3 *Administration System:*

6.1.3.1 *Ship-to-Shore Communications:*
Electronic mail and file transfer,
Connection to local telephone systems, and
Sailing instructions (weather routing).

6.1.3.2 *Cargo Planning:*
Stability and trim,
Container ordering,
Cargo manifests,
Custody transfer procedures and records, and
International Maritime Dangerous Goods Code.

6.1.3.3 *Fuel Management—Speed/Distance/Consumption:*
Fuel rate,
Running inventory,
Fuel quality records,
Bunkering checklist,
Bunker planning—grades and quantities, and
Cargo heating.

6.1.3.4 *Inspections, Maintenance, and Repair:*
Inspection schedules,
Maintenance and repair (M and R) schedules and records, and
Spare parts inventory control (use, ordered, received, and cost).

6.1.3.5 *Quality Management:*
ISM Code compliance,
Quality procedures and records (ISO 9000), and
Auditing.

6.1.3.6 *Personnel and Safety Management:*
Employment records management—payroll,
Training and certification,
Hazard communication (benzene, asbestos),
Respiratory protection, and
Occupational health monitoring.

6.1.3.7 *Ship's Documents:*
Predeparture and prearrival checklists/documents,
Bridge manual,
Muster cards and checklists,
Stability book,
Bunkering records,
Engine manual, and
Fire and damage control.

6.1.3.8 *Reports:*
Automatic information system (AIS) and
Voyage data recorder (VDR).

7. Shipboard Information and Technology Platform (SITP)

7.1 The SITP consists of the software and hardware required to support a distributed computing network based on the client/server model. In general, the SITP will be optimized to respond to a single LITP. For cases in which the SITP will respond to multiple shoreside platforms, a hierarchy should be defined. The SITP consists of layers of computer services and underlying layers of system services, including a network operating system and a database management system.

7.1.1 *Computing Model*—Client/server computing is expected to be the computing model for the SITP. Client/server is a joint operation in which specific computers perform specific tasks. Server tasks generally involve file sharing, database management, communications management, and so forth. Client tasks, on the other hand, are generally active and are defined by the application.

7.1.1.1 *Server(s):*

(*a*) Comprises software that is resident on an intelligent machine (a computer);

(*b*) Is a provider of services. The services may include database services (DBMS), communication services, and processes;

(*c*) Is a shared resource. One server can serve several clients;

(*d*) Is transparent to the user. Clients and servers communicate by a messaging interface; and,

(*e*) Is normally a dedicated PC.

7.1.1.2 The client(s) is normally software that is resident on a PC or work station.

7.1.1.3 *Quality*—Design, development, modification, replication, and installation should be subject to a documented quality plan. At a minimum, the areas of responsibility, performance, and acceptance criteria should be addressed in the quality plan.

7.1.1.4 The design and testing of the computer services should ensure that:

(*a*) The implementation satisfies the applicable requirements, which may also include statutory and classification requirements;

(*b*) Design documentation will show that specification requirements can be traced through all levels;

(*c*) Module interfaces and dependencies are clearly defined and identified;