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An American National Standard

Standard Guide for Hardware Implementation for Computerized Systems[1]

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1. Scope

1.1 This guide provides assistance in the choice of computing hardware resources for ship and marine environments and describes:

1.1.1 The core characteristics of interoperable systems that can be incorporated into accepted concepts such as the Open System Interconnection (OSI) model;

1.1.2 Process-based models, such as the Technical Reference Model (TRM), that rely on interoperable computing hardware resources to provide the connection between the operator, network, application, and information; and,

1.1.3 The integrated architecture that can be used to meet minimum information processing requirements for ship and marine environments.

1.2 The use of models such as OSI and TRM provide a structured method for design and implementation of practical shipboard information processing systems and provides planners and architects with a roadmap that can be easily understood and conveyed to implementers. The use of such models permit functional capabilities to be embodied within concrete systems and equipment.

1.3 The information provided in this guide is understood to represent a set of concepts and technologies that have, over time, evolved into accepted standards that are proven in various functional applications. However, the one universal notion that still remains from the earliest days of information processing is that technological change is inevitable. Accordingly, the user of this guide must understand that such progress may rapidly invalidate or supersede the information contained herein. Nonetheless, the concept of implementing ship and marine computing systems based on these functional principles allows for logical and rational development and provides a sound process for eventual upgrade and improvement.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1013 Terminology Relating to Computerized Systems (Withdrawn 2000)[3]

F1757 Guide for Digital Communication Protocols for Computerized Systems

2.2 *ANSI Standards:*[4]

X3.131 Information Systems—Small Computer Systems Interface-2 (SCSI-2)

X3.172 American National Standard Dictionary for Information Systems

X3.230 Information Systems—Fibre Channel—Physical and Signaling Interface (FC-PH)

X3.232 Information Technology—SCSI-2 Common Access Method Transport and SCSI Interface Module

X3.253 Information Systems—SCSI-3 Parallel Interface (SPI)

X3.269 Information Technology—Fibre Channel Protocol for SCSI

X3.270 Information Technology—SCSI-3 Architecture Model (SAM)

X3.276 Information Technology—SCSI-3 Controller Commands (SCC)

X3.277 Information Technology—SCSI-3 Fast-20

X3.292 Information Technology—SCSI-3 Interlocked Protocol (SIP)

X3.294 Information Technology—Serial Storage Architecture—SCSI-2 Protocol (SSA-S2P)

X3.297 Information Systems—Fibre Channel—Physical and Signaling Interface-2 (FC-PH2)

X3.301 Information Technology—SCSI-3 Primary Commands (SPC)

X3.304 Information Technology—SCSI-3 Multimedia Commands (MMC)

MS58 Information Technology—Standard Recommended Practice for Implementation of Small Computer Systems

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[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.A

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Interface (SCSI-2), (X3.131.1994) for Scanners
NCITS 306 Information Technology—Serial Storage Architecture—SCSI-3 Protocol (SSA-S3P)
NCITS 309 Information Technology—SCSI-3 Block Commands (SBC)

2.3 *IEEE Standards:*[5]

100 Standard Dictionary for Electrical and Electronic Terms
488 Digital Interface for Programmable Instrumentation
610.7 Standard Glossary for Computer Networking Terminology
796 Microcomputer System Bus
802.11 Wireless LAN Medium Access Control and Physical Layer Specifications
1003.2d POSIX—Part 2 Shell and Utilities—Amendment: Batch Environment
1003.5 Binding for System Application Program Interface (API)
1003.b Binding for System Application Programming Interface (API)—Amendment 1: Real-time Extensions
1014 Versatile Backplane Bus: VMEbus
1101.10 Additional Mechanical Specifications for Microcomputers using the IEEE Std 1101.1 Equipment Practice
1155 VMEbus Extensions for Instrumentation: VXIbus
1212.1 Communicating Among Processors and Peripherals Using Shared Memory (Direct Memory Access DMA)
1394 High Performance Serial Bus
1496 Chip and Module Interconnect Bus: Sbus
1394 32-bit Microprocessor Architecture

2.4 *ISO Standards:*[4]

1155 Portable Operating System Interface for Computer Environments (POSIX)
9945-1 System Application Program Interface (API) [C language]
9945-2 Shell and Utilities

2.5 *TIA/EIA Standard:*[6]

568-A Commercial Building Telecommunications Cabling Standard

3. Significance and Use

3.1 This guide is aimed at providing a general understanding of the various types of hardware devices that form the core of information processing systems for ship and marine use. Ship and marine information processing systems require specific devices in order to perform automated tasks in a specialized environment. In addition to providing information services for each individual installation, these devices are often networked and are capable of supplementary functions that benefits ship and marine operations.

3.2 A variety of choices exists for deployment of information processing devices and greatly increases the complexity of the selection task for ship and marine systems. The choice of a particular device or system cannot be made solely on the singular requirements of one application or function. Modern information processing systems are usually installed in a complex environment where systems must be made to interact with each other. Ship and marine installations add an even further layer of complexity to the process of choosing adequate computerized systems. This guide aims to alleviate this task by giving users specific choices that are proven technologies that perform in a complex environment.

3.3 Hardware resources used in ship and marine installations are a result of careful consideration of utility and function. These resources may require some physical specialization in order to inhabit a particular environment, but they are in no way different from equipment used in shore-based situations. Ship and marine computer system configurations, interconnections, and support services are essentially the same as those found in a land-based network environment and as a result, the skill sets of ship and marine information processing system users, administrators, and support personnel are interchangeable with those of shore-based activities.

4. Standards Profiles

4.1 Standards profiles are sets of specifications bundled together to describe the technical standard for a function or a service (such as operating systems, network, and data interchange services), and will include minimum criteria for the information and technology that support specific functional requirements. Profiles equate to the lowest level process, and document agreed-to implementation requirements used in building and operating systems. Systems using the same standards, but different options, will probably not interface correctly. The Technical Reference Model (TRM) is useful for assembling standards profiles across technology categories of Computing Resources, Information Management, and Applications.

4.1.1 The TRM identifies and specifies the support services (multimedia, communications, and so forth) and interfaces that provide a common operating environment and support the flow of information among enterprise and common support applications. This model represents the computer resources, information management, and applications categories and interfaces with the communication and networking technology categories that are appropriately represented by the ISO Open System Interconnect model. The TRM addresses standard profiles that provide seamless application support over widely distributed computing resources and attendant interfaces between the computing resources and other technologies.

4.2 Computing hardware resources represent generally consists of Central Processing Unit(s) (CPU), Input and Output (I/O) interfaces, main memory, buses, and peripherals. The external environment considerations that affect computing hardware resource selection are security, communications, real-time, and high availability. The computing hardware resource provides the environment necessary to support application software. From the perspective of the application software, services are provided by the computing resource, whether the particular services are provided locally or remotely as part of a distributed system.

4.3 The architecture needed to support a typical application consists of computers that perform as clients and servers. The

[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 TIA, 2500 Wilson Boulevard, Suite 300, Arlington, VA 22201-3834.

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servers host the primary application software and contain the processing power necessary to support multiple users. Servers also host the data needed to support the application. The standard 3-tiered application architecture consists of (*1*) an application server, (*2*) a data server, and (*3*) presentation clients (see Fig. 1).

4.4 In the future, most application processing software will be hosted on the server computers. Clients will use presentation software that connects to the servers using a common interface. At that time, client computers will likely be less expensive and tailored to the user's individual preference because application interoperability will not be a significant factor.

4.5 Today, however, most application software is hosted on the client and interoperability among clients is a critical factor. Even within the client-server application architecture, application specific software resident on the client is still prevalent. This demands consistency of client workstations across an entire installation to achieve seamless interoperability. Table 1 outlines a rationale for the client-server deployment strategy.

4.6 Driven by the current state of client-server technology, the general philosophy for implementing computing resources is the concept of homogeneous clients and heterogeneous servers. Homogeneous clients facilitate providing a consistent interface between the user and the system and make system support and maintenance less complex. Heterogeneous servers support the various computing requirements of applications needed to support ship and marine operations. The same advantages that homogeneous clients enjoy can be achieved if servers are homogeneous as well. Independent of whether or not the server suite employed is heterogeneous or homogeneous, it is important that they perform their function transparently to the user (that is, the user neither knows nor cares about the location, number, or vendor of the server being used.) Requiring servers to be homogeneous would restrict the introduction of new server technology, choking innovation and preventing the installation from taking advantage of advances in computing such as massively parallel processors.

5. Computing Hardware

5.1 *Computing Resources*—Computing resources consist of many computing hardware components and configurations of these components. This section covers the various hardware components that make up a computing resource system and examines how these components are commonly configured.

5.2 *Component Technologies*—The major hardware components of Computing Resources are the Central Processing Unit (CPU), one or more backplane buses, main memory (both RAM and cache), Input/Output (I/O) interfaces, and peripherals. This section will examine each of these areas and provide guidance on the selection of these component technologies as part a computing resource system.

5.2.1 *CPU*—The CPU is the "engine" of the computer system and, combined with the OS (operating system), forms the core of the computing resource. Since the OS drives many decisions concerning the computer resource, a CPU that is compatible with the OS becomes an overriding factor in determining the type of CPU. Other than the OS, the main factors to consider in determining the type of CPU for the computer are processing speed (performance) and cost. For computing resources, such as servers and multiprocessors, scalability of the number of processors can be a significant factor in determining CPU.

5.2.2 *Bus*—The computer bus connects the different components of the computer resource together and allows them to pass data between them at high speeds. Computer resource configurations, such as personal workstations, often limit or determine the type of bus that will be used. Often there are

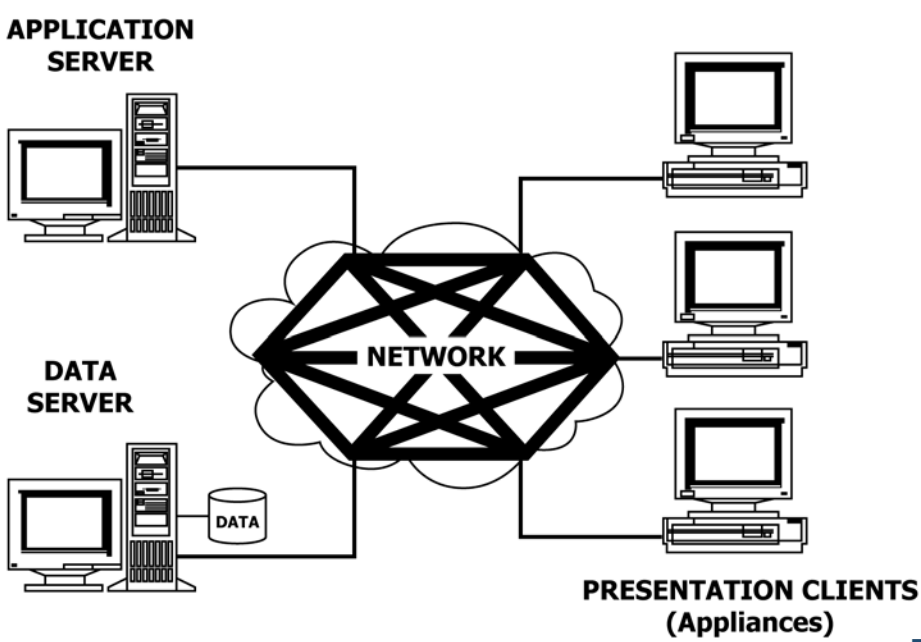

FIG. 1 Three-Tiered Application Architecture

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TABLE 1 Client-Server Deployment Rationale

Rationale for Heterogeneous Servers	The server must be tailored to the specific application that may not be supportable by computers most prevalent in the marketplace.
	Many applications work well in their current computing environment and it is not cost effective to change.
	It is not practical to have all applications on a common server for multiple reasons including the need to maintain competition between computer developers and vendors.
	Encourages innovation by not restricting the type of computer used for the development of applications.
Rationale for Homogeneous Clients	Allows for a common, consistent user interface.
	Maximizes interoperability.
	Minimizes re-training required as users transfer to different organizations within the enterprise.
	Maximizes the ability to use common support and maintenance skills, parts and labor; thereby minimizing cost.
	Maximizes portability of support for applications across the enterprise as well as portability of user skills.
	Allows for economies of scale in both procurement (volume discounts) and support (more focused skill set for help desk personnel).

TABLE 2 CPU Sample Implementations

Clients, Servers, and Special Purpose
Intel Pentium/Celeron
AMD K6/Athlon/Duron
VIA C3/Cyrix
Motorola PowerPC
Transmeta Crusoe
Servers and Special Purpose
MIPS 32/64
Compaq Alpha
Hewlett Packard PA-RISC
Sun Microsystems SPARC/UltraSPARC
Motorola PowerPC

multiple buses connected together to allow for multiple types of component cards or to extend a non-expandable system bus. Considerations in determining the type of bus to use are: number and type of commercial products compatible with the bus architecture, number of parallel data bit lines, clock speed, and cost. Once the appropriate bus architecture is determined, an important computer resource factor becomes how many interface slots are available on the bus for component cards.

TABLE 3 Sample Bus Implementations

PCI
VME/VXI
SBUS
VXI
CardBus
GPIB/HP-IB
EISA

NOTE 1—Peripheral Connect Interface (PCI) bus is quickly gaining favor as a low-cost preferred system bus architecture. PCI provides the necessary throughput to support the high-end data rates required by many of today's applications. Most commercially available computers come with a PCI bus.

NOTE 2—EISA bus should be used only to accommodate legacy systems.

NOTE 3—Although VME bus is more popular, VXI bus offers a greater degree of standardization and therefore a greater degree of interoperability between vendor's products. These are the buses of choice for embedded systems. IEEE Std 1014 applies to VME and Std 1155 applies to VXI.

NOTE 4—GBIB is the Standardized version (IEEE Std 488) of the HP-IB implementation developed by Hewlett-Packard.

NOTE 5—CardBus is the new 32-bit high performance bus defined by the new PC Card Standard released by the PCMCIA standards body and trade association. The PC Card Standard replaces the outdated PCMCIA version 2.0 and version 2.1 standards.

5.2.2.1 Use buses that provide the necessary performance economically and are compatible with the board level components that are needed to meet requirements. For buses that provide slots for component cards, use standard buses that are supported by multiple vendors providing compatible component cards.

5.2.3 *Main Memory*—Main memory is the storage warehouse of the computer where data and programs are stored for efficient processing. In the context of this section, main memory refers to cache and RAM. The main factor to consider in acquisition of a computer system is the quantity (in megabytes) of RAM. Other considerations are access speed, mounting design, and parity. Computer systems with too little memory run slowly, won't load, and crash often. Mounting designs today generally provide for easily upgradeable Memory Modules. SDRAM (Synchronous Dynamic Random Access Memory) has long been a standard for memory, but more advanced designs such as DDR (Double Data Rate) and Rambus memory offer better speed and throughput and are rapidly gaining wide acceptance. Older architecture memory designs are generally slower and less efficient and should be avoided to the extent possible.

5.2.3.1 Cache is usually hard wired to the motherboard and has a faster access time than RAM. Computer system caches of 512 KB or larger are generally satisfactory.

5.2.3.2 RAM can often be on a separate memory board and is used to store the OS, applications that are running, and data files. The amount of RAM needed for a computer system can vary with the environment and the OS. Servers generally need about an order of magnitude more RAM than personal workstations. For personal workstations with a 16/32 bit operating system, 64 MB or more of RAM is recommended; for workstations with 32/64 bit operating systems, 128 MB or more is recommended. For servers, use the Network Operating System (NOS) guidelines based on the environment. The three major factors used to determine the amount of RAM for a server are number of user connections, number of processes running, and amount of hard drive space.

5.2.4 *Input/Output (I/O) Interfaces*—I/O interfaces allow the computing resource to move data between the "outside world" and the CPU and main memory. Operations like loading a program or file from a floppy or CD, sending and receiving information over the LAN or WAN, or sending a document to the printer to get a hardcopy use I/O interfaces.

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