

INTEGRATED DATA ACQUISITION FOR COASTAL RESEARCH VESSEL

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Introduction

Scientific research vessels operating at sea collect variety of oceanographic data related to the physical chemical and biological processes occurring at sea. The technology of ship-board data acquisition has been progressively improving with advances in microelectronics.

Early research vessels in India did not have contemporary research facilities for automation in the area of data acquisition. As a result lot of effort went into development of indigenous dataloggers for ship board use. The newer research vessels launched in eighties had full fledged facilities for acquisition and processing of data. Oceanographic research vessel launched in 1983 for instance contained three separate minicomputers (HP-1000), one for integrated navigation, another for weather radar processing and the third for post processing of data. There were also several desktop computers (HP-9845) to collect a variety of data.

IDAS is being developed for a coastal research vessel (CRV) using personal computers in a local area network environment. The advantages of using personal computers and their use in a distributed system, the special requirements of local area network for ship board use and network software standards that have formed the basis of IDAS are presented here.

Personal Computers

The PDP series from Digital Equipment Corporation and minis and desktop computers from Hewlett Packard have been popular systems on board. Recently however the trend has been to use the IBM PC compatibles. PC's are preferred for following reasons.

- * Universally available hardware and spares at low cost facilitate easy maintenance.

- * Large software base and a variety of add-on hardware modules ease the development of new applications.

- * Well documented well known and open architecture allows a system designer to build special interfaces with ease.

The major drawback of PC's, for real time applications have been its IO bus, inability to support multiprocessing and multitasking, limited interrupt inputs and inability to handle nested interrupts.

Distributed system

Different equipment on board need to share the data with other equipment such as positional information, speed and heading and bathymetry. The

distributed computers therefore need to be interconnected. A most simple method of interconnection is via RS 232 link. The RS 232 link is limited to its maximum transmission speed of 9600 baud. The parallel bus connections, including IEEE- 488 GPIB link, cannot drive signals beyond a few feet and are not suited for interconnecting distributed systems.

The local area networks (LAN) which have emerged in recent years can offer transmission speed in excess of 10 Mbit/sec. and have become ideal choice for interconnecting distributed systems. LAN based systems are easy to expand. New systems can be connected to network to share the data collected in real time. Another advantage of LAN is that data collected at one node can be monitored, analyzed or displayed at one or more nodes in the network.

Networks for Shipborne Applications.

The use of personal computer networks have increased greatly and they have become standardized and more reliable. PC networks have become popular because of their use in office automation, however the aspects such as networking protocols, network media and topology which are important for ship board applications are discussed.

There are three different types of network viz. ethernet, token bus and token ring. Ethernet networks are the oldest and use a carrier sense multiple access / collision detect (CSMA/CD) technique for network transmission. Ethernet networks use statistical avoidance methods for transmission, as a result of which increasing number of nodes decrease the throughput due to increased collisions. A worst case access time per node is not guaranteed in standard ethernet network making this type of network unsuitable for real time applications.

Token bus and token ring networks on the other hand use controlled access protocols and have deterministic worst case access times per node. Token network automatically reconfigure themselves when a node is switched ON or OFF if a token is lost under any circumstances. As an example an ARCNET network manufactured by Standard Microsystems supports 2.5 Mb/sec transmission rate and a maximum of 255 nodes.

Token ring technology is relatively new and has gathered momentum since 1985. Token ring networks are more suitable when compared to a token bus for real time applications and shipboard use since they support nodal priorities in addition to being deterministic and fault tolerant. Token ring networks with 16Mbit/sec transmission speed using twisted pair cables and 100Mb/sec using fiber distributed data interface are gradually becoming available.

In addition to network protocols other aspects such as network media and topology require special attention for shipboard use. Fiber optic cable is a good choice for following reasons.

- * is immune to electromagnetic and radio frequency interferences and high voltage transients.
- * avoids problems due to grounding and shorting.
- * is easy to bend and route being light and thin.
- * unaffected by corrosive effects of the marine environment.

The star topology wiring with centralized hub is preferred to bus topology for following reasons.

- * routing cables from centralized hub is easy.
- * isolating faulty cables is easy.

Software standards

International Standards Organization's (ISO) has defined seven layered , Open System Interconnect (OSI) model which has been widely accepted. IEEE 802 committee defined standards 802.3, 802.4 and 802.5 for ethernet , tokenbus and token ring protocols. These protocols have covered the aspects such as transmission bandwidth, topology, media defined at layer 1 & layer 2 of the OSI model.

Higher level layers of OSI model define software protocols for application to network interfaces. Until 1985 standardization did not exist on the software protocols. IBM's NETBIOS program released in 1985 has become an industry standard for program to program communication.

NETBIOS supports four categories of services viz. name, datagram, session and general services. Name services are required for identification or addressing of nodes. The datagram and session services are transport services for communication between user processes. The datagram services, unlike session services, do not guarantee the delivery of the data.

Integrated Data Acquisition System

The concepts discussed so far have been the basis of the Integrated Data Acquisition System (IDAS) being built for a Coastal Research Vessel (CRV). CRV is a small vessel of 45 meter length and 10 meter breadth accommodating two fixed laboratories (viz a wet and a dry lab.) and two modular container laboratories. Figure 1 shows the schematic diagram of IDAS consisting of PCs connected by an ARCNET network.

The computer "NAV PC" collects navigation data from a satellite navigator, depth data from an echo-sounder, and ship's speed and heading data. The data is recorded every 10 sec and broadcast every second on the network to all other PCs. "Met PC" collects data from a suit of meteorological sensors viz. wind speed, wind direction, air and surface temperature, barometric pressure and solar radiation etc. Wind data is corrected with the output from the NAV PC. "WET PC" is dedicated to equipments such as conductivity depth temperature (CTD) profiler, wave recorder, auto-analyzer etc. "MOD PC" are connected to equipments in modular laboratories such as magnetometer, electronic bathythermograph (EBT) and current meter etc.

Software and Data Integration

Software is being written in 'C'. The communication software between the nodes is planned through NETBIOS calls without involving a file server. The software is interrupt driven so that no data is lost whilst updating the discs or whilst waiting for network communications.

Data is recorded at a file server by all the acquisition nodes which is available to all the computers on the network for analysis, processing and display. The maximum data collected by all equipment on CRV will not exceed 1Mbyte/day and a 40 MB disc on the server will easily store data from a full length cruise of 30 days.

Conclusions

The personal computers have become appropriate choice because of their easy availability, low cost, large software base and well known open architecture. The distributed PCs connected by a local area network allow concurrent data acquisition, processing and display, simultaneously at one or more nodes. LAN based configuraion described here can be easily expanded depending on the required sophistication.

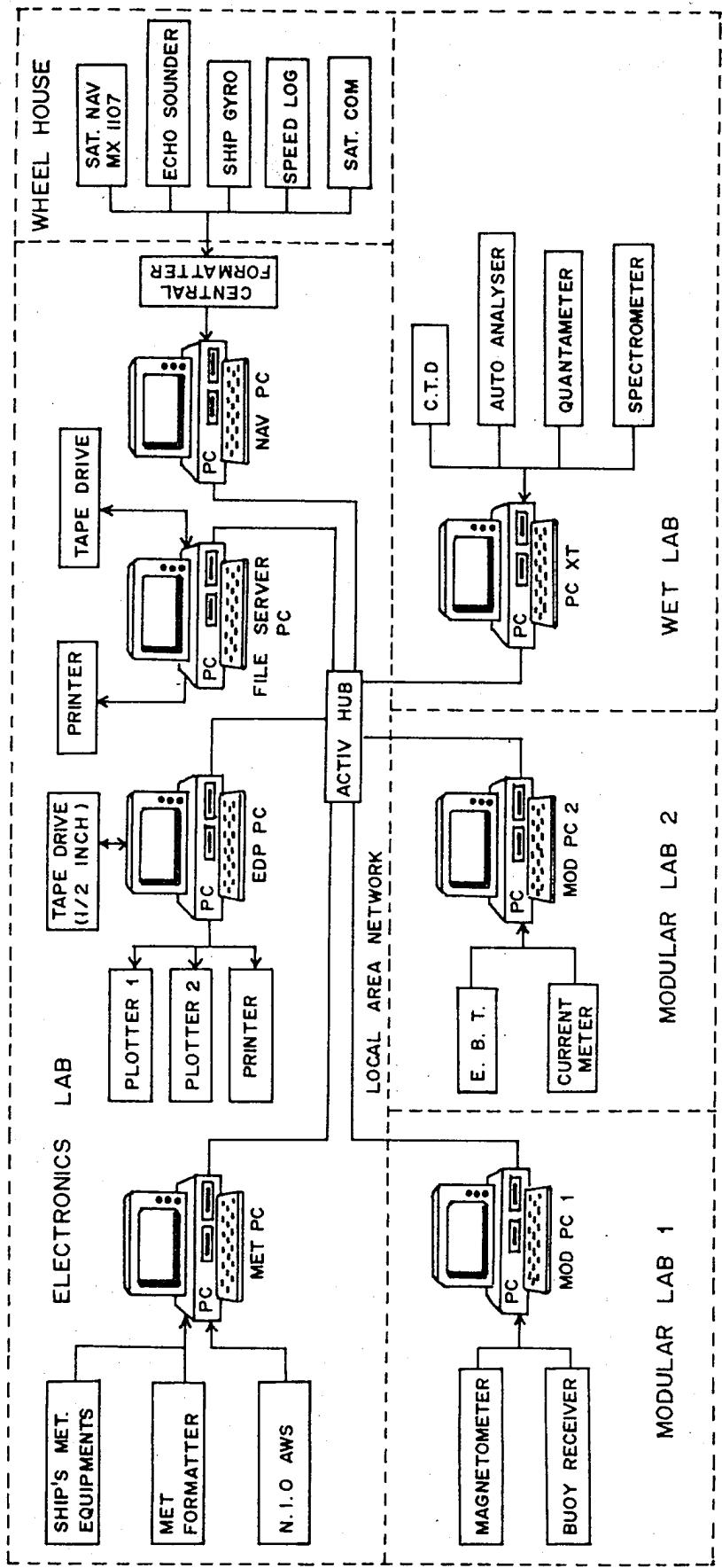


FIG. 1 -- SCHEMATIC CONFIGURATION OF INTEGRATED DATA ACQUISITION SYSTEM