

CHAPTER 5

SYSTEM DESIGN

5.1 Assumption's for System Design

For the system design for the power plant, the assumption is the power plant managers are willing to buy software, hire a contractor to do the implementation and allocate necessary personnel resources to accomplish it. The other assumption is outsourcing, which is the practice of hiring an outside company to handle all or part of the data processing activities. A list of advantages and disadvantages is presented in Figure 5-1 [6].

When system development projects are outsourced, company benefits from the skills of trained industry specialists who have installed many systems. Outsourcers often specialize in particular industries with unique computing needs. Outsourcers provide help with development and design to handle the complete design and installation of a new system, including the selection of hardware and software. Outsourcers are also able to help organization cut through much of the company politics surrounding systems development [6].

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Advantage	Disadvantage
It is the least costly approach.	<p>The software may not fit the company's needs.</p> <p>The changes required to use the software may not be in the company's best interests.</p>
<p>There is little delay; the software is ready to run.</p> <p>The buyer can reduce risk by test-driving software and talking to other users.</p> <p>Users can select the package that best meets their needs.</p> <p>Programs are more likely to be bug-free.</p>	<p>An evaluation of the packages is time consuming and costly.</p> <p>Often the software is not as efficient as custom or modified software.</p> <p>No in-house expertise is available for solving software problems.</p> <p>The developer may go out of business or fail to maintain and update the package.</p>
<p>Updates are inexpensive.</p> <p>Highly specialized packages are difficult or expensive to duplicate.</p> <p>Better user documentation is provided.</p>	

Figure 5-1. Advantage and Disadvantage of Buying Application Software.

5.2 Application Software Design

The organization needs to determine the specifications of the programs to be purchased and should select a vendor with a proven track record. The application software, which is designed for the power plant, should support a strategic and fully integrated solution. The suitable software must at least support all basic business function requirements, should be flexible, scaleable, has ability to transport applications from one technology platform to another, and should perform the functions automatically as much as possible to reduce the overall operational efforts. In addition, it should provide advanced functions and features in order to provide accurate and timely information or answer the ad-hoc management queries to the management group for effective decision making.

The software can be approached by the following:

- 1) Customized system
- 2) Various software packages
- 3) One integrated software package.

The appropriately selected software provides abundant functionality and flexibility to support business needs in future. The fully on-line integrated system allows crosschecking and sharing of data among these applications to speed up the overall process and ensures the accuracy and availability of information. The system should be designed to ensure that the users are able to learn and use the system easily.

Following the main conditions of the MIS systems are formulated:

- 1) Data should be available for everyone who has authorization for retrieving.
- 2) Data and applications must be opened for future changes of work organization.
- 3) The different module must be as much compatible as possible.

To meet the above goals in obtaining of application software, the following major actions have been taken:

1) Establish a high performance and redundant communication backbone, which it is mostly of optical fiber [7].

2) Procure such proven applications that do not require considerable customer specific development, i.e. use vendor standard products, which are applicable to business targets and MIS strategy.

3) Have as few vendors as possible

4) Define key application functions and modules to support all of the possible business operations

5.3 Software Selection

In 1993, EGAT defined to use automation equipment to retrieve the update and accurate operating information of Operation management, Maintenance management and Supplies management for EGAT's power plants. EGAT bought a software package. The software is provided by an Australian company, with significant experience in operations, maintenance and supplies software. EGAT established a project to implement this software package to the organization. The missions of this implementation are as follows:

1) Implementation of the Management Information System (MIS) software which consist of operation management, maintenance management, and Supplies management.

2) Installation of computer hardware, Local Area Network (LAN), and Wide Area Network (WAN)

3) Introducing end-users to operation management, maintenance management, and Supplies management functions, which they will change the recent operational processes.

EGAT's implementation team implemented this application software at several thermal power plants and all hydro power plants in Thailand. According to the experience, the chosen application software will be able to support basic business function requirements. The system architecture is an "open" platform, which means that the power plant should be less tied to one vendor's products. The open platform will allow technologies from different vendors fit together to perform the required functions. The modules that make up the MIS are shown in Figure 5-2 [5].

Finally, the software selection for Wang Noi Power Plant should be the application software that is implemented at EGAT's power plants because of the following reasons.

1) The software can support Plant Operations management, Plant Maintenance, Supplies management, Financial Accounting and Human Resource management.

2) The system architecture is an "open" platform. The power plant can implement modules for Plant Operations management, Plant Maintenance management, Supplies management, and Financial without application software cost.

3) EGAT's implementation team has enough experience and resources to implement the software.

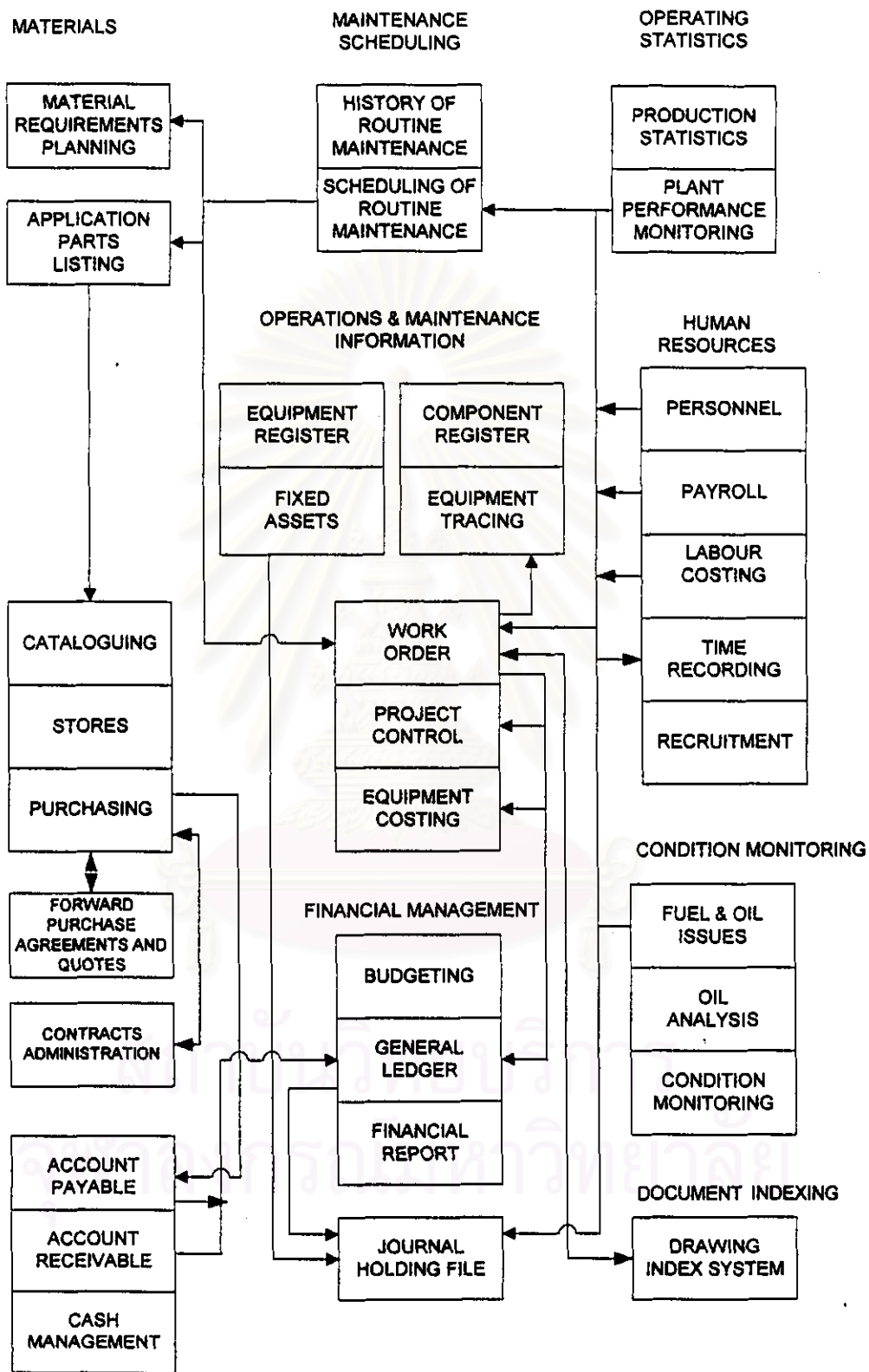


Figure 5 -2. Overview of MIS Subsystems

5.4 Modules Implementation

According to the analysis of the power plant information requirement in Chapter 4, the available MIS application software in EGAT and widely used in the market is considered to fit the requirements. The following sub-sections describe the detail of modules that support the requirements.

5.4.1 Plant Operation and Maintenance Management System (MMS) [5]

The Plant Operation and Maintenance management software package provides automated plant operation and maintenance management processes, covering plant maintenance, facilities management, work design, work management and performance analysis. It provides accurate and timely equipment and technical plant information, preventive maintenance, maintenance management as well as work management and reporting. Modules in the package are summarized as follow:

5.4.1.1 Equipment Register

The Equipment Register module is the primary means of identifying equipment in the power plant. It identifies and describes of equipment and component. The Register must suit the overall the power plant organization. It should be set up and designed to capture the data necessary for operational use.

5.4.1.2 Maintenance Scheduling Information

Maintenance Scheduling module produces periodic lists of all recurring maintenance tasks (preventive maintenance) to be performed by individual work groups. History of recurring maintenance is linked to work order of corrective maintenance to provide for comprehensive review of all activities. With this module, the maintenance

planning can be changed from manual preventive maintenance and outage planning work to an automatic work by the system automation. This module is supported by extensive maintenance reports to assist maintenance managers in controlling and budgeting the total maintenance function.

5.4.1.3 Work Orders

The Work Order module is used for recording the circumstances and costs associated with specific works or maintenance jobs, providing powerful recording, reporting and analysis tools. The operators can create the on-line work request, on-line tracking requested works and cancel paper work request. This assists the maintenance staff to have good history records and automatically collect the costs of individual work orders.

5.4.1.4 Equipment Tracing

Any component entered on the Equipment register can be traced throughout its life cycle of purchase, install, remove and rebuild, providing a complete life history of each equipment and its current location.

5.4.1.5 Condition Monitoring

Condition Monitoring module provides for the recording of machine condition measurements to monitor performance and to trigger condition based scheduling and maintenance.

5.4.1.6 Production and Operating Statistics

The Production and Operating Statistics module provides a tool where both the statistics held, and the modeling process to calculate them, are completely user-definable for recording plants' events. It can define codes and formula for recording downtime, reporting of availability/utilization and daily statistics. This module can also generate hire charges, based on usage statistics, to both internal and external and equipment users.

5.4.1.7 Equipment Costing

Equipment Costing combines work order costs related to an equipment item with costs which have been charged directly to that item. Then it can show a comprehensive cost picture for each individual piece of equipment.

5.4.1.8 Labor Costing

The Labor Costing module allows wage and/or staff payroll to be costed to general ledger accounts, work orders, projects.

5.4.1.9 Project Control

This module enables expenditure on major operational and capital projects to be controlled independently of the normal organizational reporting hierarchy. Project Control allows projects to be defined and split into any level of sub-project. Actual costs, outstanding purchase orders and budget amounts are automatically accumulated up the project hierarchy.

5.4.1.10 Fuel and Oil Issues

This module records the issues of fuel and lubricating oil to items of equipment and allows this important element of costs to be monitored.

5.4.2 Supplies System [5]

The Supplies management software package provides automated material management processes, covering material requirement planning, purchasing, inventory, and warehouse management. This package contains the following modules:

5.4.2.1 Catalogue Records

This module provides for disciplined identification and description of individual items of material used by the plant. Each item is identified by a unique stock code.

5.4.2.2 Inventory and Warehouse Management

The Inventory and Warehouse management module provides for the accounting and control of all items held as inventory. The main function areas supported include:

- 1) Receipt of items into inventory
- 2) Controlled issue of material and maintenance of the quantities and locations of stock on hand.
- 3) Cyclical or periodical stock audits.
- 4) Provision of detailed and summarized information for the management, control and analysis of inventory.

5.4.2.3 Purchasing

The Purchasing module provides for the ordering of all material, both catalogued and direct charge order, with a minimum of clerical intervention. Inventory controllers and purchasing staff may selectively define items they wish to review before ordering, allowing automatic provisioning of items, which do not require special attention.

5.4.2.4 Inventory Tracking

The Inventory Tracking module provides for visibility of items while they are in inventory and they were acquitted by the users. These facilities also provide a complete history of movements of any selected items.

5.4.2.5 Forward Purchase Agreements

This module supports the negotiation of contracts for future purchase of material. An acceptance of price level is kept on file, then a purchasing on negotiation based on usage shall be conducted rather than a single order volume. This can make purchaser have lower prices and eliminate inventory proceeding.

5.4.3 Financial Management system (FMS) [5]

Financial software package provides automated financial management processes, covering general ledger, account payable, account receivable, cash management, budgeting, fixed asset management, and financial reporting. Such financial information significantly supports the strategic and annual planning, general accounting and reporting/ control activities.

5.4.3.1 General Ledger

The General Ledger is the module, which draws together all financial and operational data. On-line facilities are provided, which allow managers and accountants to access current results together with comparison to budget.

5.4.3.2 Account Payable

Account Payable module provides for the recording and payment of monies owing to creditors. Where applicable, invoices relating to orders are automatically matched to the purchase order details to ensure the receipt of goods or services prior to making payment to vendors. Facilities are provided to allow effective management of cash flow, including the capability to take advantage of settlement discounts.

5.4.3.3 Account Receivable

The Account Receivable module provides for the recording and receipt of monies owned by debtors. Invoices with either cash or credit terms and receipt can be created then printed online.

5.4.3.4 Fixed Asset

The Fixed Assets module records and controls fixed assets whether owned or leased and calculates depreciation for book, tax and other accounting purposes.

5.4.3.5 Cash management

An accurate expectation of cash in and cash out in a certain period, daily, weekly or monthly is very important for an organization to run the business. This module,

linking with Account Payable and Account Receivable modules, assists management in effective manage cash flow and get prompt cash flow reports.

5.4.3.6 Budgeting

The Budgeting module provides for the control budget and actual costs within an operating unit.

5.4.3.7 Financial reports

This module creates reports of each individual point of view according to management's requirements. These reports are used to analyze for controlling work processes and improving weak points. The module finally provides 'Balance Sheet' and 'Profit and Loss' reports.

5.4.4 Human Resource Management System (HRMS) [5]

HRMS package provides information of individually personal qualification, historically personal detail, salaries and wages, and other activities including recruitment, hiring, training, assignment, compensation, evaluation and discharging employees. This system enables management to get more effective resource planning and decision. Additional advantage from this package is providing employees with easy access to personnel information at their allowable levels through various operational areas of the organization. The modules are as follows:

5.4.4.1 Personnel

This module is used to support the management of human resources within the organization. The employee database, together with the position control file and the

applicant files for each position, form the organization's human resource database. The employee database includes the following data about each employee.

- 1) Prior educational and employment background
- 2) Current job grade, title, department, and supervisor
- 3) Current level of compensation and benefits
- 4) Training programs completed
- 5) Time and attendance
- 6) Output, productivity, and performance measures
- 7) Special skills and abilities
- 8) Payroll history
- 9) Performance appraisals
- 10) Job history within the organization

5.4.4.2 Time Recording

This module manages and evaluates the information of personal working time from time sheet and also monitors staff utilization. Recording of time spent on specific tasks and entry of this into the payroll and costing system.

5.4.4.3 Payroll

The Payroll module takes data from time sheet and Leave, then it calculates the employee's gross pay. After the employee's gross pay is determined, payroll deductions probably tax and others, finally net are computed.

5.4.4.4 Recruitment

This module provides information, which manages the recruitment of staff, both from within the existing employee base as well as from external sources. It keeps track of the stages through which applicants are appointed, and the arrangement of those applicants who are not appointed, e.g. are eliminated at the second interview. Finally, information of applicants who become employees and their contracts signed with the organization are recorded.

5.4.4.5 Training

The Training module uses the resourcing information held by employees and provides information about their needs for future training. Managers, trainers and supervisors are able to plan training courses and sessions, and to nominate staff for courses and sessions.

5.5 Hardware Design

After selection of the application software, the selection of hardware, computer system, shall be either one of the following two possibilities.

5.5.1 Client/server environment [7]

Client/Server architecture is a mature and proven technology enabling the organization to distribute functions and messages across the network. It means functions and messages can be called up and transferred across the network. Figure 5-3 shows Client/Server model.

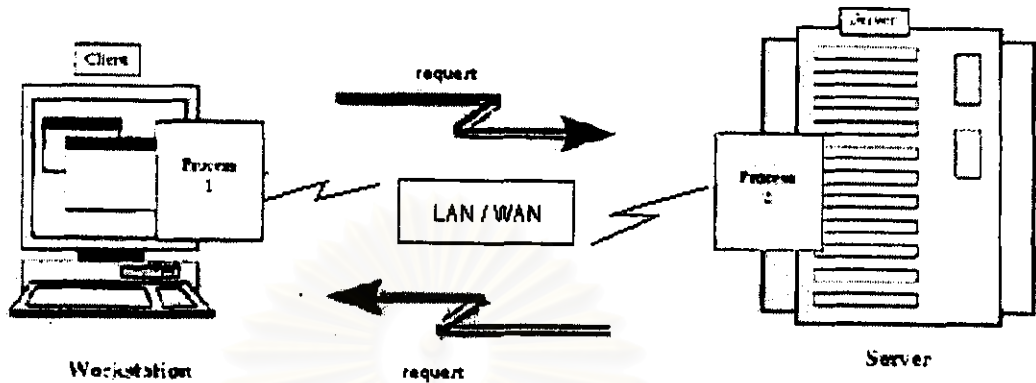


Figure 5-3. Client/Server model

5.5.2 Mainframe environment [7]

The mainframe (host) computer system is typically used as the center of corporate database systems and as a computing tools where high speed and volume are characteristic of the applications.

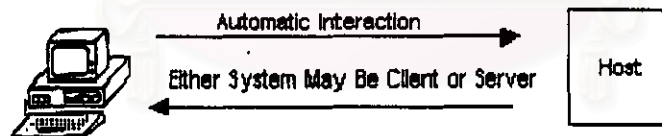


Figure 5-4. Micro-Mainframe Transparent Service

5.5.3 Protocol [7]

The network software that is required to support data communication, is a formal set of conventions governing the format and relative timing of message exchange in communication network. Many protocols deal with maintaining the integrity of data when

on the network. It is true that different kinds of networks provide different challenges when transferring data, therefore selection of protocol should consider the one, which complies with the most current use in existing networks.

EGAT currently uses a centralized system, Mainframe or Host computer system, "IBM 9672/RC4", for the data processing of power plants that have implemented Operations management, Maintenance management, and Supplies management and Financial modules. Data and application software are installed on the mainframe while the communication path between mainframe and power plant is a network that belongs to outsourcers.

In this case the Information Technology division (IT division), a division in EGAT, acts as outsourcer for every power plant. It has duties of doing maintenance application software, daily data backup, data security, that means protection against unauthorized log-in and accessing protected files on the mainframe.

The study showed, that the typical payment for outsourcer, IT division, is a set fee per month and an additional fee based on the number of item processes are reasonable and stabilized, rather than buying hardware at bulk price and splitting development and maintenance costs between projects and operating at higher volumes.

Finally, the selected hardware that is suitable for the power plant shall be mainframe computers since the existing system of EGAT as explained above has cost effective and highest quality service. This enables the power plant management to focus on their core business.

5.6 Design of Computer Network and Communication

To design the network components for linking between the power plant and mainframe computer at EGAT's head office that necessarily supports the MIS implementation, one must primarily determine the base network, make a list of the existing equipment for finding out additionally necessary items and choose a proper protocol.

Figure 5-5 shows EGAT's computer network. As above section 5.5, "Computer System", an IBM mainframe computer is selected as hardware. It has a computer network 16 Mbps Token Ring backbone and connects to local and regional offices by the following communication paths:

- 1) Via telephone line
- 2) Via lease line
- 3) Via microwave
- 4) Via LAN-to-LAN connection using Router concentrator or hub

The base network thus is derived from this configuration and existing (LANs) in the power plant. Presently it has been providing enough personal computers (PC) for all users and all PCs are connected to LANs. After investigating, the power plant needs to add up only a server with "screen presentation" application software. This application will assist to reduce the communication traffic between mainframe computer and PCs in the power plant since there is only one communication channel provided.

With completion of the MIS implementation, the PCs which right now are connecting to LANs will become to be workstations of MIS.

The protocol "Transport Control Protocol/Internet Protocol (TCP/IP) is well known and widely used, particularly IBM uses this protocol as well. TCP/IP is then selected.

In conclusion, computer network and communication are:

- 1) The Ethernet backbone LAN network
- 2) Server with the NT LANs operating system
- 3) TCP/IP communications protocol between different computer platforms
- 4) Bridges and routers linking LANs

The MIS proposed network configuration for the power plant is shown in Figure 5-6. The hardware, peripheral, and network requirement that will be required to support MIS users are as follows:

Specifications of screen presentation server:

1 x Pentium processor with 256 MB Ram

1 x Ultra Wide SCSI controller

3 x 9 GB Ultra Wide SCSI harddisk

1 x 10/100 network card, CD ROM Drive, and Optical Drive

Prerequisite Software:

Microsoft Windows NT Server v4, Enterprise edition, with service pack 3 & 4 patches

Oracle 8.0.3

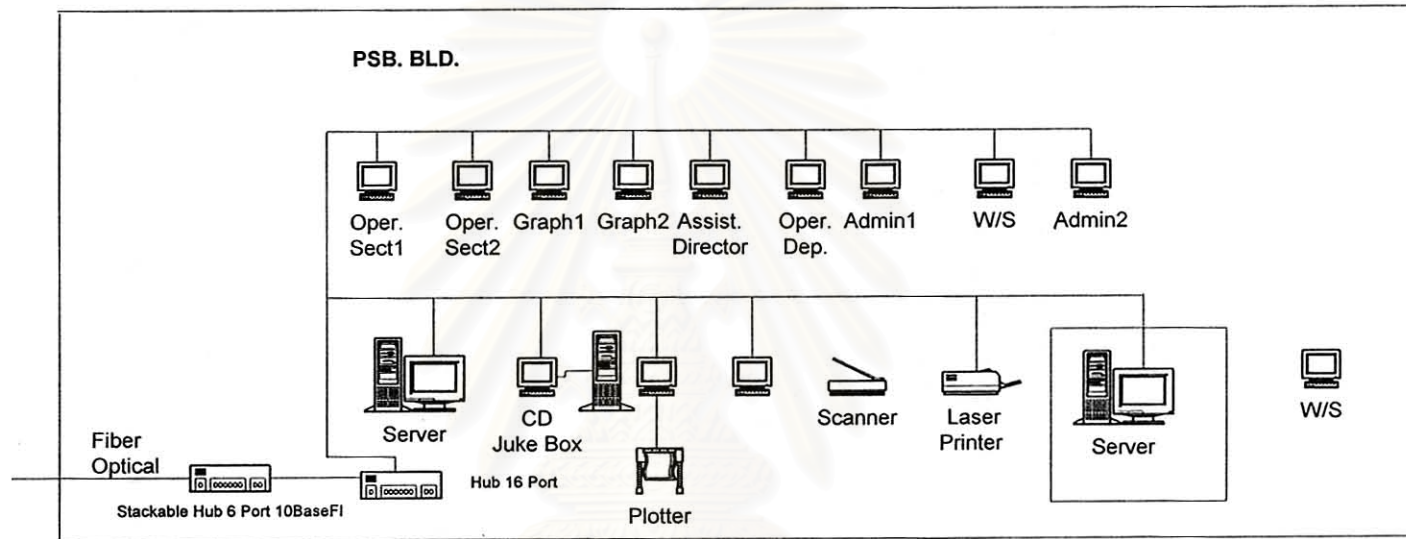


Figure 5-6. The new hardware, peripheral, and network requirement.