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Supplement to
TECHNICAL REPORT NO. 11

CLIS
CRIMINALISTICS LABORATORY INFORMATION SYSTEM

VOLUME 3
SYSTEM AND ORGANIZATIONAL IMPACT

SEARCH GROUP Inc.
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CRIMINALISTICS LABORATORY INFORMATION SYSTEM

VOLUME 3
SYSTEM AND ORGANIZATIONAL IMPACT

Final report on work performed under Law Enforcement Assistance Administration Grant No. 73-SS-99-3309, awarded to the California Crime Technological Research Foundation for Project SEARCH. In 1974, Project SEARCH was incorporated as SEARCH Group, Inc., and the project was continued to completion under its guidance.

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GLOSSARY

DATA PROCESSING TERMS

baud Number of bits transmitted per second. (It usually requires eight bits to transmit one character.)

byte That portion of a computer word capable of containing a single character. Used synonymously with "character" in this report.

CPU Central processing unit. A computer without its data storage and other peripherals.

CRT Cathode ray tube.

hardwired Accomplished by electronics rather than programming.

I/O Input and output.

modem Device which connects a terminal or computer to a telephone line.

peripheral Device with which a computer stores data or communicates with the outside world, such as a disk drive, card reader, or teletypewriter.

INSTITUTIONAL ABBREVIATIONS

ASTM American Society for Testing and Materials (Philadelphia, Pennsylvania).

FCIC Florida Crime Information Center (Tallahassee, Florida).

HOCRE Home Office Central Research Establishment (Aldermaston, United Kingdom).

WRAIR Walter Reed Army Institute for Research (Washington, D.C.)

GEOGRAPHIC ABBREVIATIONS

NE = NEW ENGLAND
- Connecticut
- Maine
- Massachusetts
- New Hampshire
- Rhode Island
- Vermont

MA = MIDDLE ATLANTIC
- New Jersey
- New York
- Pennsylvania

ENC = EAST NORTH CENTRAL
- Illinois
- Indiana
- Michigan
- Ohio
- Wisconsin

WNC = WEST NORTH CENTRAL
- Iowa
- Kansas
- Minnesota
- Missouri
- Nebraska
- North Dakota
- South Dakota

SA = SOUTH ATLANTIC
- Delaware
- District of Columbia
- Florida
- Georgia
- Maryland
- North Carolina
- South Carolina
- Virginia
- West Virginia

ESC = EAST SOUTH CENTRAL
- Alabama
- Kentucky
- Mississippi
- Tennessee

WSC = WEST SOUTH CENTRAL
- Arkansas
- Louisiana
- Oklahoma
- Texas

M = MOUNTAIN
- Arizona
- Colorado
- Idaho
- Montana
- Nevada
- New Mexico
- Utah
- Wyoming

P = PACIFIC
- Alaska
- California
- Hawaii
- Oregon
- Washington

PR = PUERTO RICO

PREFACE

The model for a criminalistics laboratory information system described in this report was developed by Project SEARCH (now SEARCH Group, Inc.) as part of its ongoing program of facilitating the application of advanced technology to the administration of criminal justice. The project, funded by the Law Enforcement Assistance Administration, addressed itself to three topics:

- definition of the information needs of criminalistics laboratories throughout the nation
- conceptual design of an automated information storage and retrieval system
- creation of a plan for implementing the system

Future efforts will include the detailed design, implementation, and evaluation of a pilot system and, eventually, full system implementation.

SEARCH Group, Inc. (Project SEARCH) is a private, non-profit justice research organization owned and operated by the fifty states, the District of Columbia, Puerto Rico, and the Virgin Islands, which fosters research of greater magnitude than can normally be undertaken by individual states.

Thomas M. Muller served as CLIS Project Chairman and Fred Wynbrandt as Vice-Chairman. Subcommittee Chairmen were Edward Bigler, Richard Fox, and Frank Madrazo. Administrative staff services for the project were provided by the California Crime Technological Research Foundation; technical support was provided under contract by PRC Public Management Services, Inc.

Four volumes providing detailed information about specific aspects of the project are being published.

- Volume 1 — *Identification of User Needs*
- Volume 2 — *Systems Design For a Conceptual Model*
- Volume 3 — *System and Organizational Impact*
- Volume 4 — *Implementation Plan*

Copies of these volumes are available from SEARCH Group, Inc.

CHAPTER 1. SCOPE OF VOLUME 3

INTRODUCTION

The purpose of Volume 3 is to develop a cost comparison and analysis for the various alternative CLIS configurations.

The costs discussed in this volume are those that will be required to keep the eventual system running, *not* programming and other costs required to get the system running in the first place. Implementation costs will be dealt with in Volume 4.

In Volume 1 the needs of the laboratories that CLIS would support were identified and a set of prioritized requirements were developed based upon in-depth interviews with, and questionnaire responses from, the potential user population. Volume 2 described a conceptual design of each application area and summarized the basic functions which the CLIS must be capable of performing in order to support these application areas. Volume 3 will provide cost information so that the feasibility of CLIS might be evaluated in a more quantitative manner.

Chapter 5 of Volume 2 defined several system configurations that would satisfy the CLIS requirements as summarized in Chapter 4. Five system functions were identified as being the major functional components of CLIS. The distribution of these major functions was arranged and rearranged in order to present various design alternatives along with a list of functional and administrative advantages and disadvantages for each alternative. Volume 3 will provide design detail and cost analysis for the four hardware components of the system: User Terminals, Communications Network, Computer Processing and Data Storage. This information will be presented in Chapter 2 of this volume.

It is expected that there will be several ways to implement each of these four hardware components, all with dissimilar cost factors. In Chapter 3, the design alternatives presented in Volume 2 will be evaluated: user independent, centralized, distributed processor, distributed communications, distributed processor hierarchical, and centralized hierarchical configurations will be evaluated in terms of the listed advantages, disadvantages and cost factors. The most economical and functional configuration will be developed for each design alternative.

Chapter 4 of this volume will identify a recommended CLIS configuration. First, the overall CLIS requirements will be reviewed in order to ensure that the selected configuration will meet these requirements. The most favorable cost alternatives will be summed and matched in such a way as to obtain maximum system capability within feasible cost criteria. This will provide the necessary means with which the selection of the proper configuration will be made. Advantages and disadvantages will be discussed. In summation, this chapter will identify the PRC/PMS recommended configuration.

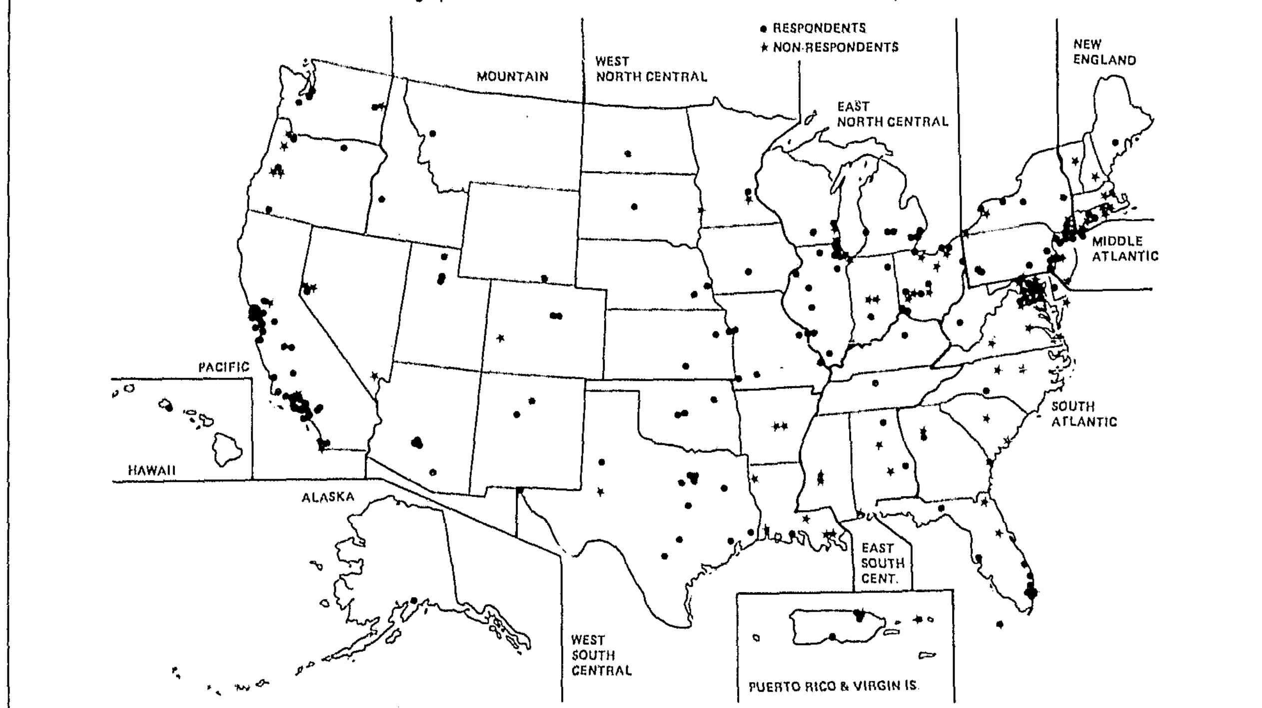
A glossary explaining some of the terms used is appended to this volume.

SYSTEM USAGE CRITERIA

In Volume 2, we defined a conceptual design for each application area and estimated the processing, data storage and communication requirements. The primary reason that these requirements are just an estimate is that the user population of the system has not yet been defined in final terms. While this makes it difficult to estimate user transaction volume, it is even more difficult to define a communications network due to this lack of detailed knowledge of the geographic locations of eventual CLIS users. It will be the communications network that will be the most pervasive aspect of CLIS, and therefore one of the most important.

As a way around this problem, a gross assumption has been made that all respondents to our questionnaire are potential CLIS users and will employ CLIS capabilities at some time during the life of the system. Although there are a few large municipal laboratories that have not responded and who would most certainly be considered potential CLIS users, their inclusion would be offset by a number of laboratories that for a variety of reasons could not or would not become users. Figure 1 identifies the geographical location of each responding laboratory. Anticipated CLIS transaction volume has been estimated for analysis of responses to questions 6 and 7 of the CLIS information form.

Figure 1
Geographic Distribution of Laboratories Included in CLIS Survey



COSTING CRITERIA

One cannot go out and buy a criminalistics information system as an existing package. Most computer vendors supply "system" software-operating systems, language compilers, sort/merge utilities and the like; but their offerings of programs for specific applications are generally very limited and require extensive modification to suit the specific needs of individual users. System implementation, to be treated in Volume 4, will include applications programming which must be done by individuals well versed in criminalistic applications. Such services are available from firms which will contract to specify hardware and provide software which will make that hardware do a specific job. References to "software" or "programming" in this volume refer to the manufacturers' system software only.

Of the four system components under consideration, two are relatively independent — the processor (computer) and the network. Each of the other two components, terminals and data storage, depends on one of these. The data storage devices will be determined in large measure by the processor selected, and the types of terminals to be used will be greatly influenced by the network to be employed.

Some aspects of the costing of system components are obvious, while others are more obscure. The purchase prices for pieces of hardware and the monthly cost of leased or rented hardware or services are among the obvious criteria. Less apparent are hidden costs such as the price one pays for buying inferior services or hardware or even good hardware that is supplied with inferior system software. The penalty here is in terms of the time and manpower required for a more difficult implementation process. Sometimes a decision has to be made between paying a premium in order to deal with a company of known stability, a good service record, and with familiarity with the type of application being implemented versus foregoing these reassurances in order to obtain a bargain price. Three aspects of costing discussed below are categorized as dollar costs, performance considerations (hardware and software), and vendor criteria.

Dollar Costs

Whether equipment is to be purchased, leased, or rented depends upon the vendor's policy and buyer's desire for flexibility; leased equipment can usually be upgraded or reconfigured more economically than purchased hardware. Lease situations may involve a one-time charge in addition to the by-the-month cost.

Hardware Considerations

Besides speeds and capacities and other such measurables, an important consideration is the "state of the art" or up-to-dateness of the equipment. In this case an ideal balance must be struck between devices which are so new as to be unproven, and those that are so well proven as to be obsolete.

Software Considerations

Processors, intelligent terminals and network services all involve manufacturer-supplied software. Sometimes other types of terminals and data storage devices are provided with "driver" programs. The utility of these kinds of software for CLIS applications will undoubtedly vary.

Vendor Criteria

Company size, the number of working installations of the equipment or service under consideration, and the vendor's experience with applications similar to CLIS are factors pertinent to the selection of a system component as are the locations of the vendor's corporate, technical and sales and service offices. However, these factors cannot be evaluated until the geographic constituency of CLIS is known.

CHAPTER 2. COST BREAKDOWN OF MAJOR SYSTEM COMPONENTS

User Terminals

Equipment selected to be located in a CLIS user's laboratory could be one of the following three types. There is no sharp distinction between the types; rather, they represent points in a continuous range of complexity:

Basic Terminal. A Basic Terminal is a simple keyboard/printer, such as a Teletype or a Keyboard/CRT with a printer. With this type of terminal every character sent from the terminal to the computer or from the computer to the terminal is communicated separately.

Intelligent Terminal. An intelligent terminal is one that can be programmed to perform certain functions that would otherwise require the services of a computer. It may also be in the form of a keyboard/printer or a Cathode Ray Tube (CRT). In addition to the basic terminal capability, it will include a stored-program device which may consist of anything between a simple hardwired controller to a medium-sized computer. The intelligent functions performed may include formatting, simple or complex editing, and the collection of information so that it can be sent over the communications network in greater-than-single-character quantities (packeting).

Local Processor. This is a computer system residing in the user's laboratory. In addition to formatting and editing, it is capable of a great deal of computation and data base interaction on its own. It may or may not be connected to a central computer for large application requirements.

Typical costs for each of these types are discussed below. It is not necessary that identical equipment be located in all laboratories. It is desirable, however, that all equipment selected have the same interface with a central processor. This would greatly simplify the communications programming.

Vendor Criteria. Characteristics for evaluating the manufacturer who supplies the terminal are important because users require many manufacturer services. Consideration should be given to these factors:

- Manufacturer's reputation concerning delivery schedules, service promptness, and training.
- Distance of terminal site from manufacturer or service center; since a national network of terminals is being proposed, the selected vendor should have a national service network.
- Quality of hardware and system software documentation.
- Number of systems delivered.

For the most part, the terminals selected for the examples below are believed to adequately meet these criteria.

Basic Terminals. The major categories and subcategories are these:

- Keyboard Printers (K/Ps)
- Alphanumeric CRT Terminals.

Table 1 is a comparison of selected basic terminals. The information was gleaned from these sources:

- *Auerbach Computer Technology Reports* for Data Communications Terminals;
- "Fast Interactive Hardcopy Terminals"; *Datamation,* October 1973;
- "Alphanumeric Display Terminal Survey"; *Datamation,* November 1973.

Compatibility indicates which of the industry standard devices (ASR 33 Teletype or IBM 2741) can be directly replaced by this device without modification.

The major advantages of Teletype-speed keyboard-printers are price, dependability, and compatibility with a wide variety of computers and communications equipment. The arguments in favor of faster keyboard printers involve communication line costs; the job can be done and off the line quicker. They also involve user time and convenience; the terminal operator is too expensive a piece of the system to be allowed to be idle while waiting for a line to be printed.

Following are the advantages of CRT displays over keyboard/printers:

- *Speed.* CRT's can operate at electronic rather

Table 1
Characteristics and Prices of Selected
Basic Terminals

Manufacturer	Datapoint Corp.	General Electric Data Communications Prods.	Hazeltine Corp.	IBM	Teletype Corp.	
Model	3300	Terminet 1200	1000	2741	33 ASR	35 ASR
Compatibility	Teletype 33	Teletype 33	Teletype 33	2741	Teletype 33	Teletype 33
Type	CRT	Fast K/P	CRT	Slow K/P	Slow K/P	Slow K/P
Price: Purchase	To $3200	(1)	$1800	$3900-7000	$850-1000	$3000-3500
Monthly Maintenance	$15	$15	$10	$25-35	(2)	(2)
Monthly Cost of One-Year Lease	$50-95	$180-300	$49	$100-180	(3)	(3)

Notes:
(1) General Electric terminals are available only as a part of their commercial network service.
(2) Not available from Teletype, but widely available from independent contractors.
(3) Available on purchase basis only, but same equipment is provided on rental basis as part of many common-carrier switched services and multistation leased systems.

than mechanical speeds.

- *Silence.* The only sounds produced by CRT's are those produced by the operator at the keyboard and perhaps a faint hum from the electronics.
- *Data Entry Convenience.* Instructions or special forms can be displayed to aid the operator in performing his task without having to retype standard or semistandard information.
- *Error Control.* Immediate data display and interaction between the computer and the terminal greatly simplify and improve error detection and correction. Since data is not permanently recorded on the CRT screen, it can be changed easily. Normal operating experience indicates that 90 percent of keyed errors are sensed by the operator and can be corrected immediately after key depression. Computer control, in many cases, can detect data input errors as they are being recorded; consequently, the complexity of error detection and correction is greatly reduced, and the resulting time lag is minimized, if not totally eliminated.
- *Paper Reduction.* Computer users are sometimes in danger of being snowed under by piles of printout. Information displayed on CRT's, being ephemeral in nature, does not contribute to the paper blizzard.

CRT terminals with graphics capabilities are not considered here. Their utility is thought to be marginal, and they could not be implemented without considerable aditional expense, not only for the terminals themselves, but also for increased communications, data storage and processing requirements. Their major use would be for the reproduction of actual spectra which would not be possible without adding detail, and therefore size, to the proposed files.

Intelligent Terminals. A selection of currently available intelligent terminals is listed in Table 2. The minimum requirement for intelligence is that information be sent to the computer in greater-than-single-character quantities. Additional intelligent functions are those of basic text-handling, such as horizontal tab, insert/delete character or line, and transmit-data-only functions, or those of on-line operation, such as data entry, data editing, and field definition. Some terminals have special functions, such as automatic answering, polling and cursor-moved and/or read by Central Processing Units (CPU); and a few have very intelligent functions like user-programmable fields, advanced text editing, and validity and range-checking. The authority for the prices and characteristics of these terminals is an article, "Alphanumeric Display Terminal Survey," in the November 1973 issue of *Datamation.* Compatibility is expressed in terms of interchangeability with the "industry standard" devices — ASR 333 Teletype, IBM 2260, or IBM 3270.

Some of the advantages of an intelligent terminal system over a hardwired terminal are:

Table 2
Characteristics and Prices of
Selected Intelligent Terminals

Manufacturer	Data 100 Corp	Datapoint Corp.	Hazeltine Corp.	IBM		Sanders Data Systems, Inc.	Sycor, Inc.
Model	73	2200	2000	2260	3270	804/810	250
Compatability	Teletype 33	Teletype 33	Teletype 33	2260	3270	IBM 2260,3270	IBM 3270
Basic Text Handling	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Off-Line Functions	Yes	Yes	Yes	No	No	Yes	Yes
Special Functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Very Intelligent Functions	No	Yes	Yes	No	Yes	Yes	Yes
Price:Purchase	$3500-3800	$6000-13,000	$3000	$15000	$4000-7600	$6100-9900	$4300-4800
Monthly Maintenance	$22	$30	$20	$73	N/A	$29	$24
Monthly Cost of One-Year Lease	$105-115	$170-360	$88	$370	$150-300	$200-290	$98-110
Number Installed November 1973	800	2000	7000	N/A	N/A	800	10

- Fast response — Some data and data-entry formats can be stored locally to avoid constantly accessing the central computer. Storage capability can be quite large if a local disk file is used.
- Compatibility with a variety of central computers — If a future change is planned or multiple communications (to different types of CPU's) are required, intelligent terminal systems can provide the required flexibility.
- Multiple tasks — If at different times the terminal must be a data entry unit and an inquiry response unit, then the stored program capabilities and the ability of the intelligent terminal to operate off-line make it a logical choice.
- Editing — Data editing can be handled without the use of the CPU through the CRT-oriented terminal. With sufficient memory storage, paragraphs and pages can be edited and rearranged.
- Local processing — Many applications require only a small amount of processing. The intelligent terminal can use its processor rather than sending data to the CPU.
- Preprocessing/data reduction — Communications costs are a significant part of any system. Thus, reducing the amount of data sent reduces cost. In addition, CPU throughput can often be increased through data reduction by lowering the number of Input/Output Devices (I/O) to be serviced. In addition, data can be verified and edited before transmission in order to eliminate erroneous data at the source and free the CPU from these tasks.

Local Processors. This type of terminal is really a small computer system located in the user laboratory. It would consist of a small central processor, a small data storage device, and a connection via the network to the main centralized or distributed CLIS processor or processors. The following sample costs have been selected from the nearly 300 makes and models of general-purpose minicomputers presently available. Each system was configured with a central processing unit — 16,000 words of memory and 128,000 words of fixed-head disk storage (and disk controller). Two cases are noted where the smallest available fixed-head disk is larger than 128,000 words. Price authority was the *Auerbach Computer Technology Reports for Minicomputers.*

	Monthly Rental	Purchase Price	Monthly Maintenance
Data General Nova 840		$17,000	$130
Novadisc Drive		8,000	70
TOTAL	N/A	$25,000	$200
Digital Equipment Corporation PDP 11/20		$21,000	$180
RS64/RS64-A Fixed-head Disks		11,000	50
TOTAL	N/A	$32,000	$230
General Automation SPC 16/45		$12,000	$130
3342-1043 Head-per-Track Disc Drive		8,000	60
TOTAL	N/A	$20,000	$190
Hewlett-Packard 2100S		$16,000	
Disc File Subsystem (11,800,000 words)		28,000	
TOTAL	N/A	$44,000	N/A
Honeywell System 700	$820	$29,000	$150
4511 Fixed-Word Disk	480	16,000	55
TOTAL	$1,300	$45,000	$200
Modular Computer MODCOMPII/20		$10,000	
4102 Fixed-head Disk		13,000	
TOTAL	N/A	$23,000	N/A
Varian Data 620/L		$13,000	
620-38-C Disc Storage		10,000	
TOTAL	N/A	$23,000	N/A
Xerox 530	$1,100	$30,000	$210
7202 Rapid Access Data Storage Unit (300,000 words)	400	21,000	130
TOTAL	$1,500	$51,000	$340

The following would be advantages of having local processors located in the laboratories:

- Stand-alone capability — could operate without being controlled by an external agency.
- Ability to better serve high-volume users.
- Acquisition and reduction of data directly from instruments.
- Ability to handle some applications without accessing the main processor.
- Could support clusters of subterminals in larger laboratories.
- Would allow laboratories to do non-CLIS computing as desired.

COMMUNICATIONS NETWORK

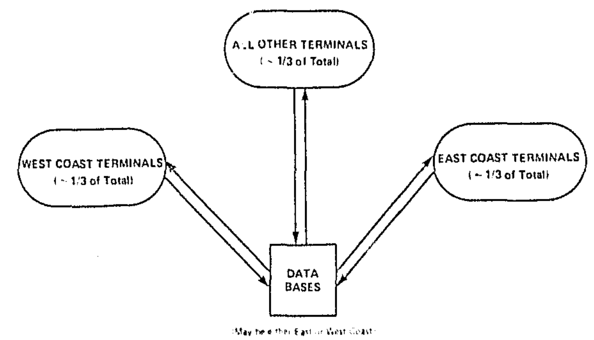
The primary function of the CLIS Communications Network (herein referred to as "net") is to provide for the transmission of information from the data bases to the user laboratories and vice versa. As indicated in the system usage criteria, some assumptions have been made in identifying the users of the system; i.e., the respondents to the CLIS information survey. Considering that responses have not been received from several large laboratories and that the usage rates of large laboratories will demand that more than one terminal be installed, we can consider that there will eventually be approximately 200 terminals on the operational CLIS. The geographic location of these terminals is indicated in Figure 1.

At the other end of the net are the data bases. These data bases may be located in a central processor complex or in distributed function processor complexes. Each terminal must have access to every data base, and the heaviest concentrations of terminals are on the east and west coasts. This indicates that the net topology is somewhat independent of the

location of the data bases as long as the data bases are either on the east or west coast. Location on the east coast would mean somewhere on the New York/Washington base line. Location on the west coast would mean somewhere on the San Francisco/Los Angeles base line.

Therefore, the net can be topologically simplified to include centralized data bases and three approximately equal groups of terminals: a group of local terminals within a radius of 300 miles; a group of remote terminals in a 300-mile radius at a distance of 2,500 miles; and a group of terminals scattered in between. Figure 2 indicates this approximate geographic locations of data bases and terminals. Note that it is not necessary to have each terminal connect to other terminals.

Figure 2
Simplified Network Topology



The net must connect all terminals with the processor(s) that control data base activity. This means that the net connections will consider modem-to-modem transmission. Terminals and processor transmission control units and various line adapters were not considered. Message concentrators and switchers and any other hardware devices (with associated software, if applicable) were considered.

The composite system requirements developed in Chapter 4 of Volume 2 indicate an average communication load of 6.4 million characters per day. This is a daily average based upon the working hours of most laboratories, first shift and perhaps the first half of the second shift. An hourly average would be about 500,000 characters per hour. Considering a doubling of this rate for peak-hour usage, the net must be able to accommodate a peak loading of 1,000,000 characters per hour.

There are three types of terminals that may be used on the CLIS: basic, intelligent and local processor. The transmission speed requirements for these three terminal types can be considered to be 300 baud, 1,200 baud, and 2,400 baud, respectively. The local processors could operate at lower speeds and the intelligent terminals could operate at higher speeds. Based upon these and other hardware considerations, the net should be capable of servicing each terminal at 1,200 baud (which is well within the state of the art for unconditioned lines) with provisions for expansion to 2,400 baud and higher speeds for those local processors that shows signs of heavy usage. The net must support half-duplex connections to each terminal and must be able to accommodate at least 20 terminals simultaneously. The terminal connect time can be considered to average one hour per day per terminal.

CLIS Independent Net. In this communications configuration the CLIS operational staff would directly manage the net. The actual data paths and communications lines would be leased from common carriers and would be independent from any other communications network.

The facilities of the common carriers can be broken down into two general categories: dial-up service and private line service. Dial-up services have the advantage of covering large geographical areas and only the time during which the terminal is actually connected to the remote processors is charged for. This means that a user would dial the remote processor directly only when he wished to use the system. A major option available to the dial-up user involves WATS (Wide Area Telephone Service). WATS allows the user to make calls within a designated area over a single dial-up telephone line for a set monthly charge. There can be many terminals that have access to WATS but only one call can occur at a time. If one line is insufficient, multiple lines can be rented on the same basis. Private line services require leasing of a dedicated line from the terminal to the processor. A private line must be leased on a full-time basis, so that if the total traffic is not enough to use the line all the time, dial-up service may be more economical. Private line options include multidrop connections and concentrators. Multidrop connections are another way of saying party-line service. A group of terminals (not necessarily located close together) share a single line and are connected to it all the time. Each terminal has a unique identifying code such that the processor can address each terminal separately. However, there is additional processor overhead in selectively addressing and polling terminals in this fashion. A concentrator is a small computer processor that will centralize all terminals in a remote area and connect to the central location by a single leased line. The concentrator in effect acts as a funnel, coordinating all message transmissions to and from each terminal, thus making very efficient use of the single higher-speed leased line.

There are many ways that a system of this type may be connected using various combinations of dial-up service, inbound WATS, private lines, message concentrators, etc. The most efficient and cost-effective system cannot be designed until detailed information on terminal location and usage is determined. In an effort to produce a representative cost factor for this type of network, the following design is intended to define a worse case situation. Referencing Figure 2, Simplified Network Topology, the local terminal group would have access to the data bases via a net of local direct dial numbers and local service area WATS. This would entail an approximate cost of $4,000 per month. The remote terminal group would also be serviced by a net of local direct dial numbers and local service area WATS connected to a message concentrator which would in turn be connected to the central location by a single high-speed private line. The additional monthly costs are approximately $2,500 for the leased line and $1,000 for the concentrator. All other terminals not falling within these groups could be serviced by four WATS lines at an approximate cost of $5,000 per month. It may be possible to reduce this cost by careful consideration of multidropped lines and message concentrators. Each terminal would need a modem as well as each WATS connection and leased lines. Modem costs will range from about $20 to $50 per unit. At a median cost of $40 per modem, this would be $8,000 per month for the entire system. Therefore, summarizing by monthly common carrier lease costs:

Local Terminal Group	$4,000
Remote Terminal Group	
Local Service	4,000
Concentrator	1,000
Leased Line	2,500
All other terminal service	5,000
Modems	8,000
Total approximate monthly cost	$24,500

It is possible that this monthly cost may be reduced by as much as 30 percent due to new pricing structures recently announced by a common carrier. AT&T has recently filed a tariff with the FCC for its new DDS Digital Data Service. If approved, this new tariff could result in a monthly saving of about $7,000. The current downward trend in data communications costs by land line, microwave and satellite links will have a positive effect on the cost of communications systems of this type.

Government Systems. There are two operational communication networks serving the law enforcement community: NCIC (the National Crime Information Center) and NLETS (the National Law Enforcement Telecommunications System). The NCIC is housed and operated by the Federal Bureau of Investigation in Washington, D.C. and is governed by a policy board made up of representatives of the law enforcement community. The NCIC is a real-time computer system that maintains files on wanted persons, stolen vehicles, boats, firearms and securities. Each state and 17 of the most populous municipalities have access to these data bases and may inquire, update and modify them. Operating costs are included in the annual FBI budget. Thirty-seven states currently have a high-speed computer/computer data connection to the NCIC.

NLETS is a not-for-profit corporation composed of a representative from each state with an elected board of directors, an executive director and elected corporate officers. Its prime function is to provide interstate message-switching capabilities for law enforcement agencies. NLETS was initially implemented as an eight-line, multidropped teletype system. Recently, the system was upgraded to provide increased message-switching capabilities and high-speed computer/computer data connections. This computerized system, located in Phoenix, Arizona, maintains no on-line data files and is solely dedicated to message switching. It is operated by the Arizona Department of Public Safety under the direction of NLETS. Operating costs are shared by all user agencies with some subsidization by LEAA. Twenty-six states currently have a high-speed computer/computer data connection to the NLETS switcher with an expected increase to 35 by the end of 1974.

Both of these systems are extremely similar in the facilities that they can provide to CLIS. Both have adequate expansion capabilities to handle the peak volume of estimated CLIS traffic. Although NLETS has slightly fewer high-speed data connections, to state-controlled centers than NCIC, this difference is expected to be eliminated by mid-1975. In effect, every state communications center that has a computerized message-switching capability will have a high-speed data connection to both NCIC and NLETS. In both systems, message-formatting differences can be accommodated by computer program changes. Each system can be adapted to connect to CLIS processors and data bases.

In considering the use of either of these systems, there will exist a number of CLIS users that will not be able to directly access them because of the lack of a computerized state-switching facility. It is expected that the number of these terminals will be less than 20, and their connect requirements could be easily satisfied by use of dial-up services. The estimated cost for these services would be about $3,000 per month.

For most of the users who will have access to a statewide message-switching system, there is the cost of connecting the terminal to the statewide system. This is difficult to estimate because of the many hardware and configuration differences between statewide systems across the country. Also there may exist terminal compatibility and formatting differences that would prevent use of a standardized terminal system for CLIS. A detailed analysis of statewide message-switching systems would have to be made before terminal specifications are developed. These terminal connections could range between multidroppd, private-line services to dial-up WATS services within each state. For cost consideration purposes, the average cost per terminal can be estimated at $50 per month. Modem costs would approximate those of the independent system or about $40 per terminal per month.

Therefore, in summary:

• Dial-direct service (for 20 remote terminals)	$3,000
• Terminal connection to state systems (180)	9,000
• Modems	8,000
Total monthly costs	$20,000

It is important to note that a significant portion of this cost is the connection of terminals to statewide systems. This estimate may be reduced once more detailed information on the configuration of state message-switching systems and terminal compatibility is available.

Commercial Systems. Time-sharing companies are service organizations and provide terminals, communication networks, computer processors and data storage services to the general public for a fee. These services may range from simple processing and message switching to full implementation of application areas. In this case, we are particularly interested in the communications and message-switching capability that these systems can provide to CLIS.

There are two of these commercial time-sharing services that appear to approach the CLIS communications requirements: the General Electric MARK III system and the TYMNET system by TYMSHARE. Both of these services have very extensive communications networks that cover almost all of the continental United States. Other time-sharing services do not approach this coverage. Network equipment will check for transmission errors and convert codes and route data to the proper computer destinations.

The General Electric Mark III time-sharing service has the most extensive network in the industry. It gives users local dialing access to centralized data files from almost anywhere in North America and Europe. However, at this time General Electric does not offer use of its communications net as an independent service. Programs and data bases must reside on General Electric-fr rnished equipment. This makes it difficult to evaluate the communication costing criteria with regard to CLIS requirements. General Electric did indicate a willingness to accommodate all of the hardware and software requirements; i.e., terminal equipment, communications net, processing and data storage. An estimated fee for this service was quoted to be in the neighborhood of $250,000 per month. It is highly probable that this figure could be reduced when more detailed information concerning user location and expected volume is developed.

TYMNET is an open-ended communications network that operates coast to coast in the United States. The network provides alternate routing of messages in case of line trouble, and any computer center can be addressed by any point in the network. TYMNET does provide communications services independent of its processing and data storage capability. Nominal charges for this communication service are in the neighborhood of $10 per terminal connect hour. It may be possible to negotiate a reduced rate depending on system volume; for instance, the National Institute of Health's MEDLINE system has been able to reduce its communication costs to about $5 per terminal connect hour by careful evaluation of user needs and equipment capability. Considering a worse case condition of $10 per terminal connect hour, the costs of this service would be $44,000 per month.

In spite of the extensive coverage of both of these systems, it is probable that there will be a small percentage of CLIS users who would not have access to a toll-free number of the net. It is expected that this small number of mostly remote terminals could be adequately serviced by one or two short-range WATS lines.

It should be remembered that these time-sharing services are for profit organizations and as such are very competitive. This can be used to advantage when considering that CLIS would be a large user of any such system and could demand a large volume discount.

Summary. The costing information for each of the three general areas described is based upon many assumptions, among them being number of terminals, hourly usage and current pricing data. The cost range of the CLIS network will be between $20,000 and $52,000 per month. More detailed cost and system design trade-offs can be developed once the CLIS user population is defined more accurately with regard to exact geographic location and other system criteria such as terminal specifications and processor configuration and location.

DATA STORAGE

The data storage function is represented in two types of processor configurations: the centralized (and distributed) processor alternatives and the local processor alternatives. Data storage characteristics at the local level have already been covered under the User Terminal section and are not pertinent to this discussion. As has been stated previously, the processor and data storage devices should be included in a single complex due to the high rate and volume of information transfer between them. There are several different techniques available that have the capacity to contain the volume of data that will have to be stored upon CLIS Among these subsystems are magnetic tape, drum, movable head disk, large-core storage, fixed-head disk and mass storage. In general there are three parameters involved in our analysis of mass storage systems: capacity, access time and cost. Capacity represents the total number of characters that the data storage system can hold.

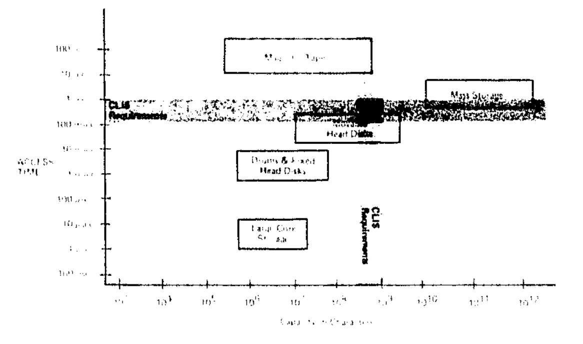
Access time is the amount of time required for whatever mechanical and electrical actions must take place between the time the access starts and the time that data is available to the processor. Cost, of course, is what you have to pay to have the storage space available and will be expressed in dollars per character.

The capacity requirements in terms of data storage were depicted in Table 5 of Volume 2. This table indicates the storage requirements and anticipated growth rates for each application area. This is a total of 400 million characters with an estimated annual growth rate of 54 million characters. The data storage requirements at the end of five years will be approximately 650 million characters. Therefore, the total system requirements over the first five years will range from 400 to 650 million characters. While the 400-million-character requirement will not assert itself immediately at project initiation due to a staggered implementation schedule, our cost criteria will be based upon the eventual requirement of 650 million characters.

The overall system access time requirements for each application area were addressed in the conceptual design of each application area. Note that these are defined as overall system-response times and include the times for communications, processing, and waiting for the availability of system resources. The data-storage-access time must be a small fraction of the system-response time in order to allow for the concurrent multiple data search capability that the system is to provide. With the minimum system response times expressed in minutes less than five, the data storage access time must be in the order of a second or less.

Figure 3 indicates the relationship of capacity-versus-access time for the five classes of storage considered. From this it is apparent that the movable

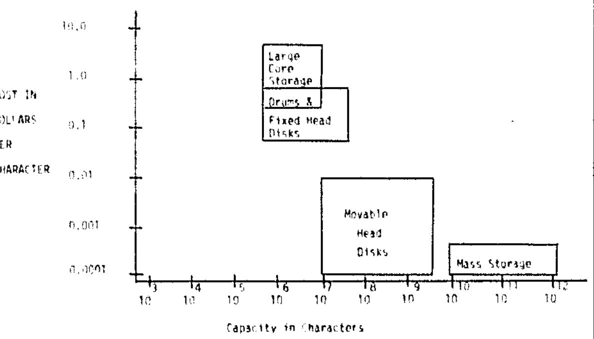
Figure 3
Storage Devices
Access Time vs. Capacity



head disk meets both the access time and capacity requirements of CLIS.

Figure 4 depicts the general relationship between capacity and cost per character of these classes of storage devices. This includes the costs of both the storage mechanism and the transport mechanism. (For magnetic tape, the transport mechanism cost is highly dependent upon installation configuration; so this class has not been indicated in this figure.)

Figure 4
Storage Devices
Costs vs. Capacity



Thus we can see that the movable disk data storage cost will range between 0.0001 and .01 dollars per character.

The reason for this large range is the many differences in device capability, configuration and manufacturers. Since the configuration that the CLIS will assume is somewhat dependent upon other system cost considerations and the results of the organizational impact task, there will continue to be some range of estimation until the actual system specification is finalized. However, the current state of the art in movable-head-disk storage systems centers about the IBM 3330 disk storage subsystem and the plug-compatible competition devices. A system of this type can provide 100 million characters of storage per spindle (a spindle is a single disk drive); therefore, seven spindles would be required to satisfy CLIS requirements. The estimated cost for the device controller and seven spindles would range between $200,000 and $250,000. This would be a cost per character of about $0.0003.

As indicated in the beginning of this section, the data storage media must be both highly interactive and compatible with the CLIS processor(s). Thus, selection of the most economical and efficient device cannot be made independently of the processor selection. Considerations such as the host facility's multi-vendor policies, CLIS configuration, available expansion parts on existing controllers and lease/purchase agreements must be taken into account. In the case of a distributed processor system, the data storage costs may increase due to current unavailability of 100 million character/spindle devices for these types of processors. However, this may be offset by the possibility of accomplishing the distributed processing on a cost-shared basis on existing large processor complexes. It is our opinion that this estimated data storage cost of $200,000 to $250,000 is representative regardless of the eventual CLIS configuration. Some of the manufacturers of this type of data storage devices are:

International Business Machines
California Computer Products
Storage Technology
Telex Computer Products
Ampex
CIG Computer Products.

PROCESSING

Prices for typical hardware for centralized and distributed CPU's are discussed in this section. The computers recommended as possible centralized processors are in the medium-sized category. Those suggested for distributed processing are small or minicomputers, similar to those described for local processor terminals. Authority for this section was the *Auerbach Computer Technology Reports* for computer systems, for minicomputers and for data communications equipment.

Centralized Processors.

What follows is a list of examples of medium-sized CPU's. Prices are for the processor itself; the manufacturer-supplied memory configuration that comes closest to 64,000 words; data communications equipment; and other necessary equipment such as consoles, power supplies, etc. Data storage and other peripherals are not included:

	Monthly Rental	Purchase Price	Monthly Maintenance
* Burroughs 3700			
B3741 CPU (with 100-kb IC memory)	$5,560	$267,000	$344
B3301 type B I/O channel	95	4,560	11
B3342 console	30	1,440	NC
B3350 data communications processor	315	57,000	120
	$6,000	$330,000	$475
First system delivered 1972.			
This is a business-oriented machine but it can perform scientific functions.			
* Control Data Corporation Cyber 72			
72-14 central processor with 65,500 words of memory	$25,200	$1,020,000	$4,050
791-1 communications control	920	38,000	100
(8) 792-2 communications adapters	80	3,200	20
7077-1 communications station	1,100	38,800	120
	$27,300	$1,100,000	$4,290
First installed in 1972			
This is an extremely sophisticated, although expensive, system.			
* Digital Equipment Corporation DECsystem 10			
KA10s processor package		$ 160,000	$ 393
DF10 data channel		14,000	67
MF10A memory (32,000 words)		50,000	311
MF10E MF10A expansion module (32,000 words)		35,000	130
DC10A data line scanner		10,000	19
DC10B 8-line group		5,500	18
DC10C 8-line telegraph relay		3,000	19
DC10D telegraph power supply		500	8
	N/A	$ 278,000	$ 965
First system installed in 1971.			
This is the best system available for network configurations.			
The data storage peripherals supplied with this system are not as up-to-date as those from some other manufacturers.			

	Monthly Rental	Purchase Price	Monthly Maintenance
* Honeywell 2050			
2051C-2 central processor (with 131,000 char. of memory)	$ 6,740	$245,000	542
2600N DATANET 2000 communications processor	855	32,000	165
2605N basic multiline controller	103	4,000	15
(4) 2606 asynchronous interface modules	932	38,000	163
	$ 8,630	$319,000	$885
First system installed in 1972.			
This system does not support time-sharing.			
* IBM System 370 Model 145			
3145-GE processing unit (164 kb memory)	$12,400	$595,000	$1,090
7844 3210-1 console printer-keyboard adapter	137	6,600	4
3210-1 console printer keyboard	178	5,710	86
3704-A3 communications controller	881	36,000	153
1302 attachment base-type 2	18	754	1
1542 channel adapter-type 2	145	7,226	12
4701 line interface base-type 1	41	1,710	4
	$13,800	$653,000	$1,350
First system installed in 1971.			
This system is strong in batch processing and weak in time-sharing and telecommunications capabilities.			
* Univac 1106			
3011-20 processor	$ 6,320	$289,000	$1,310
7005-60 storage (65,500 words)	4,565	210,000	425
4009-99 display console	765	33,300	281
3021-99 communications symboint processor	449	22,200	63
F1276-02 1100 channel adapter	113	5,400	21
(8) F1291-00 synch CLT (EIA)	288	14,100	80
	$12,500	$574,000	$2,180
First system installed in 1969.			
A capable, but expensive, system.			
* Xerox Sigma 8			
8501D central processor with 64K words	$11,800	$440,000	$2,080
8521 interrupt control chassis	65	2,200	26
(4) 8522 2-level priority interrupts	36	1,400	NC
7012 KSR35 keyboard/pointer & controller	150	6,000	45
7611 communications controller	263	10,000	45
7612 timing module	6	200	NC

7613 line interface unit	25	1,000	NC
7615 formatted send module	6	250	2
7616 formatted receive module	6	250	2
7618 automated dialing unit	138	5,500	40
2621 EIA interface	5	200	
	$12,500	$467,000	$2,240

First system installed in 1971.

This computer is capable in both data communications and data storage.

Distributed Processors

Distributed processors will require a type of computer intermediate in size between those proposed for local processor terminals and those suggested as centralized CLIS processors. The following manufacturers, among many other, produce machines in the proper size range:

Datacraft Corporation
Data General Corporation
Digital Equipment Corporation (DEC)
General Automation, Inc.
Hewlett-Packard Company
Honeywell Information Systems, Inc.
Interdata, Inc.
International Business Machines Corporation (IBM)
Lockheed Electronics Company, Data Products Division
Modular Computer Systems
Sperry Rand Corporation (Univac)
Varian Data Machines
Xerox Corporation

The newer Xerox 550 and 560 processors might be more competitive and should be evaluated when information on them becomes available.

A final selection among these and probably other candidates will involve consideration of all the criteria listed in Table 3. There are nearly 80 computers classified as "medium-sized" by Auerbach, and selection among them will be difficult.

Products of three of these manufacturers are selected below, without specific endorsement, as representative cost examples. Each is configured with a powerful minicomputer processor, 32,000 words of memory, an interface through which to talk to other computers, and sufficient peripherals for communication with the outside world, but no data storage. The authority for prices is, again, the *Auerbach Computer Technology Reports* for Minicomputers.

	Purchase Price	Monthly Maintenance
Digital Equipment Corporation PDP 11/45		
FE central processor, 8000 words memory, power supply and power fail/restart, programmer's console, interface for console, and A/N CRT	$19,500	$178
(3) MM11-S 8k words of 16-bit read/write core memory	14,100	105
KW11-P programmable real-time clock	600	3
CD11 card reader	10,000	70
LP11-KA line printer	19,000	80
TC11 DEC tape controller	4,000	12
TU56 dual DEC tape transport	4,700	30
DC11-DA dual asynchronous line control	600	7
H312A null modem	100	2
	$72,600	$487

	Monthly Rental	Purchase Price	Monthly Maintenance
Hewlett Packard HP 3000			
30000A central processor with 64 K-byte memory (includes module control unit, S10 multiplexer, system clock and console interface)	$2,320	$95,000	$339
30030A high-speed channel	121	5,500	13
30115A-100 mag tape subsystem	335	14,600	118
30107A card reader subsystem	471	18,000	126
30109A-001 printer subsystem	905	32,200	103
30123A CRT console	100	3,500	64
30032A asynchronous, 16-channel terminal controller	86	3,000	26
30032A-002 modem capability	142	1,200	42
	$4,480	$173,000	$831
Xerox 530			
41C6 system: processor with I/O processor, extended arithmetic, 2 real-time clocks, fault interrupts, memory protect, power monitor, 6 levels of external interrupt, keyboard/printer control, and 8,190 words core memory; card reader; line printer; and mag tape control and drive	$1,970	$52,000	$655
4191 KSR 35 keyboard printer	110	3,300	15
4119 field addressing instruction	50	1,500	15
(3) 4151 8,190-word core memory expansions	900	16,500	135
4170 external interface feature	14	400	5
7700 interprocessor interrupt feature	19	500	
7611 communications controller	216	10,500	47
7612 timing module	6	200	
7613 line interface unit	25	1,000	
7615 formatted send module	6	250	2
7616 formatted receive module	4	250	2
	$3,320	$86,400	$876

A choice among these and the many other candidates in this category would also require consideration of the criteria in Table 3.

Table 3

Computer Selection Criteria

I. Price

A. Purchase Price

1. price of system meeting full specifications
2. price for reduced spec configuration
3. maintenance charges

B. Lease Costs

1. term of lease
2. one-time charges (single usage ccst)
3. by-the-month cost
4. maintenance charges (it not included in lease).

II. Performance

A. Hardware

1. Architecture

a. date of first delivery (measure of up-to-dateness of system)
b. word length
c. number of interrupts
d. interrupt response time
e. program-controlled input/output rate
f. direct memory access input/output rate
g. block transfer setup time
h. cycles stolen at maximum input/output rate
i. availability of additional memory parts

2. Speed

a. cycle time
b. extended-precision floating point add time
c. extended-precision floating point divide time
d. CPU performance for standard computations
e. total performance with input/output limitations for standard computations
f. straight-line transfer rate within core
g. programmed loop transfer rate within core

B. Manufacturer's Software

1. name of operating system
2. assemblers, compilers and utilities available
3. memory required for operating system
4. simultaneous batch and online processing
5. simultaneous compilation and online processing
6. ability to operate in batch-only mode
7. number of simultaneous foreground tasks
8. ability of foreground to checkpoint background
9. fixed or dynamic memory allocation
10. executive priority scheduling

C. Vendor Criteria

1. size of company
2. number of this model installed
3. delivery time
4. location of corporate, technical, and sales and services offices
5. vendor's experience with similar applications

CHAPTER 3. EVALUATION OF DESIGN ALTERNATIVES

Table 4 combines the costs developed in Chapter 2 according to the various configurations recommended in Volume 2.

User Independent CLIS. Even though this alternative involves only one type of hardware component, duplicating it 200 times results in by far the most expensive configuration.

Centralized CLIS. Combination of simple terminals with a centralized processor and data storage via a communications network leads to a relatively attractive total cost. There appears to be no particular cost advantage, however, in a centralized processor.

Distributed Processor CLIS. This configuration costs out essentially the same as the centralized processor scheme. The data storage cost, however, might be greater than shown since additional controllers would be required to attach the storage devices to more than one CPU.

Distributed Communication CLIS. The requirement that every terminal must have access to every data base indicates that this configuration would create totally redundant communications networks. The state of the art of data communications is such that this redundancy is not necessary and would be very costly. The mean time to repair current network is such that network failure would not seriously affect the response time of CLIS terminals. This alternative is not considered further and is omitted from Table 4.

Distributed Processor Hierarchical CLIS. In this and the next configuration an arbitrary 70/30 split was assumed between those localities requiring simple and elaborate terminals. The inclusion of local processor and storage capability at some laboratories adds substantially to the total system cost. As with the nonhierarchical distributed processor alternative, the data storage cost might have to be revised upward somewhat to include additional controllers.

Centralized Hierarchical CLIS. This alternative results in essentially the same total cost as the distributed processor hierarchical configuration. As was

Table 4

Comparative Cost of Design Alternatives

(Monthly Costs in Thousands of Dollars)

		"EACH" COSTS	USER INDEPENDENT CLIS	CENTRALIZED CLIS	DISTRIBUTED PROCESSOR CLIS	HIERARCHICAL CLIS	CENTRALIZED HIERARCHICAL CLIS
LOCAL TERMINALS	No. Range Median	1 $0.049-$1.37 $0.21		200 $9.8-$74 $42	200 $9.8-$74 $42	140 $6.86-$51.8 $29.4	140 $6.86-$51.8 $29.4
LOCAL CPUs AND DATA STORAGE	No. Range Median	1 $1.3-$1.5 $1.4	200 $260-$300 $280			60 $78-$90 $84	60 $78-$90 $84
COMUNICA-TIONS	No. Range Median			1 $20-$52 $36	1 $20-$52 $36	1 $20-$52 $36	1 $20-$52 $36
CENTRAL CPUs	No. Range Median	1 (Distributed only) $3.32-$4.48 $3.9		1 $6-$27.3 $16.65	2-6 $6.64-$26.88 $16.76	2-6 $6.64-$26.88 $16.76	1 $6-$27.3 $16.65
CENTRAL DATA STORAGE	No. Range Median			1 $5.76-$7 $6.38	2-6 $5.76-$7 $6.38	2-6 $5.76-$7 $6.38	1 $5.76-$7 $6.38
TOTALS	Range Median		$260-$300 $280	$41.56-$160.3 $100.93	$42.2-$159.88 $101.04	$117.26-227.68 $172.47	$116.62-228.1 $172.36

the case with the nonhierarchical system, centralization of processing and storage results in no significant savings.

COST ALTERNATIVES

Table 4 describes the comparative costs of the pertinent design alternatives. As can be seen from the totals, the cost range for some of the alternatives can be quite significant and may not accurately depict what the eventual cost might be. In order to provide greater insight into these cost ranges, Table 5 presents relative estimated hardware costs of various components of a CLIS system and totals them according to various configuration alternatives. For clarity of presentation the terminal and processor system components which are not affected by communications network alternatives have been grouped as shown in Table 6. The major alternatives are determined by the nature of the communications network — independent, governmental or commercial.

Within the major alternatives the options of using either basic or intelligent terminals are broken out. Additionally, under government systems, separate figures are given depending on whether or not a processor, communications hardware, and data storage are available from the hosting (or other) agency, and whether there would be access to an existing national criminal justice network.

The "terminals" component includes only local terminals, local processors, or local data storage. "Communications" includes all costs of lines, modems at both terminal and computer end of the network, remote concentrators, etc. The central processor component includes the actual CPU, centralized data storage and any central communications hardware.

The last rows of Table 5 provide a relative indication of the impact of implementation and operating costs on the eventual total system cost. Detailed development of these costs are described in Volume 4; however, the differences between communications alternatives can be presented in terms of relative magnitudes (the last three rows of Table 5).

Note that terminal costs are different for basic and intelligent terminals but do not vary according to the communication alternative.

DISCUSSION OF NETWORK ALTERNATIVES

The major advantages and disadvantages of using different types of networks for the CLIS system are discussed below. It is important to distinguish between a system and a communications network. The latter is a part of a total system but to CLIS it is most critical.

Use of Commercial Networks. It is also important to distinguish between a *network* service and a time-sharing service. Time-sharing vendors offer their customers computational capability and a place to store their data bases. Communication is generally via public telephone lines. Time-sharing is not considered appropriate for CLIS for numerous reasons of responsiveness and security. Network vendors sell the use (shared with other customers) of a dedicated network of communication lines. There are two major commercial network services — TYMNET (Tymshare, Inc.) and Mark III (General Electric Corp.). Both these companies were contacted. CLIS was described to them in terms of the system size estimates as developed in Volume 2, and they both provided preliminary cost estimates. General Electric does not offer the network service separately from their terminals and processing hardware. TYMNET, however, does offer the customer the capability of attaching his own terminals and processor. Because only Tymshare was willing to price communications separately, the cost estimate for the commercial alternative is based on their figures.

A few applications coincident with those of CLIS are available on the existing commercial nets. The Mass Spectral Search System (MSSS) is on the GE net, and the IRGO IR search system and the National Library of Medicine's MEDLINE and TOXLINE are all on TYMNET. The costs incurred by the National Library of Medicine in using TYMNET for MEDLINE served as a further check on the cost of operating CLIS in this manner.

The major disadvantage of using a commercial network is the extremely high cost. (See "hardware total" row under "commercial" columns, Table 5). Then too, communication with other types of criminal justice systems such as NCIC and NLETS, would be precluded and integration into any future national telecommunications system for criminal justice, would be impossible.

Use of the GE net would have the further dis-

Table 5
CLIS Network Alternatives

	Commercial		Independent		State or Federal Government							
					National Network Not Available				National Network Available			
					Some Costs Assumed by Host Agency		Costs Not Assumed		Some Costs Assumed by Host Agency		Costs Not Assumed	
Item	Basic Terminals	Intelligent Terminals	Basic Terminals	Intelligent Terminals	Basic Terminals	Intelligent Terminals	Basic Terminals	Intelligent Terminals	Basic Terminals	Intelligent Terminals	Basic Terminals	Intelligent Terminals
Terminals	108.3	116.1	108.3	116.1	108.3	116.1	108.3	116.1	108.3	116.1	108.3	116.1
Communications	52.0	52.0	20.0	20.0	20.0	20.0	20.0	20.0	24.5	24.5	24.5	24.5
Central Processing	23.0	23.0	23.0	23.0	–	–	23.0	23.0	–	–	23.0	23.0
Hardware Total	183.3 High	191.1 High	151.3 Medium	159.1 Medium	128.3 Low	136.1 Low	151.3 Medium	159.1 Medium	132.8 Low	140.6 Low	155.8 Medium	163.6 Medium
Implementation Costs	Low	Low	High	High	High	High	High	High	Low	Low	Low	Low
Operating Costs	High	High	High	High	Low	Low	Low	Low	Low	Low	Low	Low
Overall System Costs	High	High	Highest	Highest	Low	Low	Medium	Medium	Lowest	Lowest	Low	Low

Note: All figures are median monthly lease costs (including maintenance) in thousands of dollars.

Table 6

Grouped System Components Used in Table 5

All figures are median monthly lease costs including maintenance.

The cost ranges on which these medians are based were developed from the data presented in Chapter II of this volume.

	($ in thousands)
BASIC TERMINAL CONFIGURATION	
140 Local Terminals	$24.3
60 Local CPU's and Data Storage	$84
	$108.3
INTELLIGENT TERMINAL CONFIGURATION	
140 Local Terminals	$32.1
60 Local CPU's and Data Storage	$84
	$116.1
PROCESSOR	
Central Communications Hardware	$ 1.18
Central CPU	$15.4
Central Data Storage	$ 6.38
	$23.0

advantage of being inflexible about the addition of "foreign" terminals or processors to the communication net. The addition of local processors in the laboratories would probably be precluded entirely.

A commercial net would offer some advantages over a dedicated network in that message-switching or other communications programming would not have to be repeated and there would be a smaller dial-up component than with the dedicated configuration proposed. However, these characteristics are also true of government networks, so use of a commercial net would offer no advantage over use of a government net.

An Independent Network Dedicated to CLIS. It is impossible to propose a system which would consist of leased lines and facilities solely under the control of a CLIS organization. The major appeals of such a configuration would be the freedom from control by an "outside" agency and the opportunity to design all aspects of the system specifically around CLIS requirements. There would also be an advantage in that coordination with other functions sharing the same equipment would not be required.

An independent net would be cheaper to operate than a commercial net. By offering minimal facilities it could be configured also to be less expensive than a government net. However, an independent net equal in capacity to a government net would necessarily be more expensive to operate since part of the cost of the latter would be borne by an existing agency.

Compared with either commercial or government nets the independent alternative would also be at a disadvantage regarding implementation costs. An independent net would require development of message-switching and other communications software that would already be in existence in the other case (both commercial and to a greater degree governmental). An independent net would also incur direct personal, processor and data storage costs, which in the case of a government net would most likely be assumed by the appropriate agency in their budget.

A further disadvantage of an independent net is that, as would be true with a commercial net, consolidation of CLIS with any future national telecommunications criminal justice network would be more difficult.

USE OF A GOVERNMENT AGENCY AS THE CLIS HOST

In an effort to examine the possibility that an existing non-federal government computer facility might be an appropriate host for a CLIS system, the California Crime Technological Research Foundation distributed a questionnaire prepared by PRC/PMS. The questionnaire explored each agency's data processing capabilities and their interest in supporting CLIS. The response to this survey was very poor — the six responses received are summarized in Table 7. Following up on a report that the Florida Crime Information Center had expressed interest in being a CLIS host, their response was elicited by telephone and is also included in Table 7.

All the responses describe law enforcement data processing except that of West Virginia, which was from the State Department of Finance and Administration. The reply from Ohio described only a very small batch-processing system presently dedicated to crime laboratory applications and has no national system capability.

It is not clear from the Arizona questionnaire whether the communications capability described is directly associated with the CPU's mentioned. Arizona is noteworthy as being the NLETS operating agency for national message switching.

Illinois had the largest facility reported whose service is dedicated to law enforcement. This agency entered a somewhat equivocal response in their questionnaire which might be taken as an expression of interest in supporting CLIS.

Florida and New York were the only respondents which presently support any applications similar to those of CLIS.

West Virginia reported the largest facility of those replying and was the only one that expressed positive interest in supporting CLIS. However, this response comes from a data processing facility attempting to satisfy the needs of twenty-eight state government organizations on a shared-time basis and could not qualify for NCIC of NLETS access because of the security and privacy requirements. Experience has shown that these types of central computer facilities have extreme difficulty in meeting law enforcement needs.

Use of a federal criminal justice agency as host of CLIS would carry with it the advantage of access

Table 7
State Government Data Processing Capabilities

Agency Name	Arizona Department of Public Safety Data Processing Department	Florida Crime Information Center	Illinois Department of Law Enforcement, Division of Data Processing	New York State Division of Criminal Justice Services	Ohio Bureau of Criminal Identification and Investigation, Data Systems Division	West Virginia Department of Finance and Administration, Information Systems Services Division
Computers	1 IBM 370/145 1 IBM 370/135	2 Burroughs 3500s	2 IBM 370/155s	2 Burroughs 6700s	1 Burroughs L4311	1 IBM 370/158 1 IBM 360/65
Memory (Bytes)	896K	840K	2100K	1476K	4K	2750K
Disk Storage (Bytes)	1600M	1600M	1600M	248M	None	2500M
Communications?	Yes	Yes	Yes	Yes	No	Yes
Staff Size	27	60	76	63	8	124
Existing CLIS Applications?	None	X Ray Diffraction	None	Infrared Spectra	None	None
Interested in Supporting CLIS?	"No position without more details on CLIS"	"Can't answer at this time"	"With enhanced facilities and resources through existing organization"	"DCJS support is dependent on the nature of the alternative organizational arrangements of CLIS, the method of funding, and State policy at the time of implementation planning"	No Response	"Would like to"

to one of the existing national criminal justice networks (NCIC or NLETS — see "national network available" columns of Table 5). Use of a state agency might also provide access to NLETS. If no such hookup were available, it would mean that some sort of dedicated network would have to be created, as was the case with the "independent" alternative (see "national network available" columns of Table 5) with the same attendant higher implementation costs. Whether or not an existing network is accessible, a government agency as host would offer the advantages of possibly providing personnel, processing, and data storage; some or all of these might be provided without additional direct costs to CLIS users. (Compare "some costs assumed by host agency" columns in Table 5 with "costs not assumed" columns.)

Cost in upgrading a state law enforcement system to service CLIS with respect to data bases might be the same or more likely greater than with a federal facility. More importantly, no state system manages a national network even though it may have access to one. In addition, access to free processing and data storage seems less probable with a state facility. There is also the question of how such a system might be funded; probably the administrative entity would have to be an NLETS-like organization.

Minor disadvantages with use of existing government nets are those associated with coordinating with an existing structure and those resulting from the fact that a diversity of terminal types is being connected with these networks. This is a valid concern only if it restricts the level of service; e.g., by precluding the addition of more intelligent terminals.

Use of a government network shares with the "commercial" alternative but to a greater extent the advantage that message-switching and operations would already be provided; hence, implementation would be less costly. The monthly operating cost of a government net would, however, be much cheaper than that of a commercial net.

CLIS's highly specialized applications would benefit from close association with an existing national criminal justice network in a number of ways. The need for monitoring of the input data would be satisfied and there would be access to specialized data bases pertinent to laboratory operations; e.g., gun files, vehicles, criminal histories, etc. Neither control by, nor responsibilities of, the user labs would be lost in this approach. The development program would not be retarded by the shared environment and, in fact, the responsiveness to all users should be enhanced.

Finally, utilization of one of the existing government nets would, of course, pose no problem of integration into a national criminal justice telecommunications system because those existing nets are the base for any such system.

CHAPTER 4. RECOMMENDED CLIS CONFIGURATION

REVIEW OF CLIS REQUIREMENTS

In Chapter 4 (Summary of System Requirements) of Volume 2, it was shown that a CLIS system would require the storage of a 400-million character data base, and based on an estimate of 100 terminals, there would be a communications load of 6.4 million characters per day. A processing capability would be required sufficient to access and maintain the data base and to hold conversational discourse with the terminals via a communications network. Additionally, there must be the terminals themselves in the users' laboratories. In a further analysis the number of terminals was revised to 200, which would double the communications load.

In Chapters 2 and 3 of this volume, the costs of the system components have been examined in detail, resulting in the following general choices.

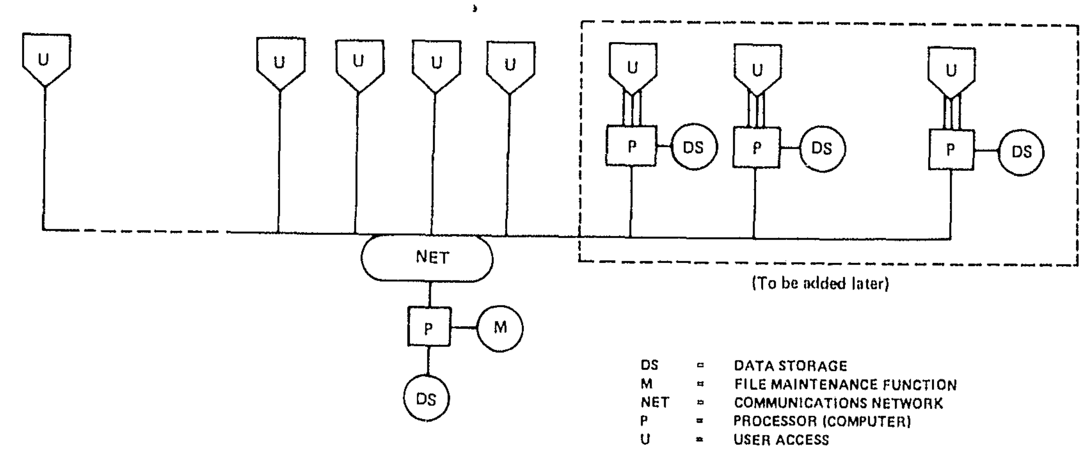
FAVORABLE COST ALTERNATIVES

Table 5 in Chapter 3 summarizes the costs of the various possible configurations defined at the end of the previous task report. The "Distributed Communications CLIS" was discarded as being unnecessarily redundant. The "User Independent CLIS," with independent processors and data storage in each laboratory which do not communicate with each other, turns out to be by far the most expensive approach. The least expensive alternatives (about $100,000/month) are the nonhierarchical configurations, whether the data bases and processing are centralized or distributed. The hierarchical configurations, that is those with local processing capability in some laboratories, are intermediate in cost — about $170,000/month. The following configuration is recommended:

SELECTED CONFIGURATION

For reasons which will be elaborated later in this chapter, a CLIS configuration with centralized processing and data storage, using an established government network, and which is not hierarchical but has the capability of growing into a hierarchical system, is recommended. This configuration is diagrammed in Figure 5.

Figure 5
Recommended CLIS Configuration



JUSTIFICATION: ADVANTAGES AND DISADVANTAGES

The following list of advantages and disadvantages is reproduced from Volume 2 (an additional advantage has been added):

Advantages:

- Flexibility
- Centralized control
- Easy coordination of file maintenance
- Local processors can handle specialized non-CLIS data peculiar to each laboratory
- Multiple terminal capability for high-volume users
- Potential of acquiring/reducing data directly from instruments
- Ease of expansion from basic terminal through intelligent terminal and local processor capabilities.

Disadvantages:

- Configuration may not be optimal for the specialized needs of some application areas
- Possible peak-period competition for system resources, resulting in response delays
- Increased complexity resulting from communication between local and main processors
- Increased cost of local processors and data storage
- Local systems and programming support must be provided.

Phased Hierarchical Approach. Experience indicates that the hierarchical configuration will produce the most flexible system which will have the capability of providing user access to CLIS via all of the three terminal types. It is recommended that the initial implementation of CLIS concern itself not only with the use of the basic terminal, but that the capability of controlling information flow with local processors should be designed into the system from the very beginning. This planned expansion approach will eliminate the need for major programming and format changes when it becomes necessary to upgrade the terminal capability at the user laboratories.

Use of Government Communication Network. The CLIS communications network should reside with one of the operational government systems, either NCIC or NLETS. While this can be justified by cost considerations, there are other important reasons why this should be so. CLIS will be a tool of law enforcement agencies and thus should be grouped with other law enforcement communications rather than maintaining an independent separate system. The National Institute of Law Enforcement and Criminal Justice is currently funding a program to provide initial definition of systems requirements and systems concepts for the establishment of a national operating telecommunications network for the purpose of transmitting information among criminal justice agencies (NALECOM). It is envisioned that the CLIS communications activity will form one of the major components of this system and use of NCIC or NLETS will lay the groundwork for integration into NALECOM.

CLIS needs a national network to make it a system — users, data bases, computers, operating staff, data transmission, communications and terminals. There are two existing national law enforcement networks; namely, National Law Enforcement Telecommunications System (NLETS) and National Crime Information Center (NCIC). Both NCIC and NLETS are capable of supporting CLIS in its immediate national network needs and, with some enhancement, the future expansion as well.

Reasons for Selecting an Existing Governmental Network:

1. CLIS is a law enforcement function and should logically utilize a national law enforcement network.
2. CLIS as a law enforcement function needs access to other law enforcement data bases (NCIC) and agencies (NLETS) for information and communications to assure maximum effectiveness.
3. Security and confidentiality implications of CLIS are resolved on either network.
4. Cost on dedicated or commercial networks is substantially above absorption of CLIS costs by existing NCIC or NLETS networks.
5. CLIS utilization of NCIC or NLETS will ensure its smooth integration into any future national telecommunications system for criminal justice.

Selection of this communications alternative means that user terminals will have to connect to state law enforcement message-switching systems were available. This will preclude use of a standard model of terminal and impose some reprogramming and reformatting tasks on these state centers. However, the capability and availability of these operational government systems will still prove to be advantageous.

Comparison of Governmental Network Alternatives. In addition to the general advantages and disadvantages of a governmental system presented earlier, there are some more specific conclusions which can be drawn from information available at this stage of design development. These conclusions further explain the recommendation of the governmental system approach for major consideration in the future design and implementation activities. As has been mentioned earlier, there are only two existing national law enforcement networks, NCIC and NLETS. Comparisons between the two are presented in Table 8.

Table 8
Comparison of Governmental Network Alternatives

	NCIC	NLETS
1. Control	NCIC Policy Board, 27 administrators from local, county state and federal criminal justice agencies (elected). NCIC operated by the FBI.	Board of Directors (elected) representing eight law enforcement agencies. NLETS operated by Arizona Department of Public Safety.
2. Network Coverage	50 states, Puerto Rico and RCMP, Canada.	48 continental states and Hawaii, Alaska and Puerto Rico through NCIC.
3. Cost	Interstate connection assumed in continuing appropriation of FBI.	Cost per state $600 per month
4. Software Capability	Has extensive software experience to handle data bases.	Software is highly specialized for message switching.
5. Data Base Capability	Has data base experience and capacity to handle at least the initial CLIS applications.	No data base capability.
6. Line Capacity	Has one 4800 baud line, 56 2400-baud lines, 73 150-baud lines. Has 61 computer-to-computer interfaces in 41 states, 17 large metropolitan areas and 3 federal agencies (including DEA).	Has 23 2400-baud lines - 21 to states and one each to NCIC and Customs, 4 150 baud computer interface line and 27 150 baud lines to state terminals. (manual model 37)

Both NCIC and NLETS could handle the initial communication needs of a CLIS; however, at the present time, NCIC offers a greater capability in view of its more extensive coverage, line capacities and data base storage. A cost comparison would not be significant since, should NLETS assume the communication needs of a CLIS, it is unlikely that the $600 a month state cost would be increased. It is very possible that in designing a network to support CLIS that a mix of both NCIC and NLETS would be utilized. Both networks are interfaced and are servicing the same group of law enforcement and criminal justice users. Another factor in the choice of either NCIC or NLETS would be the location of the national data bases. If this results in being the Washington, D.C. area, then NCIC is the logical network from the standpoint of cost.

The preceding statement is offered as a preliminary conceptual design for the evolution of the final system. It by no means reflects results of a detailed "trade-off" study which will be accomplished in Phase II but it addresses some of the significant capabilities and limitations of both systems.

Processor Centralization. CLIS requirements have identified data bases that are more efficiently and effectively maintained at the national level and that are capable of serving all users. This concept reduces, if not eliminates, the need of duplicating such files at local, regional, state and national levels. CLIS applications are highly specialized and the data bases require a high degree of centralized quality control.

These requirements indicate that the centralized processor configuration will best suit the needs of the CLIS. While this is not clearly indicated by the cost comparisons of the hardware equipment involved, a centralized data base repository will provide the CLIS user laboratory population with a common source of solutions to their varied problems. Also, there very likely will be hidden costs which would be multiplied by the number of processor locations. The CLIS will need a strong organization to represent the disparate structures and requirements of the user laboratories, and the implementation of CLIS in a single location and single organization will reinforce the effect of system control while being responsive to the users. The advantages of a centralized operations staff will be dealt with more fully in the chapters to follow.

National data bases are best maintained by a functional crime laboratory with wide forensic experience and operations. Responsiveness of CLIS to its users and high priority development at the national level is more likely if the national data bases and the processing are maintained by a functional crime laboratory of broad experience and operations. A well established functional laboratory is capable of obtaining and sustaining on-going funding for data base development and maintenance. Additionally, a multi-disciplined laboratory can provide an active and comprehensive testing and research environment.

At the present time, one of the governmental alternatives, the FBI Laboratory, satisfies all of the above considerations and is also a source for major file conversion. In addition, the Drug Enforcement Administration also located in Washington, D.C. has a data base on drug identification which would supplement CLIS capabilities. They can be considered prime candidates for serving as the host agency for CLIS.

CHAPTER 5. ORGANIZATIONAL IMPACT

The placement of CLIS administrative and operational responsibilities will be one of the most critical decisions made during the Phase II implementation activities of this project. The "host" agency or organization, in whatever form eventually selected, must be fully capable of controlling and operating CLIS as it is conceptualized during the Phase I design efforts. The best design alternative is useless unless it can be implemented in an effective and efficient manner. This design is being developed to provide a practical solution for the informational need requirements of potential users. It will be one that lends itself to effective and efficient implementation. Therefore, the ultimate responsibility for CLIS success will rest with the organizational process which services its users.

The development of a proposed CLIS organizational structure is based upon the following objectives:

Analysis of organizations potentially having access to the criminalistics information system, to assure that fair and objective criteria can be established for such access.

Analysis to consider alternative organizations which would operate the criminalistics information system. This analysis should explore alternative user-maintained relationships including contractual ones.

Analysis to determine whether sufficient statutory or administrative authority is vested in the organization maintained to assure that abuses of the system can be properly and promptly dealt with.

Chapter 6 will reveal the various types of potential user organizations visited during the data collection stage. The possible impact of user organization structures and processes upon the central CLIS organization will be presented, and the relationships between the two will be outlined.

In Chapter 7 the central issues regarding the administration, operation and control of CLIS will be addressed. The advantages and disadvantages of the administrative alternatives of CLIS will be presented for comparison. These alternatives will cover the important elements or organization, management, staffing, functions, and funding possibilities.

The feasibility and desirability of establishing a user-represented control and/or policymaking group will also be discussed in this chapter. Realistic alternatives and their respective advantages and disadvantages will be included.

The remaining sections of Chapter 7 will suggest (1) legal considerations relative to the provision of services and control of the system and its users and (2) initial user operating criteria for CLIS.

Chapter 7 will summarize the recommendations for the administration and control of CLIS.

CHAPTER 6. IMPACT OF USER ORGANIZATIONS

Collectively, the eventual users of CLIS will have a significant impact upon the operation, administration and control of the system. This impact has been felt to some degree already as laboratories responding to the CLIS information form make known their informational needs and priorities. It is anticipated that the needs of laboratories will continue to have the most significant single impact upon the responsiveness of the CLIS organization to adequately service its users. Individual laboratories are organized within their respective governmental structures in the manner which is felt will best serve the needs of their users — the investigative personnel of the law enforcement agencies serviced. In a like manner, the central CLIS organization must be capable of providing the quality and variety of services demanded by its users. However, it is unlikely that the actual organization structure and process of user laboratories will be a major contributor in dictating how CLIS should be organized to discharge its responsibilities. This conclusion is drawn from the experience of 17 laboratory visits as described in Volume 1.

TYPES OF LABORATORY ORGANIZATIONS

The types of organization structures encountered during the 17 field visits were as many and varied as the number of laboratories visited. This was neither a surprising nor unexpected occurrence since the basic principles of organization are flexible enough to permit an infinite number of organizational alternatives to be structured within one of three general types — line, staff and functional. A detailed analysis of the organization structures of all 17 laboratories visited would not be particularly appropriate or productive at this point. We need not be concerned either with the general merits of one type of organization structure over another or the organizational effectiveness of one particular laboratory over another. Therefore, a brief organizational summary of three laboratories generally representative of the majority of potential CLIS users is presented to illustrate that the organization of user laboratories will have a relatively insignificant impact upon CLIS organizational considerations compared to the demands for services based upon the line operations of a laboratory rather than its administrative structure.

Case No. 1

- Controlling Jurisdiction: City
- Technically Trained Employees: Seven
- Cases — 1973: 13,000
- Services Provided: All except toxicology.

Figure 6 shows the organization structure of a municipal laboratory serving an area with a population in excess of one million. As is generally the rule, this laboratory is an organizational element of the law enforcement agency serving a particular jurisdiction. The law enforcement agency may be directly under a department of public safety or some other municipal government department. With increased frequency during recent years, laboratory services of several law enforcement agencies within a particular geographic area have also been consolidated. In this instance the laboratory bureau has been functionally placed under a staff division. For the most part, the sections and units within the laboratory bureau have been functionally organized. The following information needs were reported by this laboratory in priority order:

1. Computation of statistics to determine specimen uniqueness
2. Analytical/identification support
3. Sources of standard samples
4. Literature abstract information
5. Rifling specifications
6. Sources of specialized expertise
7. Bibliographic information.

Case No. 2

- Controlling Jurisdiction: County
- Technically Trained Employees: 38
- Cases — 1973: 35,000
- Services Provided: All except explosives and trace elemental analysis.

Figure 7 shows the organization structure of a county laboratory serving an area with a population in excess of seven million. This laboratory is also

Figure 6
City Laboratory Organization — Case #1

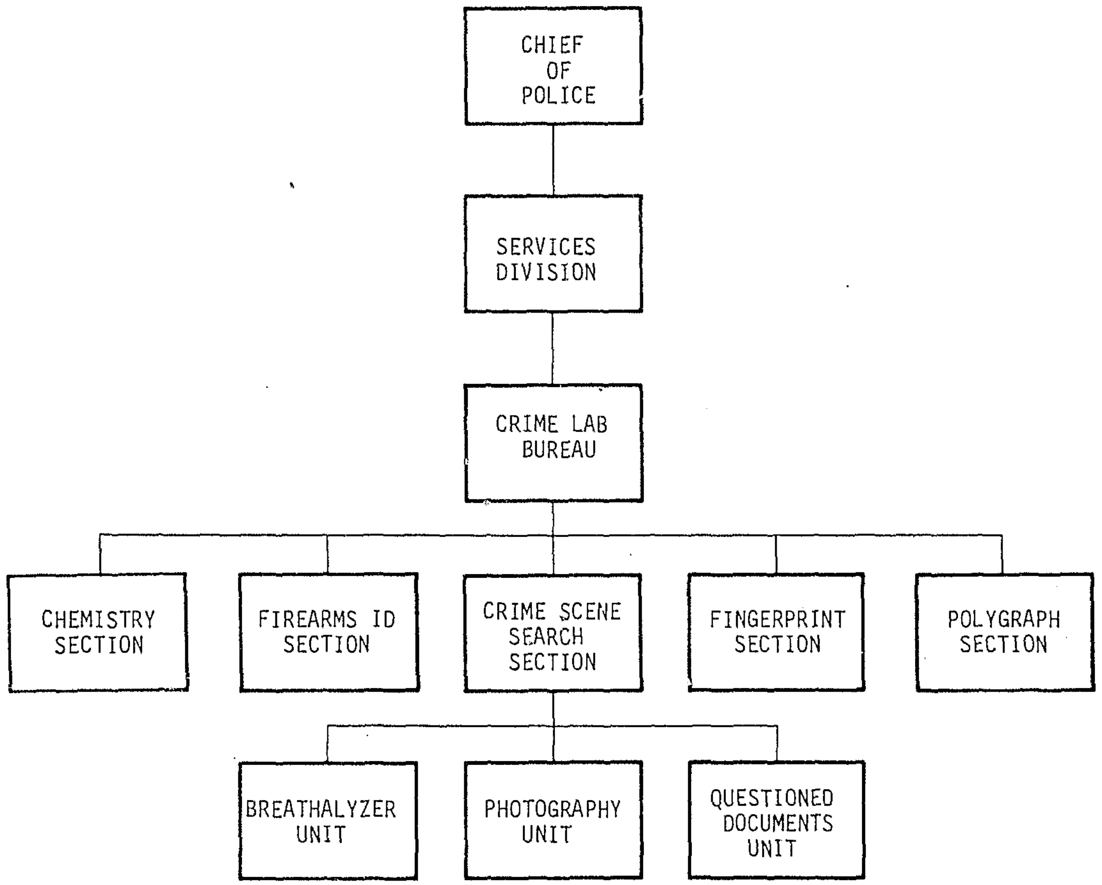
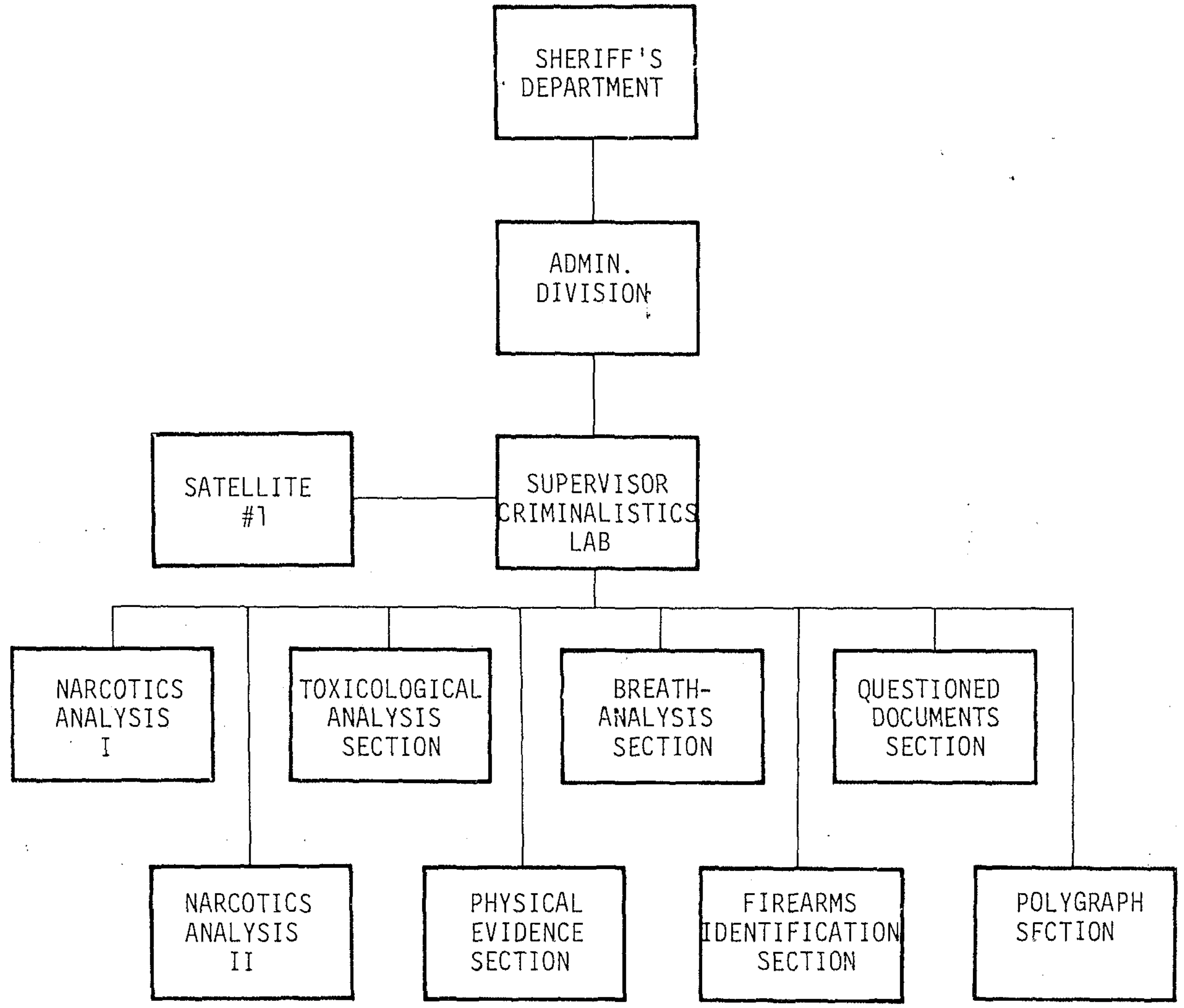


Figure 7
County Laboratory Organization — Case #2



organized under a staff services department of a law enforcement agency and includes one small satellite laboratory. Activities are again functionally grouped but with a higher degree of specialization due to a significantly larger case load than the Case 1 laboratory. The staffing pattern includes the use of both sworn and nonsworn personnel. The following information needs were reported by this laboratory in priority order:

1. Analytical/identification support
2. Bibliographic information
3. Literature abstract information
4. Compilation of statistics to determine specimen uniqueness
5. Sources of standard samples
6. Sources of specialized reagents
7. Rifling specifications
8. Explosive tagging.

Case No. 3

- Controlling Jurisdiction: State
- Technically Trained Employees: 10
- Cases — 1973: 2,435
- Services Provided: All except trace elemental analysis.

Figure 8 shows the organization structure of a state laboratory with several satellites servicing a geographic area with almost 1½ million people. The central staff is somewhat small and the unit designations do not represent distinct areas of specialty. The use of satellite laboratories, particularly in laboratory systems with statewide or large regional responsibilities appears to be an upward trend. The increased demands of decentralization for additional supervisory and technical staff and instrumentation is justified by proponents of this system by the increase in submissions by users because the service is closer and more convenient. The following information needs were reported by this laboratory in priority order:

1. Analytical/identification support
2. Rifling specifications
3. Compilation of statistics to determine specimen uniqueness
4. Literature abstract information
5. Bibliographic information
6. Computation data
7. Sources of standard samples
8. Explosive tagging
9. Sources of specialized reagents
10. Sources of specialized expertise.

ORGANIZATIONAL DIFFERENCES

Subtle organizational differences make the organization structures and processes of the laboratories visited unique each in its own way. The cases summarized in the previous section include a state, city and county laboratory. Each laboratory is an organizational component of different total structure under the control of the chief administrators of the respective jurisdictions. Of the laboratories visited all were affiliated with law enforcement or investigative agencies and most were organized as staff or support groups. Visits were made to federal, state, city, county and regional laboratories. Both main and satellite laboratories were included in the sample.

The internal organizations of the laboratories were structured on a functional basis with wet chemistry, narcotics, firearms and toolmarks, and questioned documents most often comprising the basic specialization groupings. The use of either generalist or specialist staffs seems to have little or no effect upon the functional organization of a laboratory which is generally dictated by the types of services provided. The internal organization of a laboratory could vary significantly from the norm if it provides only a limited number of highly specialized services; e.g., drugs, toxicology, etc. The organizations of full-service laboratories tend to be generally similar.

Another contributing factor that usually influences the organizational sophistication of an agency is size. The sophistication and detail of an agency's organizational structure and process normally increases as the agency grows. A review of Figure 9, however, indicates that size has no appreciable bearing upon the information needs and priorities reported by potential user laboratories. Figure 10 shows that geographic location, which minimally affects organization, does not have much more influence upon information needs than does the size of a laboratory.

The following conclusions are drawn regarding the potential impact of user laboratory organization structures upon the central organization of CLIS:

1. The services provided by potential users are generally the same regardless of size, function or geographic location. Therefore, the information support needed to facilitate the provision of these laboratory services is also generally the same (Figures 9 and 10).

Figure 8
State Laboratory Organization — Case #3

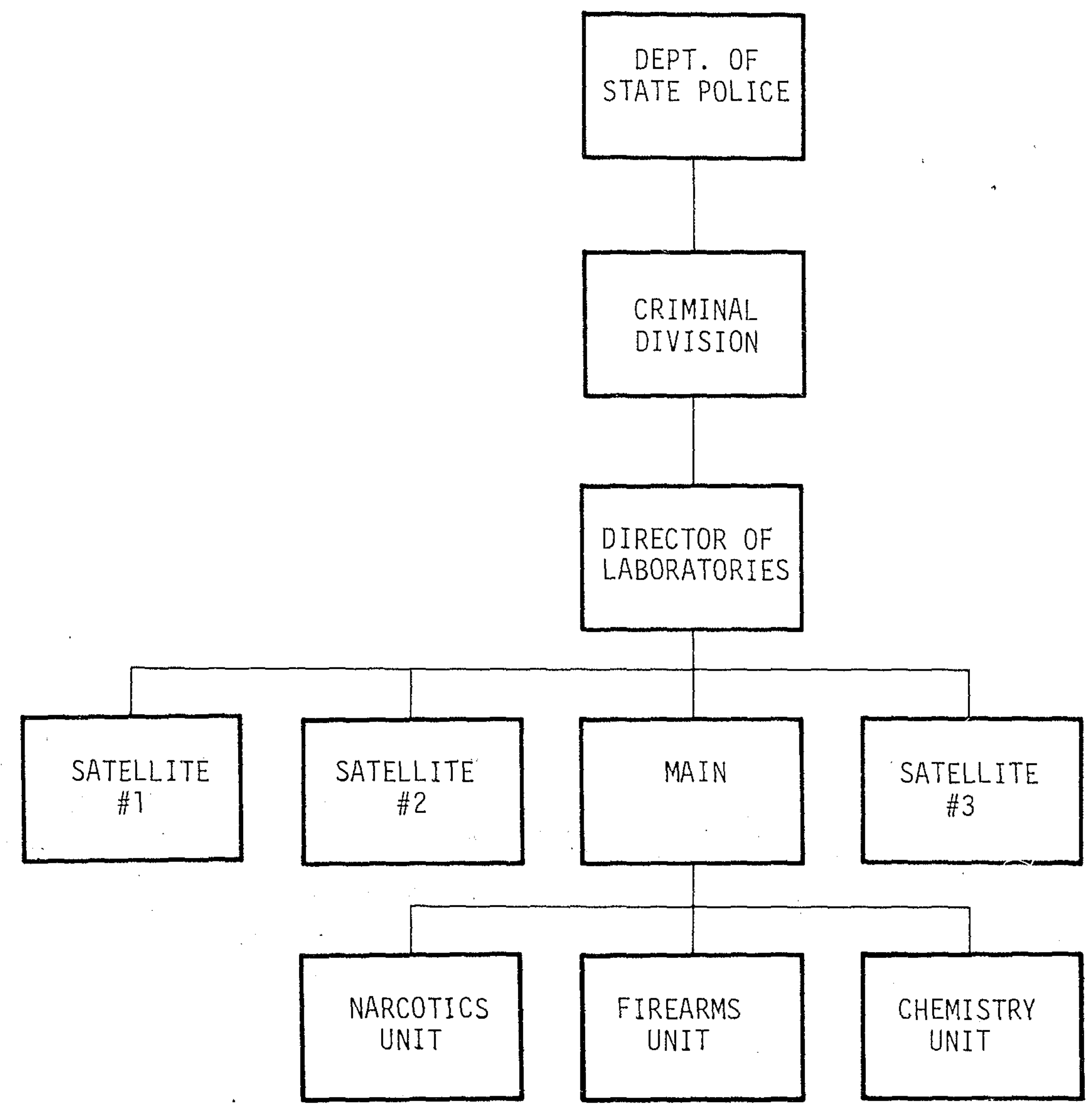


Figure 9

Priority Averages and Rankings by Size of Laboratory

APPLICATION AREA	Final Tabulation (176)* Rank	Ave	1-5 R	A	6-10 R	A	11-20 R	A	21+ R	A
Analytical/ID Support	1	2.45	1	2.47	1	2.00	1	2.48	1	2.63
Compilation of Statistics to Determine Specimen Uniqueness	2	3.26	2	3.61	2	2.89	2	3.29	2	3.06
Sources of Standard Samples	3	3.82	3	4.09	4	4.08	3	3.65	3	3.45
Literature Abstract Data	4	4.65	4	4.27	5	4.90	4	4.32	4	5.18
Rifling Specifications	5	4.87	5	4.53	3	3.95	5	5.13	6	5.64
Bibliographic Data	6	5.30	6	4.86	7	5.67	6	5.52	5	5.37
Sources of Knowledge	7	5.91	7	5.47	6	5.47	7	6.09	10	6.57
Sources of Reagents	8	6.35	8	6.00	8	6.26	9	6.91	9	6.41
Computation Capability	9	6.40	9	6.64	9	6.29	8	6.68	7	6.07
Explosive Tagging	10	6.92	10	7.40	10	6.50	10	7.22	8	6.33

* Responses Analyzed (not all laboratories indicated size)

Figure 10

Priority Averages and Rankings by Geographic Area

APPLICATION AREA	Final Tabulation (176)* Rank	Ave	MA NE R	Ave	ENC R	Ave	WNC R	Ave	SA R	Ave	[illegible] R	Ave	M R	Ave	WSC R	Ave	ESC R	Ave
Analytical/ID Support	1	2.44	1	2.50	1	2.56	1	2.31	1	2.67	2	2.75	1	1.50	1	2.64	1	1.00
Compilation of Statistics to Determine Specimen Uniqueness	2	3.14	3	3.50	2	3.05	2	1.64	2	2.86	1	2.75	3	4.00	2	2.83	4	3.67
Sources of Standard Samples	3	3.77	2	2.00	3	4.42	3	4.97	4	3.31	3	3.76	7	5.33	3	2.92	2	2.00
Literature Abstract Data	4	4.03	5	4.51	5	5.00	5	5.23	4	3.65	4	4.09	4	4.18	7	5.90	7	6.33
Rifling Specifications	5	4.78	10	6.80	4	4.82	6	5.36	8	5.67	5	4.10	2	3.50	4	4.86	3	2.67
Bibliographic Data	6	5.43	4	3.87	6	5.53	8	6.20	5	4.50	6	5.44	5	4.62	6	5.70	10	7.67
Sources of Expertise	7	5.75	6	5.20	9	6.00	4	5.09	6	5.27	7	5.76	10	7.30	5	5.20	9	7.33
Sources of Reagents	8	6.32	7	6.00	8	5.83	7	5.57	9	7.50	8	6.91	8	6.00	9	6.67	6	4.33
Computation Capability	9	6.32	8	6.03	7	5.72	10	6.67	7	5.33	9	7.18	6	5.00	10	7.11	8	6.33
Explosive Tagging	10	6.99	9	6.73	10	6.33	9	6.62	10	8.20	10	7.87	9	6.14	8	6.20	5	4.00

* Responses analyzed (not all laboratories indicated geographic area)

2. The information needs of user laboratories, not their organization structures and processes, will dictate the services to be provided by CLIS. CLIS must be organized to be responsive to the need for these services rather than to the organization of its users.

USER OPERATING CRITERIA

If all users, regardless of size and affiliation, are given equal say in the operation of CLIS as suggested, their influence will be collective rather than individual. User operating criteria can be defined as the regulations and policies that will be developed for the proper administration of the CLIS. Each user must be cognizant of his role in the operation of the system and how his inquiries and data will contribute to the successfulness of the system. The operating criteria will be composed of regulations and policies in the following pertinent areas:

- Terminal interactive protocol
- Data accuracy requirements
- System security guidelines
- Operating disciplines
- Personnel training requirements.

Development of some of these areas is very dependent upon system configuration and cannot be accomplished until the detailed system structure is defined. Once the CLIS has progressed to this stage, the operating criteria can be fully developed with regard to both technical and administrative policies and guidelines.

CHAPTER 7. IMPACT OF CLIS ORGANIZATIONS

CLIS ORGANIZATION

This chapter presents suggestions for two key elements of a proposed organizational structure and process of CLIS. The first aspect is the functional organization of CLIS which includes the day-to-day operation and maintenance of the system and the delivery of user services. The second consideration, equally as important, is the mechanism for making and enforcing general policies, procedures and control measures which would guide the administration and operations of CLIS.

The following discussion of these two organizational elements assumes system implementation and addresses possible requirements and alternatives for the first several years of on-going system operation. Implementation requirements will be presented in Volume 4 (Implementation Plan). The initial organizational requirements can obviously be affected by future changes in the number and types of services provided, number of users and usage rates.

Figure 11 shows the major organizational elements for which alternatives will be suggested in the following sections of this chapter.

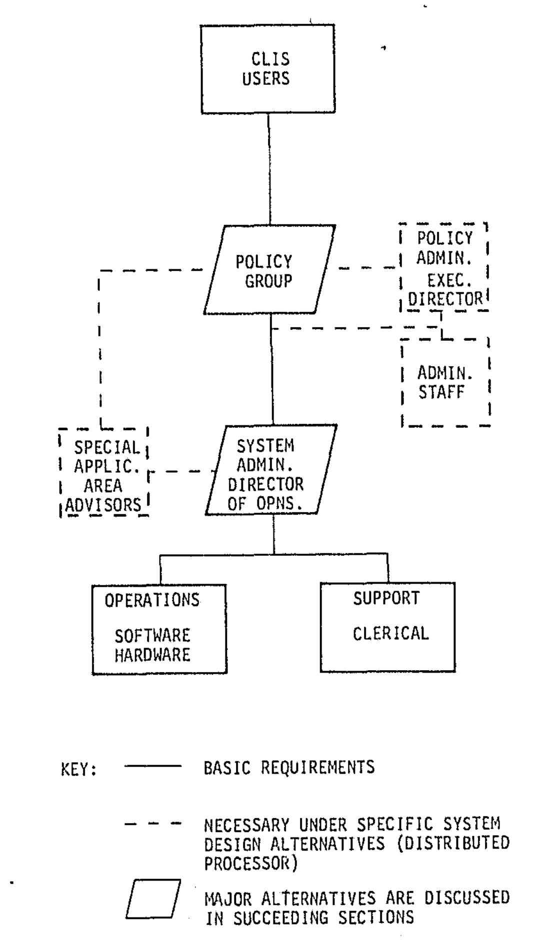
The ultimate organization of CLIS will be dictated in part by the final selection of a system design from the alternatives suggested in Volume 2. Each organizational alternative will not necessarily be an appropriate selection for each of the design possibilities.

POLICY GROUP

The various system design alternatives presented in Volume 2 can be implemented in one of several environments: as a new, autonomous entity dedicated to the operation of CLIS; as a part of an existing governmental agency; or as a part of an existing private, nonprofit entity. The need for a policy control group representing CLIS users, however, is paramount in any operational environment, even though its form may be unique to a particular environment. The act of officially formulating a policy group should also be high on the list of implementation priorities.

Figure 11

Basic CLIS Organizational Elements



The policy group should be vested with the authority to discharge the following broad responsibilities:

- Elect officers and establish duties, responsibilities of each.
- Promulgate rules and regulations and develop

policy guidelines for the administration of CLIS.

- Define the users of CLIS.
- Establish accessing and operating criteria.
- Establish administrative staff requirements and qualifications.
- Control the employment, assignment and tenure of executive staff.
- Evaluate and approve budgets.
- Require and approve annual operations plans.
- Require periodic progress reports from administrative staff.
- Distribute periodic status reports to users.
- Execute contracts and other legal documents.
- Establish and dissolve appropriate standing and ad hoc committees.
- Hold periodic business meetings.
- Control increases, modifications or decreases in user services.

GEOGRAPHIC REPRESENTATION BY STATE

This organizational alternative provides each user with guaranteed representation on a policy group. The users of each state would designate a state representative. The state representatives of each region (URC or NLETS regions could be used) would then select a regional representative to the CLIS organization. To increase potential effectiveness, these voting members of the policy group should be eligible to serve at least two consecutive terms.

Figure 12 shows this policy organization alternative. The organizational elements pictured with broken lines are those necessary if a design alternative requiring distributed processing is selected.

Advantages:

- Guaranteed and reasonably equitable representation of users
- Optional state and regional policy groups could be established in support of the national policy group
- Use of UCR geographic designations, for example, a reasonable working number of policy group members could be assembled
- Direct communication between policy group and users facilitated by state representatives.

Disadvantages:

- Optional state and/or regional policy groups would increase administrative expenses
- State representatives would not increase CLIS organizational effectiveness unless the majority of potential users are active in each state
- Geographic representation does not totally serve the need for a balance of functional experience and expertise among policy group members.

Geographic representation can also be accomplished by eliminating state representatives and having all the users in each region designate the regional representatives directly. During the early stages of implementation and operation this may be a more practical approach to reducing the possibility of "overrepresentation." Figure 13 shows this option. All relationships below the policy group level will be the same as those pictured in Figure 12.

GEOGRAPHIC/FUNCTIONAL REPRESENTATION

This alternative would enable the policy group to represent the users geographically and at the same time tap the functional specialty talent (firearms, narcotics, questioned documents, etc.), exclusive of geographic representatives required to provide the most effective and equitable policy resource

Voting members of the policy group can be selected by using either alternative suggested in the preceding section. The eight- or nine-member group would then nominate and select four to six additional voting members. The criteria for selecting these additional members should be flexible enough for the geographic representatives, after reviewing their collective experiences and talents, to strike a desirable balance of personnel resources. This balance should include a reasonable representation of users by geographic location, type of laboratory (full service or specialty), functional disciplines (firearms, narcotics, QD, etc.), controlling jurisdictions (federal, state, region, county, city) and organization (main only, main and satellite).

The same flexibility could also be extended to the selection of committee members. Committee chairmen and vice-chairmen should always be voting members of the policy group. Other committee members, however, could be selected at-large. This may be particularly useful for establishing special committees needed only during the implementation stages of CLIS. At-large members should be selected for their potential contribution to CLIS and need not be

Figure 12
CLIS Policy Organization — Geographic Representation by State

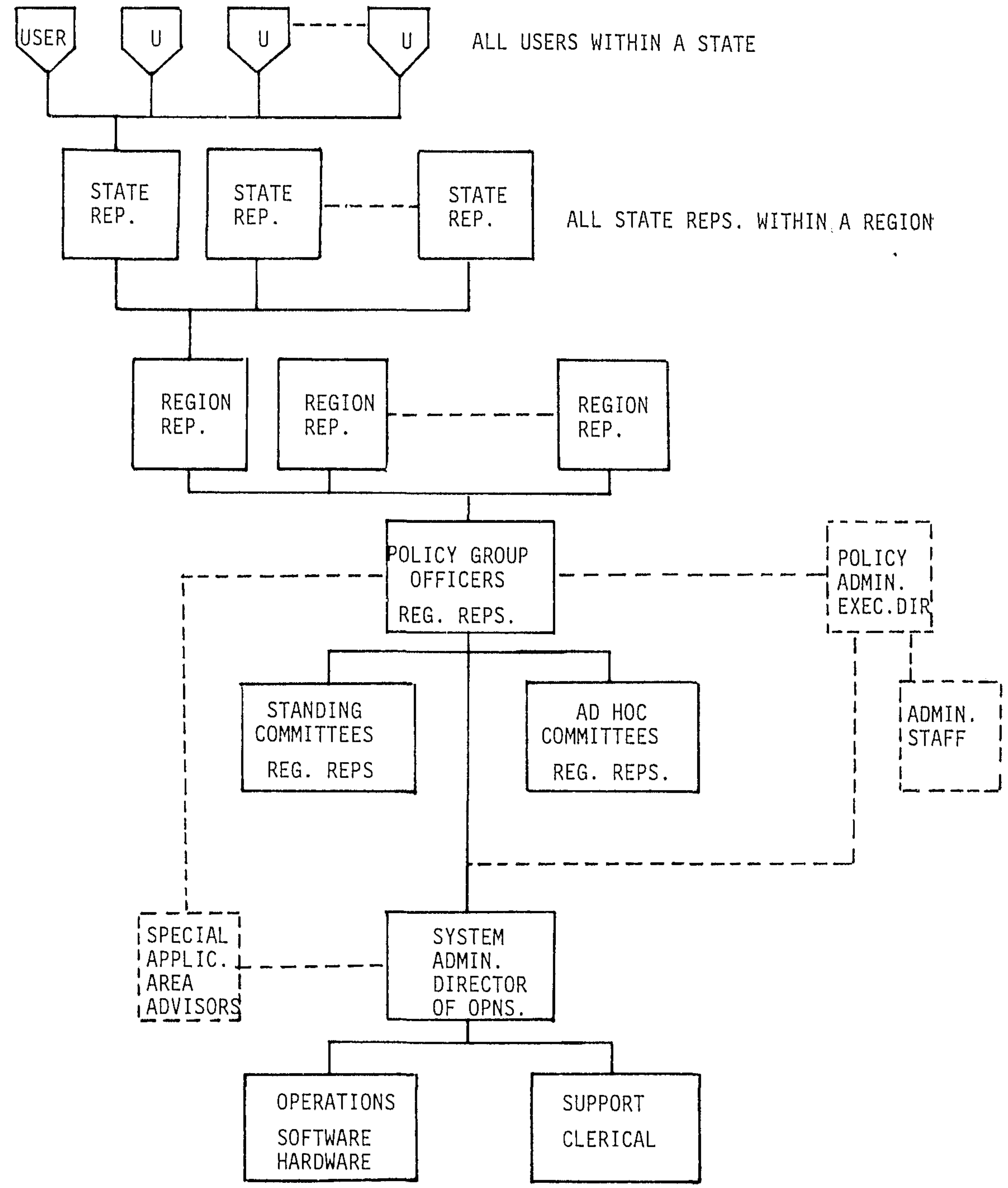
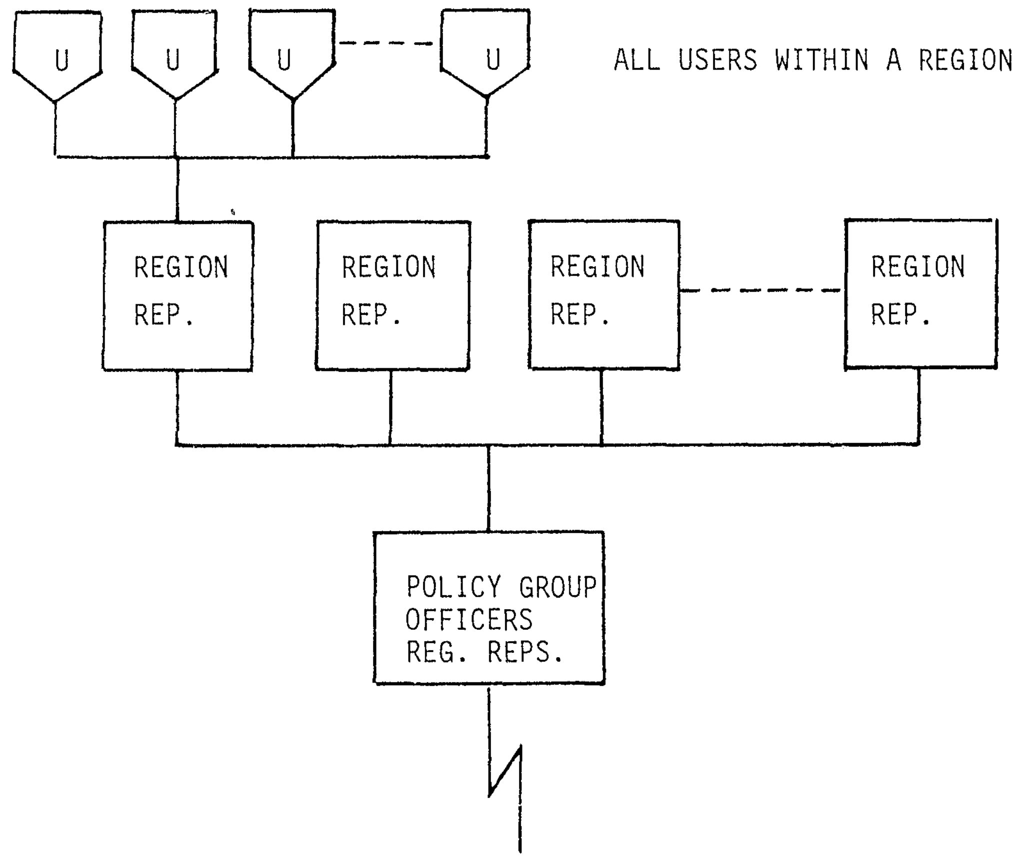


Figure 13
CLIS Policy Organization — Optional Geographic Representation by Region



restricted to active users. For example, valuable committee members could be drawn from crime laboratories, the academic community, government data processing agencies, private software firms, research groups, and public or private consulting groups.

Advantages:

- Guaranteed geographic representation of users
- Size of the policy group (12-15) not prohibitive to effective operations
- Larger size of policy group allows for fewer and more reasonable committee assignments among members
- Organizational flexibility enhanced by ability to select at-large members with specific expertise as either voting members of the policy group or as working members of comittees.

Disadvantages:

- Larger number of policy group members and committee members increases administrative expenses
- Decision-making process can become more time-consuming and difficult with additional voting members.

Figure 14 shows the organization structure for this alternative.

ADMINISTRATIVE AND OPERATIONS GROUP

Several conceptual system design alternatives were suggested in Volume 2. Cost estimates for the operation of these system alternatives was presented in the first four chapters of Volume 3. Another variable attached to the consideration of these possibilities is the line organization structure and process needed to provide effective operations under each configuration. Since the operational and maintenance demands of any of the system alternatives will not require large administrative and support staffs, the organizational alternatives can be very simple and uncomplicated without sacrificing efficiency and effectiveness.

User Independent CLIS. Although a possibility, this alternative would not be a practical one to implement nor an effective one to operate, and its chances for selection as a CLIS system alternative are considered extremely remote. For this reason, and the fact that suggesting realistic organizational alternatives for all potential independent users would be a tedious and essentially nonproductive effort, an organization structure will not be presented here.

Centralized CLIS and Centralized Hierarchical CLIS. Although the system design configurations for these two alternatives are somewhat different, the same basic organization structure could be applied to both. Figure 15 shows a suggested organization for system design alternatives with centralized processing capabilities.

Director of Operations. As the salaried staff administrator, this individual will be responsible for the day-to-day provision of user services and for the administration of policies and procedures established by the policy group. Broad responsibilities will include:

- Employment of operational and support staff
- System reliability and responsiveness
- Direction, coordination and control of system staff
- Administrative duties required by policy group for the business of its members.

CLIS Programmer. This position will have principal line responsibility for maintaining the application software of the system. Duties would include:

- Writing and modifying application programs
- Maintenance (additions, deletions, modifications) of application data bases
- Operation of system hardware in absence of operator
- Limited administrative duties as designated by director.

CLIS Operator. The operator will be primarily responsible for all "hands-on" equipment operation to include the following:

- Operation of all on-line hardware
- Operation of all peripheral equipment (keypunch, sorters, collators, etc.)
- Liaison with equipment service representatives and system engineers
- Monitoring of system activities.

Support Staff. A secretary will be needed to perform the variety of clerical and support duties required by director. These duties will include support for both the computer facility staff and the policy group and policy committee members. This individual should also be capable of operating the peripheral equipment.

Figure 14
CLIS Policy Organization — Geographic/Functional Representation

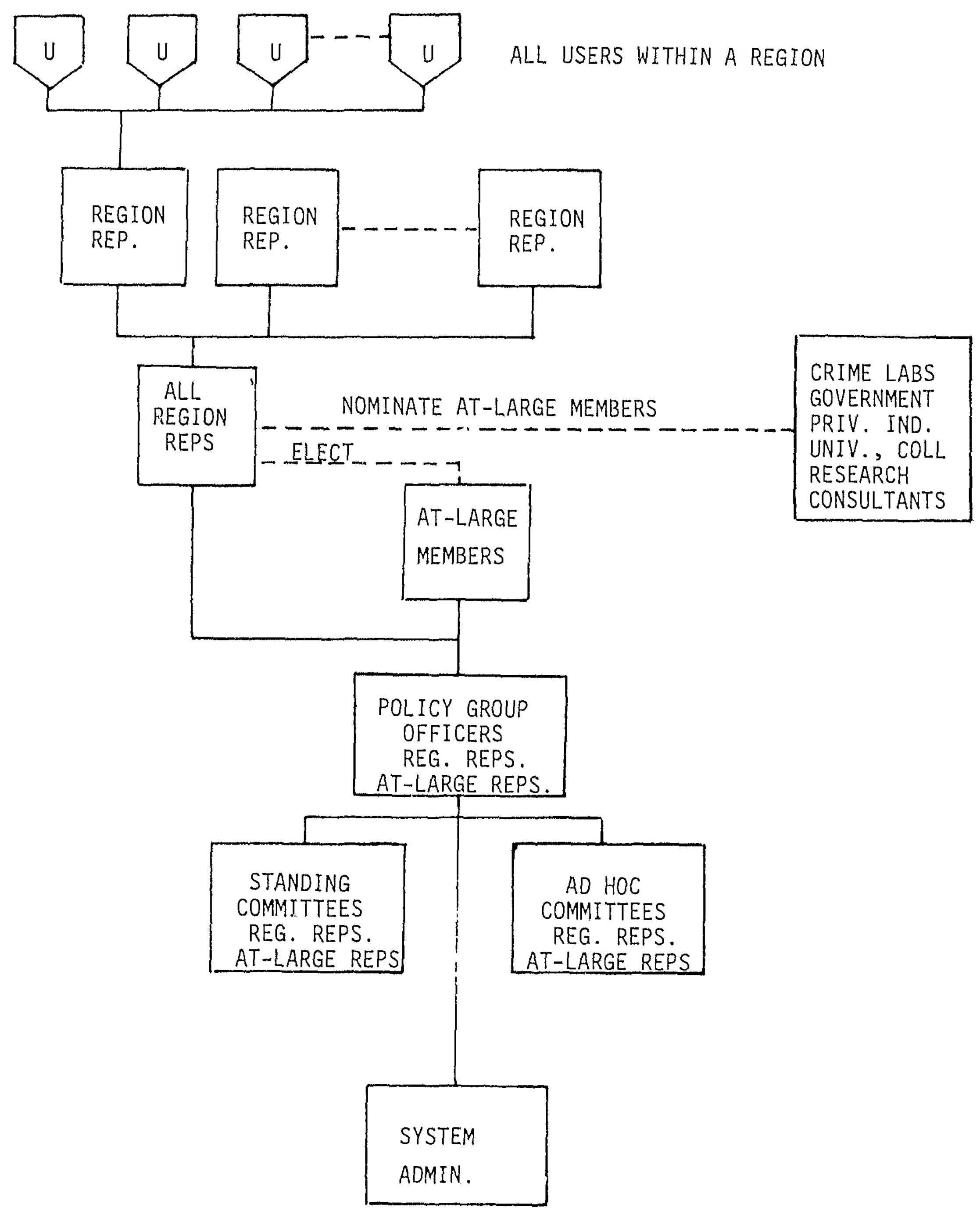
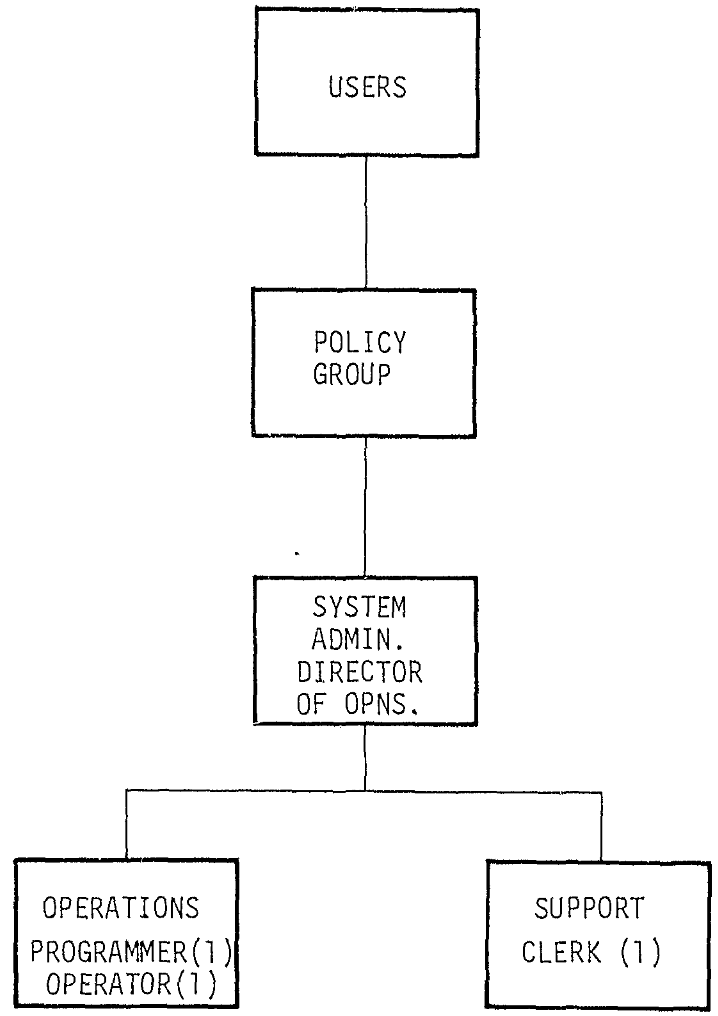


Figure 15
Organization Structure — Centralized Procssing CLIS



Advantages:

- Simplified organization structure
- Strong central control
- Minimum staff requirements
- Ability to provide backup capability with limited staff.

Disadvantages:

- Maintenance not performed or closely supervised by resident staff with specific application area expertise.

Distributed Processor CLIS, Distributed Communication CLIS, and Hierarchical CLIS. Any system design alternative with a distributed processing requirement would create the need for an organization structure similar to that shown in Figure 16.

Special Application Area Advisors. A major advantage of the distributed processor concept is the placement of application areas in computer complexes which uniquely satisfy specific functional processes and data storage requirements. It is likely that resident staff will also have appropriate expertise in the specific application area. This expertise should be used primarily in controlling the accuracy and currency of stored data. Special application area advisors may supervise maintenance actiivties personally or monitor these activities through resident systems personnel. Maintenance procedures recommended by special advisors would be approved by the policy group.

System Application Operations. Each processor location must have its own operational staff to provide user services for specific application areas. One programmer/operator will be assigned the responsibilities described for both positions under the centralized CLIS alternative. The clerical support would be for the processor facility only and would not include any duties for the policy group.

Policy Administration. The decentralization of processing functions forces an additional organizational level into the structure between the policy group and the application staffs. A salaried staff position (executive director) must be established to exercise control over the distributed processor locations. On behalf of the policy group, this individual must ensure that CLIS policies and procedures are carried out by the staffs at each distributed processor location. The administrative staff support at this level would be for the director and the policy group only.

Advantages:

- File maintenance performed or supervised by resident staff with specific application area expertise.

Disadvantages:

- Lack of direct central control
- Additional staff required to perform same function as centralized CLIS alternative.

COMPARATIVE SALARY REQUIREMENTS

As we have seen, the individual system design alternatives do not require large staffs or sophisticated organization structures for their implementation. Personnel salaries, therefore, will probably be the largest single contributor to pure organization costs at the administrative and operational levels. Table 9 shows comparative personnel costs on an annual basis for the two major system design alternatives.

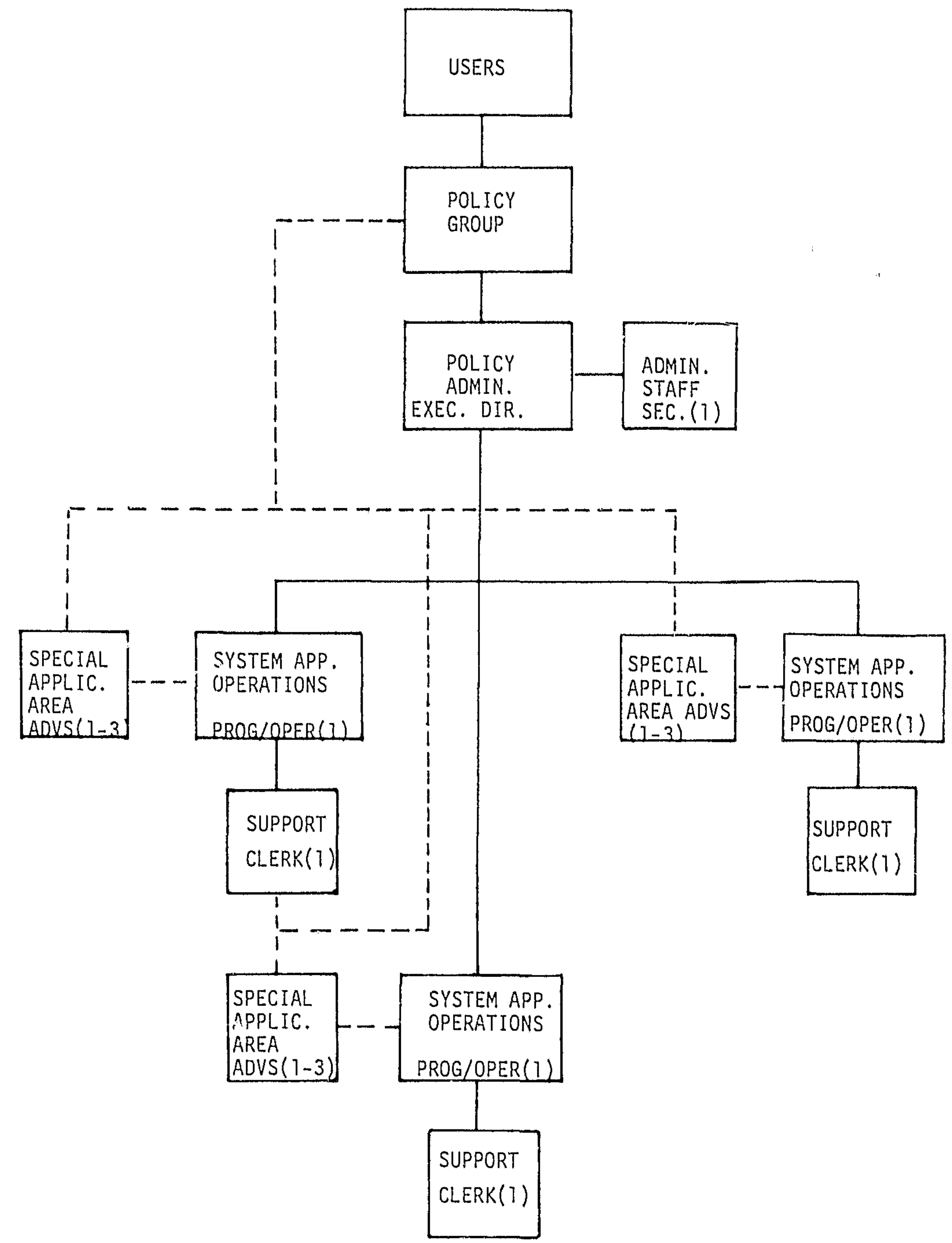
The personnel salaries for the minimum distributed processor option (two locations) represent an increase in annual costs of $6,708 over the equivalent centralized CLIS salary requirements. If four distributed processor locations were used, the annual personnel costs would exceed those of a centralized CLIS by almost $35,000.

RECOMMENDATION

Policy. Of the two alternatives presented for the organization of a policy group for CLIS, the geographic/functional representation of users is suggested as holding the most promise for ensuring prompt, high-quality service. The significant features of this alternative are: (1) a realistic mechanism for strong centralized control of CLIS staff and operations, (2) the capability to tap an unlimited personnel resource pool for policy group membership, (3) the potential for organizing a policy group which represents the interest of potential users in a most equitable manner, and (4) this alternative could be ideally implemented along with the recommendation in Chapter 4 that system operations be assumed by an existing governmental agency.

Operations. The recommendation in Chapter 4 also stressed the important advantages to centralizing the system operationally. It is an obvious corol-

Figure 16
Organization Structure — Distributed Processing CLIS



lary that the CLIS organization be structured in a similar manner. In fact, the principal guides for designing operational organization alternatives were the alternative system configuration designs. Only one alternative for operational organization is suited for this course and is suggested here to complement earlier recommendations. There is no alternative but to place operations staff in the central CLIS facility.

Additional Organization Considerations. Having CLIS operations added to an existing governmental agency would have a favorable impact upon organization requirements with most benefits gained in the personnel area.

Personnel. All administrative and operations staff could either be reassigned from existing personnel in the government agency or hired by the agency to fill the necessary positions. In either case the administrative burden of this activity on the policy group is greatly reduced. The policy group, however, must retain its authority to approve all personnel assignments.

A governmental agency with existing hardware and administrative and operating staff should also be capable of providing backup staff without serious difficulties in emergency situations.

Depending upon the size of operations, a governmental agency with relatively sophisticated data processing capabilities could conceivably have the necessary implementation staff (or reassign from existing staff) and later absorb those people either into the CLIS system or other in-house ADP service areas.

User Participation and Confidence. The eventual selection of a government host agency for CLIS must be done with much care and concern for the impact of the decision upon potential user participation. Generally speaking, an established governmental computer facility with a proven track record, coupled with a strong policy/control group sincerely dedicated to its users should be a combination which generates an adequate level of user confidence and system credibility. Having to establish an autonomous administrative and operational CLIS agency from scratch would be considerably more difficult and time-consuming and might restrict user participation until the "track record" was established and positive results were achieved. Contracting with a commercial firm of proven capability and interest would most likely fall somewhere in the middle on the scale of user acceptance. Although the same level of effectiveness might be achieved under a commercial venture, the policy control of a profit-oriented firm could possibly cause additional difficulties if CLIS were to be at least self-supporting. Most all potential users will be affiliated with some form of governmental agency anyway, and that environment is one that they know and feel comfortable with. Any change in established routines is going to generate a certain amount of concern or resistance. However, if those changes involve the introduction of a CLIS organization to which users can relate on the basis of basic similarities (governmental), the acceptance of the entire concept may be more palatable.

Funding. If a government host agency for CLIS is selected, it must accept the inherent responsibilities of providing user services, implementing CLIS policies and managing equipment and personnel resources with the guidelines established by users and their representatives. Acceptance of CLIS by an agency would also probably require a firm financial commitment by the accepting agency. Since the selection and acceptance activities have not been completed, it is impossible to predict how much of the implementation and operating costs of CLIS would be assumed directly by the host agency. It is not unreasonable to presume that a substantial portion, if not all, of the operating costs could be absorbed through additional budget appropriation requests by the agency. An autonomous CLIS organization or a commercial venture would not provide this potential funding flexibility.

If supplemental funds were required from other sources, a government agency would probably fare better than either of the other two alternatives since the major source would be the federal government (LEAA), and its process is geared to funding other government agencies at the state, federal or local levels.

Legal Implications. One of the keys to the successful operation of CLIS will be the authority and ability of the CLIS policy group to exercise control over operating agency's conformance to the established policies, procedures and guidelines regulating the provision of user services. Several precedents can be cited as the basis for future analysis of this consideration.

An NCIC policy board representing its users suggests policies which will guide the operation and security of the system. Legal agreements are entered into by the FBI and each terminal user.

The policy board of directors of NLETS is a part of a private, nonprofit corporation which has entered into a contractual agreement with the State of Arizona to further the purpose of operating a national telecommunications network.

Of the two national systems cited above, one is operated by a federal agency, the other by a state. One involves a legal agreement with each user and the other involves a contractural agreement for a fee.

The legal aspects of any organization cannot be resolved until an operating agency has accepted the responsibility for CLIS user services, but any legal agreement between the users, either individually or collectively, must represent the interests of the users and the operating agency in an equitable manner.

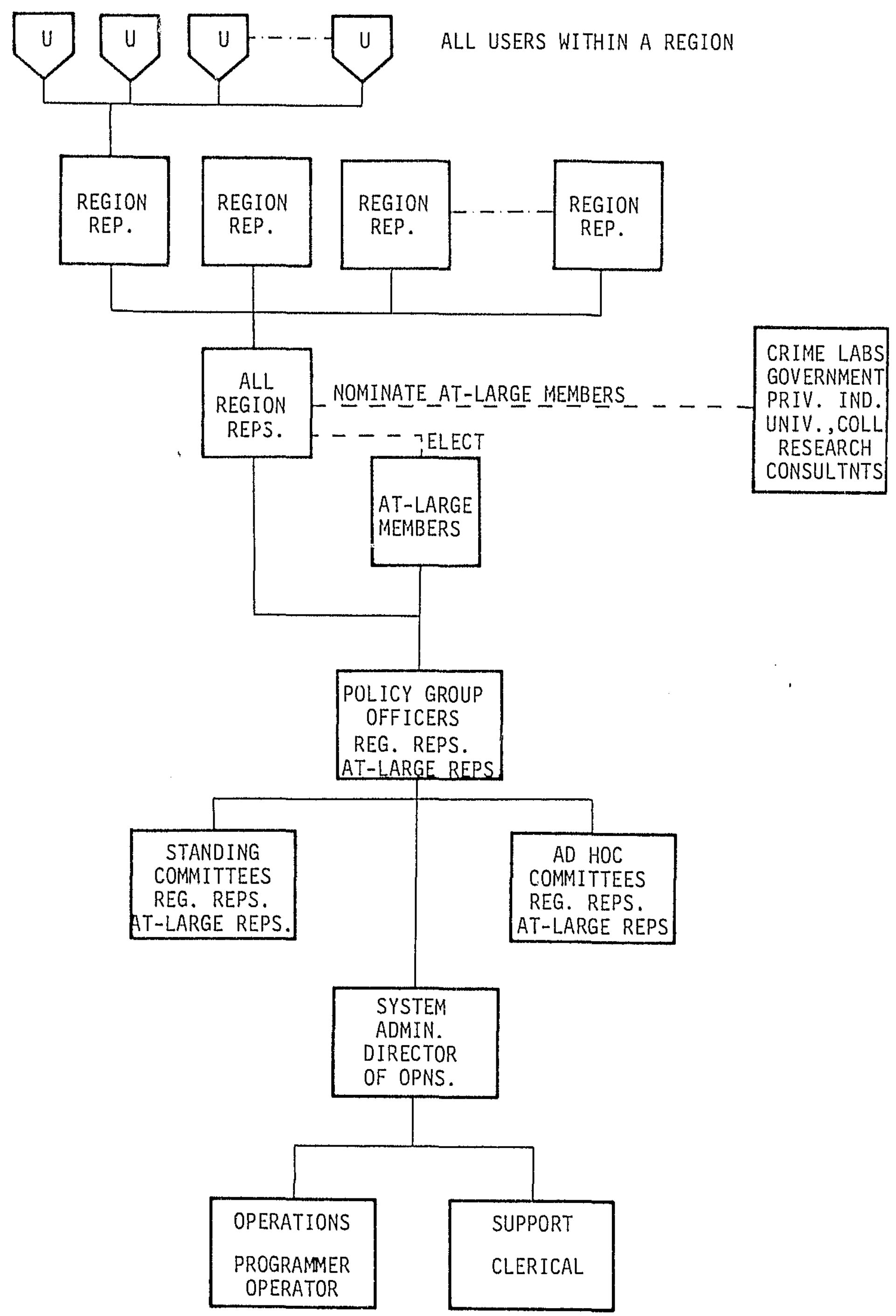
Structure. Figure 17 shows the total organization structure recommended for CLIS.

Table 9
Comparative Annual Personnel Costs
Organizational Alternatives

	CENTRALIZED CLIS	DISTRIBUTED PROCESSOR CLIS LOCATIONS		
		2	3	4
EXECUTIVE DIRECTOR		19,864	19,864	19,864
DIRECTOR OF OPERATIONS	17,368			
JUNIOR PROGRAMMER	10,348			
SYSTEM OPERATOR	7,592			
PROGRAMMER/OPERATOR		17,888	26,832	35,776
CLERK-OPERATOR	6,136			
CLERK-ADMINISTRATIVE		10,400	15,600	20,800
ANNUAL TOTALS	41,444	48,152	62,296	76,440

SOURCE: DATAMATION, May 1974
(Figures reflect national average)

Figure 17
Suggested CLIS Organization



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