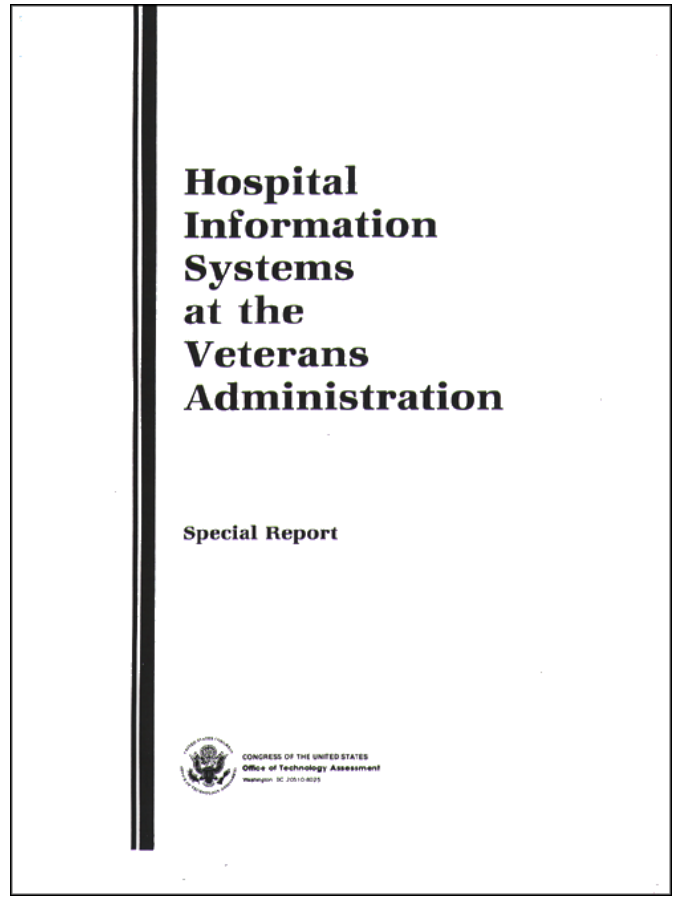
Hospital Information Systems at the Veterans Administration

September 1987

NTIS order #PB88-133087





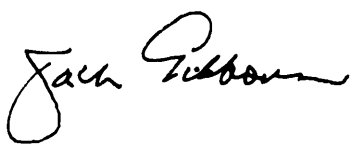
Foreword

This Special Report focuses on the Decentralized Hospital Computer Program (DHCP) currently under developmental the Veterans Administration. The study was requested by the House Committee on Appropriations and the House Committee on Veterans' Affairs.

OTA's Special Report addresses near-term and long-term decisions that must be made concerning the direction of hospital information systems development at the VA. The Special Report formulates and offers options for Congressional consideration and emphasizes VA's need for effective strategic planning and exploration of multiple technological alternatives.

This Special Report is intended as a narrowly focused, quick response to the concerns of the requesting committees. The study process included a general review of the features and costs of DHCP and three competing commercial hospital information systems, but it did not involve an in-depth review of the underlying technology of any of the systems. The study included a general review of the Veterans Administration's current development process and deployment plans for DHCP, as well as the Department of Medicine and Surgery% strategic planning processes for hospital information systems.

OTA appreciates the participation of the advisory panelists, working group participants, VA officials and staff, and many other persons who provided information or review comments. The report itself, however, is solely the responsibility of OTA, not of those who so ably advised and assisted us in its preparation.



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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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OTA SPECIAL REPORT

HOSPITAL INFORMATION SYSTEMS AT THE VETERANS ADMINISTRATION

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HOSPITAL INFORMATION SYSTEMS AT THE VETERANS ADMINISTRATION

SUMMARY OF OTA FINDINGS

OTA finds that two time scales must be considered in making decisions concerning Veterans Administration (VA) hospital information systems: both near- and far-term options must be examined.

OTA finds that, in the near term, VA has a limited set of options from which to choose because it has not taken the opportunity in the past to expand its technological options through thorough testing and study of system alternatives. If VA is to implement at least a minimum level of automation in all its hospitals within the next year or two, OTA finds no reasonable alternative to the Decentralized Hospital Computer Program (DHCP). To consider a switch to a commercial system at this time would increase costs and delay implementation in the hospitals. The "Core Plus 8" DHCP modules, assuming they work as expected, seem to offer reasonable features and functions to meet the VA's near-term needs for hospital information.[1]

This special report is limited in scope, and OTA did not make determinations concerning a number of issues, including:

- whether those Core Plus 8 modules still under development or testing will in fact work as the VA expects them to;
- whether the order-entry /results-reporting functions now being developed will prove satisfactory for Core Plus 8 in hospitals with high transaction rates; or
- whether additional modules beyond Core Plus 8 are desirable.

Thus, VA and the relevant congressional oversight committees will need to continue to monitor DHCP status so that these key issues can be determined.

In the long term, DHCP may have limitations that could make it an unsuitable platform for a transition to the information system VA will need in the 1990s. Some of the members of this study% Advisory Panel and its Federal Working Group have raised

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1. See OTA contractor report by Sheldon L Dorenfest and Associates, Ltd.: "Evaluation of Hospital Information Systems for the Veterans Administration" (Draft), Sept. 10, 1987, pp. 2 and 20-30. Dorenfest recommended that, "The Core Plus 8 version of DHCP should be adopted as the foundation for meeting future VA hospital information system requirements." In response to OTA's request for clarification as to the time frame considered for "future", Dorenfest specified that its recommendations were made, "within the context of the 10-year systems life cycle used by the VA" [i.e. until 1996]. Source: Letter from Ronald Gue (Dorenfest) to OTA, Sept. 14, 1987.

and noted the importance of this issue, citing possible limitations due to DHCP's choices of system architecture, database structure, and computer language. In OTA's view, fundamental questions have been raised that the VA will need to examine fully. The VA and the rest of the health care community are still quite low on the learning curve for integrated hospital information systems. Given the relative newness of the field, it would be unreasonable to expect any first-generation system to contain an optimal set of features, or to have a long useful life span.[2]

OTA finds that if VA wishes to reap the benefits of technological change, it needs to begin now to do long-term planning that can examine technological alternatives for the next generation of hospital information technology. VA's current planning process focuses on continual revisions to and evolution of the DHCP software, and does not provide an appropriate mechanism for exploring needs, opportunities, and alternative options for the next generation.

OTA finds that VA needs to ensure that its long-range planning process has the following characteristics:

- it must include top VA management and be given priority and support by top management;
- it should not have to compete for resources with the ongoing DHCP development, deployment, operations, and maintenance activities -- that is, these near-term needs must not be allowed to drain off resources needed for long-term planning;
- it is sufficiently separated, administratively and operationally, from ongoing DHCP production activities to ensure that the long-range planning processes[3] protected from internal biases;

2. In this paper the terms 'first-generation' or "next-generation" refer to the information system deployed, not to the programming language.
3. It is common organizational practice to separate planning and research and development activities for the next generation product from those for the current generation product. In the computer industry, for example, staff and activities devoted to a new-generation product are administratively, even geographically, separated in order to preserve their independence and avoid biases; it is not considered feasible to expect individuals who are stakeholders in the current generation product to take a detached look at it for the purposes of long-range planning. For one description of this process in the computer industry, see: Tracy Kidder, The Soul of a New Machine (Boston/Toronto: An Atlantic Monthly Press Book, Little, Brown & Co., 1981).

- it remains in touch with users' needs so that it does not become an empty, "blue-sky" intellectual exercise; and
- it makes use of a wide range of expertise from outside VA.

Many other Federal agencies are already planning for information systems that will be in place in the late 1990's or beyond. Some of these, such as the Federal Aviation Administration (FAA), are examining multiple competing technological alternatives. Because of the complexity and scale of agency information systems, and because of the temporal realities of cyclic Federal procurements, even if VA begins to plan now for its next-generation system, the system may not be in place until the end of the century.

The options discussed in this special report offer to the Congress some possible mechanisms for allowing VA to pursue its preferred course of action while at the same time insuring Congressional oversight in the face of possible risk. In addition, they give Congress mechanisms for encouraging VA to begin the processes of strategic planning and consideration of technological alternatives before VA commits itself to a "next generation" hospital information system.

The two options explored in the Special Report are:

1. Deploy the Core Plus 8 software system-wide, then cap hardware expenditures and freeze development of additional software modules. Allow VA to enter a "plateau" phase for strategic planning and evaluation of technological alternatives for its next generation information system.
2. Continue deployment of Core Plus 8 and begin parallel efforts for strategic planning and evaluation of alternatives for the next-generation system. Make release of additional funds contingent upon VA'S demonstration that: a) order-entry/results-reporting works satisfactorily in a high-transaction production environment, and b) suitable processes are underway for strategic planning and evaluation of technological alternatives for the next-generation information system.

Both options have advantages and drawbacks. Option 1 assures some control over further expenditures for DHCP and provides a clean break from DHCP development activities in order for the VA to devote agency attention to planning for the next generation. Its chief drawback is that it delays the start of the planning process for about three years.

Option 2 allows the planning process to begin immediately, but there is risk that VA is too locked into its current development process to focus adequately on alternative strategies for the next generation.

The study's Advisory Panel members, reviewers, VA staff, and others suggest that a delay in planning is the overriding disadvantage. In this case, Option 2 is probably the preferred of the two.

Continuing congressional oversight will be needed to ensure that VA's deployment of the 'Core Plus 8" DHCP system remains on target and that the agency creates and uses a suitable long range planning process.

BACKGROUND OF REPORT

OTA was requested to conduct an 'independent, objective assessment" of the Veterans Administration% Decentralized Hospital Computer Program (DHCP). This study was first requested by the House Committee on Appropriations; subsequently, the House Committee on Veterans' Affairs became an additional requester. The House Committee on Appropriations had serious concerns about the direction of the DHCP program and VA'S ability to manage a software development on this scale. The other requesting committee, the House Committee on Veterans' Affairs, did not agree with the Appropriations Committee% concern about the direction of DHCP but joined in the request in exercise of its oversight function.

This study was approved by the Technology Assessment Board on June 9, 1987 and was completed by October 1, 1987. It is intended as a brief and narrowly focused short-term response to the concerns of the requesting committees. The study process included a general review of the features and costs of DHCP and three competing hospital information systems and an overview of VA% current development process and deployment plans. It did not involve an in-depth review of the underlying technology of any system. Furthermore, the study did not attempt to examine benefits of DHCP for agencies other than the Veterans Administration (the Indian Health Service, for example, makes extensive use of DHCP, and DHCP is also used on a test basis in two Department of Defense hospitals).

Hospital information systems provide means for interdepartmental communication, bringing together information on laboratory and radiological test data, pharmacy orders, medical history, and other patient data in a way that is easily accessible and usable by caregivers. The information system can aid in patient care by providing to the staff timely information needed to make decisions, diagnoses, and interventions. Information systems also aid in hospital and agency management by bringing together information on utilization of facilities, results of treatment, financial records, inventory control, case mix, and other information that helps administrators determine the costs, effectiveness, and quality of care.[4]

DHCP History

DHCP is the primary initiative in VA's current approach to automation of hospital information systems. VA announced its plan to develop software for DHCP 1982; this development effort actually has its roots in work on clinical computer applications that began in VA in the 1970s. DHCP is being developed at six regional Information System Centers (ISCs) under the direction of the Medical Information Resources Management Office (MIRMO). A seventh ISC has been established, but as of September 1987 had no formal development assignments.

The DHCP initiative involves developing a modular set of computer packages and is intended to evolve from the initial functional packages (called the Core) into a full-scale, integrated medical-center system that is intended to provide comprehensive support for station-specific clinical and administrative automation needs as well as for VA systemwide management information.

The Core applications have all been developed, and a subset of them, called the Initial Core applications (patient registration; admission, transfer and discharge; clinical scheduling; outpatient pharmacy) have been implemented at all VA Medical Centers (VAMCs). Full Core applications (adding inpatient pharmacy and Laboratory) began to be implemented in fiscal year 1985 and VA has scheduled these to be fully deployed in fiscal year 1987.

In June 1987 VA defined its basic system to be the six Core applications plus eight high-priority Enhanced DHCP applications: radiology, dietetics, medical records tracking, fiscal and supply functions (IFCAP), medical management information (DMMS), surgery, nursing, and mental health. Except for IFCAP and DMMS, these have clinical service orientations. Of the Enhanced applications, three are complete, one is in verification, two are in test, and two are still in development.

VA currently does not have sufficient computer hardware to implement the software it has developed at all its hospitals, and on March 9, 1987 released a Request for Proposals (RFP) for the purchase of computers and peripherals. The House

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4 Examination of the contributions of hospital information systems to the quality and cost effectiveness of patient care was beyond the scope of this OTA study. Also OTA did not attempt to re-examine the determination by Congress and the VA that hospital automation in the VA Medical Centers would benefit patients and improve the quality of care provided the Nation's veterans.

Committee on Appropriations, while not formally "fencing" the funds, has asked VA not to spend the funds allocated to this hardware procurement until after the completion of this OTA study.

IHS System Test

The fiscal year 1981 appropriations act initially directed VA to carry out a continued planning effort to determine the cost-effectiveness of developing DHCP software in-house as compared to purchasing ‘off the shelf” systems from the commercial sector. As a result, in 1983 VA contracted with three commercial vendors to install prototype demonstrations in three VAMCs: Philadelphia, PA (Shared Medical Systems); Saginaw, MI (McDonnell-Douglas); and Big Springs, TX (Electronic Data Systems). VA refers to these commercial systems collectively as ‘integrated hospital systems" or IHS. The IHS demonstration period began in September 1984. Arthur Andersen & Company received a contract from VA to monitor the progress of the installations and to conduct a comparison of pre- and post-implementation environments at each IHS site. This report was to have been completed by September 1987.

Booz-A1len & Hamilton, under contract with VA, completed a comparison of IHS and DHCP in February 1987, before the formal completion date for the IHS tests. The Booz-Allen study recommended some managerial changes for the DHCP program and concluded that DHCP software could provide benefits comparable to commercial systems at significantly lower costs. This conclusion was regarded by VA as supportive of the VA’s request for additional funding to continue with DHCP and provide hardware for the eight Enhanced DHCP applications. However, the IHS vendors have proposed separate cost projections. They point out that the Booz-Allen cost comparisons are misleading or meaningless because, among other things, the three IHS systems include many more capabilities than even the Enhanced DHCP system with which the IHS systems’ costs are compared. The vendors also argue that if the 1983 RFP for the IHS test is taken as a benchmark for VA's hospital automation needs, then the same RFP should be used as a benchmark for DHCP. Also, other recent studies (including one by the General Accounting Office and one by the Investigative Staff of the House Committee on Appropriations) are in apparent conflict with the Booz-Allen conclusions on the cost of DHCP, finding that VA cost estimates were too low.

FUNCTIONALITY OF DHCP AND IHS SYSTEMS

Site visits and interviews by OTA staff and contractors found roughly similar features and functions in DHCP and IHS information systems. Clearly, each of the systems analyzed had different strengths and weaknesses. In some cases one or another IHS system had features that were missing from DHCP and that would be quite useful to the VA in providing better patient care. In some cases, too, vendors were capable of providing features that could have been of use to VA but had not been asked for by VA in its contract. On the whole, however, the differences between features and functions provided by one system and those provided by another were modest differences, not overwhelming ones.

OTA found that the Core modules plus the six (of eight proposed) Enhanced modules, currently running in at least some of the DHCP hospitals, were adequately performing the functions for which they were designed. One significant shortcoming observed in DHCP is the clumsiness of the order-entry /results-reporting function, which attempts to bring the features of modules such as pharmacy, lab, and dietetics into a common user menu for use by a nurse or ward secretary. Order entry is still under test and may improve in future releases. However, it is possible that the design of ward order entry is inherently clumsy due to the separate development of the pharmacy, lab, and dietetics modules. In this case, problems may not be solved satisfactorily, leading to deteriorating response times as more functions are integrated into the ward order entry menu and as larger numbers of terminals are used in hospitals.[5]

This possible deficiency is important because effective, reliable, and prompt order entry is basic to a successful hospital information system. A poor order entry system can reduce the effectiveness of the nursing module and other modules used on the nursing

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5. See OTA contractor report by Dorenfest & Associates, pp. 27-38 and 30 for observations concerning DHCP's module-specific order entry and results reporting design. Now that multiple modules have been implemented, VA nursing personnel have expressed dissatisfaction with the module-specific order entry; complaints have centered around the number of screens required to access functions and the menu structure they are required to use. A VA development effort called order-entry/results-reporting (OREO) is intended to facilitate multiple-application order entry through a more unified order entry system. The order-entry /results-reporting system is under test at some sites. OTA has not made a determination on how well order-entry /results-reporting will work when all the Core Plus 8 modules are running and hospital transaction rates are high. Dorenfest and Associates consider it likely that, given DHCP's overall systems design, additional module access and integration problems will be found as DHCP implementation continues.

wards. Most important, slow or clumsy order-entry systems can actually increase the workload of busy nursing personnel, reducing the time available for patient care.

The DHCP system resembles the model of a "limited" hospital information system while the three IHS systems approach the model of a 'comprehensive' system. This distinction is based, not on the number of features, but on the flexibility of the order communication system that links the nursing station with the ancillary departments. A comprehensive system is more capable of fully supporting automated charting, nurse care planning, and other patient care functions, although limited systems are widely used, especially in small and medium-sized hospitals.[6] If VA implements a successful version of its order-entry /results-reporting function, DHCP will still remain a 'limited" system in this sense, and thus may not be the system of choice for the long term (e.g., 1990s and beyond).

USER SATISFACTION AND USER INVOLVEMENT

User satisfaction was generally high at both DHCP sites and IHS sites visited by OTA. This is an encouraging finding. But it also means that user satisfaction cannot be considered a differentiating factor among the sites or a distinguishing characteristic of a particular system. People were satisfied with the system they used and proud of the work they had done to install it in their hospitals. In most cases users had no prior exposure to automation and have not been encouraged to look at alternative systems, even within VA, so they have no basis for comparison of their system to any other.

User involvement in specifying the system and in giving feedback to the developers is crucial to successful implementation. The Special Interest User Group (SIUG) process used for DHCP has been fruitful in gaining user input. It is an important element in DHCP's successes to date. As presently constituted, however, the SIUG's appear to be top heavy, with too many service chiefs and too few end-users. The VA's Department of Medicine and Surgery (DM&S) needs to continue to ensure that the process provides for end-user, as well as managerial input.

It is important to note that user involvement is also possible with software developed by an outside vendor as well as with software developed in-house. At the VA hospital at Saginaw, the process of user involvement in specifying system needs appeared to be formalized very much along the lines of the SIUG model, and the system and user

6. Dorenfest & Associates, "Evaluation of Hospital Information Systems for the Veterans Administration," (Draft) Sept. 101987, pp. 34-37.

needs appeared to be closely matched.

User involvement in implementation and operation at the department level in each hospital is also important, and VA seems to be handling this fairly well with the 'application coordinator role in each department. Some problems at IHS hospitals were not system problems but management problems that arose from not formalizing the process of user involvement. In Big Spring, for example, serious mismatches between system capability and user expectations arose from a 1984 decision by the VA central office to modify some of the capabilities to be required in the contract with EDS (resulting in a $1.7 million contract cost reduction) without first consulting Big Spring administrators or staff about their preferences or fully explaining the consequences of the modification to them.

MANAGEMENT OF DHCP

Over the past 3 years a number of studies by Congress, the VA Inspector General, and the General Accounting Office have found weaknesses in VA'S management of the software development and implementation phases of DHCP.[7] VA has responded to these criticisms and now is instituting many of the policies and procedures recommended by previous studies. For example, VA now has promulgated a security policy, programming standards, a software verification procedure, and a documentation policy.[8] With these in place, VA now appears to be in a much better position than it was a year or two ago to manage the development and implementation of a hospital information system.

However, because these have been instituted within the past year, OTA has not made a determination as to their efficacy. Nor (as of Fall 1987), does it appear that VA

7. See, for example: U.S. Congress, General Accounting Office, Hospital Information Systems: VA Needs to Better Manage Its Decentralized System Before Expansion, report to the Chairman, Committee on Veterans' Affairs, House of Representatives, GAO/IMTEC-87-28, July 1987; U.S. Congress, House, Committee on 'Appropriations, Veterans Administration Medical Computer Programs, prepared by the Investigative Staff of the House Appropriations Committee, December 3, 1986.; U.S. Veterans Administration, Office of the Inspector General, Audit of the Decentralized Hospital Computer Program (DHCP), Report No. 6AD-G07-1, August 22, 1986.
8. See, for example: U.S. Veterans Administration, Department of Medicine and Surgery, Memoranda from the Director, Medical Information Resources Management Office, "Policy and Guidelines for DHCP Software Verification," December 9, 1986; "Policy and Guidelines for VA DHCP Programming Standards and Conventions," May 5, 1987; 'Documentation Standards for DHCP Software," May 15, 1987. In September 1987, the Department of Medicine and Surgery's security policy and guidelines were still in draft form.

has yet performed or initiated a full risk assessment of DHCP per Office of Management and Budget (OMB) Circular A-130.[9] OMB Circular A-130 ("Management of Federal Information Resources," Dec. 12, 1985) establishes policy for the management of Federal information resources and specifies a minimum set of controls, procedures, audits, and reviews for Federal automated information system (AIS) security. Agencies are required to do risk analyses and define approved application security specifications. Also, agencies are required to conduct periodic audits or reviews of sensitive applications, in order to certify/recertify the adequacy of implemented safeguards, assure that these are functioning properly, identify vulnerabilities, and assist with implementation of new safeguards where required.

During GAO% evaluation of DHCP, VA revised its DHCP development plans. According to the course laid out in a June 1987 re-scoping of the DHCP program, the level of DHCP to be implemented nationwide corresponds to the Core modules plus eight Enhanced modules (Core Plus 8). In 1985, an ambitious program including the Core plus **22** Enhanced and 23 Comprehensive modules was planned. (See app. B for descriptions of the modules.) According to VA% current rescoping, additional modules beyond Core Plus 8 would only be added as they are cost-justified and approved by OMB.[10]

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9. See op. cit., GAO/IMTEC-87-28, p. 31-32. The Circular A-130 requirements have been included in the ADP security policies and programs of many Federal agencies, including some military services and departments. Appendix III to OMB Circular A-130 establishes a minimum set of controls to be included in Federal AIS security programs, and specifies that Federal agencies shall implement and maintain an AIS security program. According to OMB, agency AIS security audits, reviews, and recertification (repeated at least every three years) should be considered as part of the agency vulnerability assessments and internal control reviews conducted in accordance with OMB Circular A-123. Due in part to concerns about the adequacy of controls and security programs, the VA Administrator identified DHCP as a material weakness in 1985 and 1986 reports to the President in accordance with the Federal Managers? Financial Integrity Act (31 U.S.C. 3521(b) and **(c)).**

   Other guidelines include: U.S. General Accounting Office, Evaluating Internal Controls in Computer-Based Systems: Audit Guide, AFMD-81-86, June 1981; and U.S. Department of Commerce, National Bureau of Standards. Federal Information Processing Standards (FIPS) Publications FIPS PUB 31, ‘°Guidelines for Automatic Data Processing Physical Security and Risk Management," June 1974; FIPS PUB 65, "Guidelines for Automatic Data Processing Risk Analysis,"' Aug. 1, 1979; and FIPS PUB 73, "Guidelines for Security of Computer Applications," June 30, 1980.

10. See enclosure 2 the VA Administrator% letter to GAO dated June 5, 1987 on p. 82 in op. cit., GAO/IMTEC-87-28.

It is not clear how VA plans to handle the cost justification for development of additional modules.[11] Will it be necessary to complete development of each module and test it in order to determine whether or not it is cost-justified for nationwide use? During the 10-year period 1987-96, how many of the 37 remaining DHCP modules beyond "Core Plus 8" will eventually be developed and implemented nationwide? Will still other modules be developed and tested and/or used locally in some VAMCs There may be an opportunity cost to continued development of additional modules (beyond Core Plus 8) if it is not done in conjunction with sufficient foresight and far-reaching planning for VA hospital information technology in the late 1990's and beyond: The software may not evolve to take maximum advantage of new technological opportunities as information technology advances.

Hardware Procurements for DHCP

The Core software and most of the eight high-priority enhanced modules have been developed and are operating in at least some VAMCs. However, VA needs additional computer capacity to implement this software in all hospitals. VA's current RFP (VA-RFP 101-5-87) seeks hardware on which to run DHCP software. It provides for five stages of hardware, software, and maintenance procurement: a Stage I (including mandatory and optional quantities) plus four optional stages (II-V) The RFP specifies a 10-year system life, corresponding to the total duration of the contract if VA exercises all options to extend. The contract would specify options for increased quantities of hardware items, for acquisition of optional features, and for technology upgrades. (See app. D for further discussion of the RFP.)

Assuming funds are available, the delivery schedule for mandatory Stage I quantities specifies delivery between 60 and 180 days after VA acceptance testing is complete. This equipment is intended for the 31 largest VA hospitals and the Information Systems Centers (ISC). Again, depending on availability of appropriated funds, optional quantities in Stages I-V would be scheduled for delivery to other VAMCs between 240 and 720 days after the completion of acceptance testing.

VA estimates that the current RFP for hardware, if all options are exercised, provides enough computer capacity to run the full set of Core, Enhanced, and

11. According to VA, the accounting firm of Price-Waterhouse is being tasked to look at cost justification of applications for DHCP. Source: Enclosure to a letter from David A. Cox, Associate Deputy Administrator for Management, to OTA, Sept. 21, 1987.

Comprehensive modules.

According to MIRMO, completion of Stage III hardware purchases would provide sufficient capacity for Core Plus 8 to run in all VAMCs.[12] VA budget estimates 'how fiscal year 1988-90 procurements totaling some $84 million that correspond to the completion of Stage III. OTA estimates that Stage III would correspond to approximately 60-65 percent of the total computer capacity to be purchased in Stages I-V.[13] It is important to note, however, that hardware procurements only amount to about 22 percent of total estimated costs of DHCP. Other categories such as hardware maintenance and personnel costs for VAMC application coordinators are also significant cost drivers. (See the discussion of procurement options and costs in app. C.)

COST CONSIDERATIONS

Historical Cost Estimates

Previous studies have concluded that earlier VA cost estimates seriously underestimated the costs of developing DHCP.[14] The recent General Accounting Office (GAO) report found that, during the period 1984-86, VA had expanded its planned system by extending the estimated life of the DHCP system and adding modules.[15] The VA's 1986 lifecycle cost estimate was $1.175 billion in total costs for a more extensive version of DHCP(6 Core modules plus 22 Enhanced and 23 Comprehensive modules). This estimate was based on three overlapping 10-year lifecycles covering the period fiscal years 1983-2001.[16] The General Accounting Office found that this estimate omitted substantial telecommunication, utility, and personnel costs, possibly totaling $700 million.[17]

Measuring internal project costs is always somewhat ambiguous. The recent VA cost estimates supplied to OTA appear to be more complete; although there is probably

12. OTA interview with MIRMO staff, Aug. 28, 1987.
13. As measured by cumulative throughput units and numbers of active partitions indicated in the RFP system specifications. For definitions, see the discussion of procurement options in app. D.
14. For example, House Com-rnittee on Appropriations, Veterans Administration: Medical Computer Programs, prepared by the investigative staff, December 3, 1986.
15. See op. cit., GAO/IMTEC-87-28, pp. 12-13.
16. The VA% lifecycles covered fiscal years 1983-92 (Initial and Full Core), fiscal years 1987-96 (Enhanced DHCP) and fiscal years 1992-2001 (Comprehensive DHCP). See op. cit., GAO/IMTEC-87-28, pp. 12-13.
17. See op. cit., GAO/IMTEC-87-28, pp. 12-13 and 38-39,

no way to capture some of the sunk costs that were previously omitted, new projections are more realistic. VA historical cost data and projections for the period 1983 through 1987 indicate that the total costs for Core Plus 8 (including sunk costs) will be on the order of $l.1 billion. (See table C-3.)

Computer equipment costs included in these total cost estimates, which include sunk costs incurred in fiscal years 1983-86, amount to some $150 million to support the Core and some $89 million to support the 8 Enhanced modules. (See cumulative totals in tables C-1 and C-2.) Thus, total computer equipment costs, including sunk costs incurred in fiscal years 1983-86, for Core Plus 8 are now estimated by VA to be some $239 million. (See cumulative totals in table C-3.)

Lifecycle Costs for Fiscal Years 1987-96

VA's current IO year (fiscal years 1987-96) lifecycle cost estimates amount to some $930 million[18] for 6 core modules and 8 enhanced modules (Core P1us 8) This projection includes additional and replacement computer equipment costs to support the Core and 8 Enhanced modules. The VA's planned procurements of additional and replacement equipment to support the Core will amount to some $67 million, mostly during fiscal years 1993-96. (See appropriate columns in table C-1.) The VA estimates that additional and replacement equipment to support the 8 Enhanced modules will amount to some $89 million, with planned procurements during the period fiscal years 1988-96. (See appropriate columns in table C-2.) Thus, for the 10-year period, fiscal years 1987-96, computer equipment costs would amount to some $156 million. (See appropriate columns in table C-3.)

According to MIRMO, completing Stage 111 of the procurement would provide enough computer hardware to run Core Plus 8 in the 169 VAMCs using DHCP. The cost of procuring additional hardware to run Core Plus 8 in the 169 VAMCs corresponds to the $84.3 million over fiscal years 1988-90 indicated in table C-2.[19] However, OTA notes

18. Calculated from the fiscal year 1987-96 VA cost data provided to OTA and shown in the fiscal year 1987 -96 columns of tables C-1 through C-3. The fiscal year 1987-96 cumulative total of $883.75 million was increased by $46.7 million to reflect total Government fringe benefit costs (see app. C and op. cit., GAO/IMTEC-87-28, pp. 92, 93 and 104).
This total differs from the $925 million 10-year lifecycle cost that the VA reported to GAO in May, 1987, because of relatively small differences in estimated maintenance costs, miscellaneous contracts, telecommunications and utilities costs, etc.
19. Letter to OTA from David A. Cox (enclosure B), Aug. 28, 1987.

that if all options in the RFP were to be exercised, then the VA's procurements (for Stages IV and V, or for additional features and upgrades) would exceed the VA's current budget estimate of $84.3 million.

Based on the RFP's system requirements information (see appendix table D-11), OTA calculates that procurements sufficient to run Core Plus 8 in the 169 VAMCs using DHCP (i.e. procurements through Stage 111) would correspond to between 60 and 65 percent of the computing capacity and facilities of the potential full (five-stage) procurement with all quantity options exercised. Based on the $84.3 million additional-equipment cost estimated by VA for a 3-stage procurement (see app. table C-2), Stage IV and V procurements might amount to an additional $50 million.

If Stage IV and V procurements were made, however, total DHCP lifecycle costs would increase by more than $50 million, because there is a multiplier relationship between additional computer hardware costs and increases in other lifecycle costs: Additional hardware maintenance costs, ISC personnel costs for development of additional software to take advantage of the Stage IV and V capacity, additional VAMC staff and application coordinator personnel costs to utilize additional software, etc. would also be important cost drivers. For example, VA's DHCP budget estimates for Core Plus 8 (see app. table C-3) show that additional and replacement equipment costs over fiscal years 1983-96 amount to about 22 percent of total estimated budget.

FACTORS AFFECTING DESIRABILITY OF NEAR-TERM SWITCH TO COMMERCIAL IHS

In OTA's view, if VA wants to have automation in all hospitals soon, it would be inadvisable for VA to switch to a commercial IHS system at this time.

Under other circumstances, a switch to IHS might have been a viable option. The IHS experiment was ordered by Congress for the purpose of allowing VA the opportunity for expanding its alternative paths for automation. If it had been possible to conduct a good test, this experiment might have provided VA with a rich base of automation experience to draw from in either developing its own system or in selecting one. Unfortunately, the experiment was not designed or conducted in a way that allowed VA to make the most of the lessons that could have been learned. For example, until recently there was little or no communication between IHS and DHCP hospital staff and no effort to encourage SIUGs or users from other hospitals to visit IHS hospitals to examine possible benefits and drawbacks of vendor systems.[20] It is likely that a fair test

could not have been structured under the circumstances. Once the agency had elected to develop DHCP, it is difficult to imagine how an unbiased test could be carried out while the development was going on: VA was put in the position of being both a contestant and a judge at the same time. Comparisons are best made before alternatives have been selected.

As a result of not conducting a good test, the opportunity to choose one of the competing systems now appears to be past, and the option to select a commercial system in the near term appears to be foreclosed. At the present time, switching to an IHS system on a nationwide basis and phasing out DHCP development would probably be VA's most costly alternative and would slow down the automation of many hospitals.

If VA exercised the options to buy additional quantities under the current contracts with Electronic Data Systems, McDonnell-Douglas, and Shared Medical Systems, the contracts would require each vendor to automate approximately one-third of the VA hospitals and provide support and facilities management as they currently do at IHS test hospitals. As the contracts are now structured, each vendor is restricted to providing systems for hospitals in the size range for which it provided a test hospital. Thus, SMS would automate large hospitals, McDonnell-Douglas medium hospitals, and EDS small hospitals.

Exercising the options on the current IHS contracts would not be cost-effective. Events of the past 2 years have changed the cost of, and possibly the best approach to, automation from what is set forth in those contracts. For example, IHS vendors have done considerable R&D in tailoring their systems to IHS test hospitals, and much of the result of that work might be applied to other VA hospitals. Thus, if these same vendors were to bid on the VA system now, with their current level of knowledge, their costs might be lower than they were in 1983/84. [n addition, within the past 6 months, two vendors have proposed alternative strategies for placing computer equipment that could greatly reduce the VA% equipment and staffing costs. These are regionalized approaches that allow a mainframe computer to serve several hospitals. Any of these approaches would require a complete reanalysis of the cost, as well as a complete reorientation in VA'S approach to computerization. VA has repeatedly indicated its unwillingness to favorably view regionalized approaches to computer placement.[21]

20. A full discussion of the shortcomings of the test are detailed in op. cit., GAO/IMTEC-87-28, pp. 51-54.
21. See, for example VA comment in Appendix VI of op. cit., GAO/IMTEC-87-28, pp. 89-90.

At the very least, the three vendors would have to be given an opportunity to rebid on the IHS contract, given their new perceptions of the costs. OTA was unable to obtain new estimates of the vendors' projected costs for automating VA. The vendors stated, rightly, that development of such projections should be reserved for the competitive process. It would require several months for the vendors to prepare new cost estimates and for VA to evaluate them.

It is more likely that a completely new competition might have to be mounted. The alternative commercial approaches seem, in principle, quite promising. In OTA discussions with the vendors it appeared likely that some of them could preserve part of VA's past investment in DHCP by making use of DHCP modules. However, if the competition is to be reopened to the extent of letting the three vendors bid on strategies not included in the original RFP, it might be necessary, in fairness, to reopen the process to all potential bidders, requiring VA to go back to the stage of preparing and releasing an RFP. This process could require a 2-year delay before a selected vendor could begin work.

Meanwhile, VA would presumably not be able to purchase hardware for further deployment of DHCP, and hospitals without a substantial number of modules running would have to do without automation until the vendor system was ready for implemental ion.

Costs for the IHS systems as specified in the contract are calculated to be $1.6 billion for a 10 year lifecycle.[22] IHS vendors' alternative system proposals would likely cost less than this, but could still be larger than the $930 million lifecycle cost that VA projections now indicate for fiscal years 1987-96 (for example, the estimate used publicly by McDonnell-Douglas in March 1987 was $590 million for a 5-year lifecycle or $1.04 billion for a 10-year lifecycle, although in discussions with OTA the vendor discussed strategies that might reduce costs further).

Alternatively, VA could purchase just enough hardware to run the currently

22. The $1.6 billion figure for IHS deployment VA-wide is based on an artificial extrapolation of one-hospital IHS contract costs without allowing for scale economies, technological alternatives or changes, etc. If sunk costs for the period FY 1983-86 are included, then the VA estimates indicate a total cost for DHCP of some $1.1 billion. Op. cit., GAO/IMTEC-87-28,; Booz-Allen and Hamilton, Decentralized Hospital Computer Program and Integrated Hospital System Comparability Study, Medical Information Resources Management Office, Veterans Administration, IQC Contract V-101 -93 P1097, February 1987, p. IV-6.

available software at all hospitals while waiting for a vendor to be selected. Even this alternative would likely require some delays while VA withdrew its current hardware RFP and rewrote it. The types of hardware that would need to be purchased to put up temporary computer capacity in some of the medium and smaller VAMCs would be quite different from what is specified under the mandatory Phase I of the current equipment RFP (in the current hardware procurement, larger hospitals would receive new large computers and their used minicomputers would be handed down to smaller hospitals). While the costs of the needed temporary equipment would be have to be added to the cost of the vendor system, that cost would probably be modest in terms of a $1 billion system -- on the order of $10s of millions.

Ultimately, the best argument against making the switch to the IHS system now may well be that VA has structured the alternatives for such a switch so as to render this option undesirable in terms of its near-term impacts on the hospitals and their primary mission of patient care. As mentioned earlier, congressional oversight is important, and in the case of VA congressional oversight has been essential in requiring the management improvements that have brought the development of DHCP to its current point. Congress has the duty to exercise oversight and create situations that require agency managers to do proper planning, but in the final analysis, it is the managers' job to make a decision. [n this case, VA management has made up its mind quite firmly in favor of DHCP, and this decision is not unreasonable in the short-run, as discussed above. It may be wise, in this case, to let the decision stand, but also to create conditions under which future decisions must be based on a thorough and unbiased examination of alternatives.

What is to be Done With IHS Hospitals

These hospitals have, until recently, been "out of the loop" of SIUG/ISC/DHCP planning and communication, and therefore have been somewhat disadvantaged in terms of implementing data formatting changes for central reporting. Even for the near term, the VAMCs used as IHS test sites will need data communication interfaces with other VA systems (AMIS, IFCAP, etc.). Also, administrators and end-users at these three VAMCs will need to be represented along with those from the other 169 VAMCs in future planning and development processes. Alternatives for these hospitals appear to be:

1. Leave the three IHS systems in place for the duration of the contract options, but provide interfaces to the rest of the VA-wide automatic data processing (ADP) systems, using MIRMO funds. Provide representation from these VAMCs in the SIUGs and in any other DM&S information-system planning groups. One possible advantage of this option is that these hospitals could serve as long term laboratories for tracking changes in technology offered by

commercial vendors, if contracts were rewritten to accommodate upgrades and to permit vendors to offer their "best-cost" approaches toVA hospital automation. (A few of OTA% Advisory Panel members consider that the number of VA hospitals using commercial IHS systems should be expanded, to test the portability of vendor-developed systems from one VAMC to others.)

2. Phase out the IHS systems and convert these three VAMCs to DHCP. This will cause disruption to these specific hospitals, incur conversion costs, and in some cases cause them to give up functionality they already have, but will permit these VAMCs to be part of one VA-wide hospital information system.

It may be possible to make the the choice on a hospital by hospital basis. In any case, it would seem appropriate to ensure that the affected VAMCs are actively involved in the decision process.

NEED FOR LONG-TERM PLANNING

OTA found lacking in the Veterans Administration a true strategic plan and a vision of how automation should serve the mission and long-range goals of VA as an agency. While VA has published an "ADP Strategic Plan", this document is, at best, an operational plan describing all the types of information automation going on within the agency. According to the Office of Management and Budget, strategic planning is,

> ...a process for defining agency missions and identifying agency goals and objectives as projected over a specific period of time. [n the context of automatic data processing (ADP) and telecommunications, long-range planning develops and documents the agency% direction and specifies the activities and resource requirements necessary to support stated missions and objectives.

Strategic planning for ADP is difficult for government agencies because of frequent top-level turnover in personnel, the existence of sometimes conflicting goals on the part of Congress or OMB, the problem of phasing long-term plans with short term budget cycles, and other problems that are discussed in more detail in a previous OTA report.[24] Nevertheless, it is especially important that VA take the time to carry out a long-term planning process, because remaining on its current track may have long term adverse consequences for the agency and for the care of America% veterans.

Currently, DM&S considers that the process by which DHCP is developed and managed includes, by its very nature, VA's long-term planning process for hospital information systems.[25] view the DHCP process as a continuum that can

23. See, Office of Technology Assessment, Federal Government Information Technology: Management, Security, and Congressional Oversight. February 1986, p. 44.
24. [bid., especially pp. 44-47.
(continued)

continuously update and refresh DHCP through inputs from SIUG members, each of whom follow advances and changes in technology, medical practice, and user needs in their areas of interest. Therefore DM&S and MIRMO consider that continuous feedback and input from SIUGs can ensure that DHCP continues to keep pace with technological and institutional changes.

OTA finds that the DHCP process as it now exists is at best a "tactical" planning process. It identifies and schedules the means for attaining specific objectives, but always within the framework of a single strategy for achieving automation, that is, designing and building software in-house on a module-by-module basis. Further, while each disciplinary SIUG may well keep track of technological advances within its own discipline, there seems to be no mechanism for considering synergistic effects between disciplines or allowing for radical or discontinuous changes in either technology or medical practice.

While this type of planning process can be effective in the near and even mid-term (and has proven effective for VA so far in the DHCP development cycle), it is biased towards incremental, marginal changes and adaptations. For the long term -- for the mid-1990's and beyond -- this process may be fundamentally unable to reap advantages from radical advances in computer hardware and software and may be inefficient in accommodating large or rapid changes in medical technology and practice.

The VA might find it useful and prudent to take an independent look at the future outside the narrow disciplinary confines of the current SIUG structure. As a first steps VA could augment the current SIUG structure and DHCP planning process with a multi-disciplinary group (perhaps a new SIUG for long-range system evolution) to track trends and discontinuities in technical and institutional areas affecting hospital information system needs and capabilities. It would be OTA% suggestion that this group have MIRMO representation but its composition (including, perhaps, its chairman) should include individuals that have not been involved in the development of the current system. Several of the members of OTA study's Advisory Panel and Federal Working Group have suggested that VA include a broad selection of outside experts in this planning process, similar to the way VA's Department of Medicine and Surgery (DM&S) has outside advisory groups for medical practice.[26] The suggestion for outside help is not meant as

25. This view was espoused in several conversations with VA managers, most recently in a discussion with Dr. John Gronvall, Chief Medical Director, and David Van Hooser, Director of MIRMO, Aug. 28, 1987.
26. The VA has already indicated that it welcomes this suggestion and plans to put in (continued)

criticism of VA, but reflects the reality that the medical information field is currently very parochial. Few people are thoroughly familiar with more than two or three systems, and the VA process would benefit through exposure to a variety of perspectives.

What VA's Long-Term Plan Should Include

As was mentioned above, strategic planning for ADP is difficult for any government agency, and VA's difficulties in this area are not unique. An information system is more than an assemblage of hardware and software -- it is a function of the setting and work structure. Many of the critical dimensions of the context in which agency strategic planning must take place are not wholly within the agency's control; among these are Federal and agency budgets, Federal and agency policies and management, the labor market, technological innovations, and the evolution of the work environment. These dimensions are dynamic. Taking them into account in strategic planning requires formulating assumptions about their alternative paths over time, developing a structured means for thinking about these assumptions, and using these to create alternative strategies.

While OTA considers that DHCP, if it functions as planned, is adequate for the first generation of hospital information systems at VA, the ability of DHCP to evolve into the second generation is in question. Therefore, a long-term plan --a true strategic vision for the second generation of hospital information systems at VA -- should take into account:

1. changes in medical needs over the long term (patient demographics, epidemiology, new diseases, new medical technologies and treatments);
2. changes in available computer and communications technologies (the basic hardware technologies and also software engineering tools such as fourth-generation languages for system development);
3. changes in Federal health policies (historical examples include eligibility requirements and means testing, third-party payments, quality assurance);
4. current and future Federal information policies, including privacy, security, intellectual property, freedom of information, private-sector processing of Federal data;
5* new computer applications for medicine (e.g. pattern recognition, diagnostic

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place an advisory group for this purpose, following the model already used in DM&S to keep the Chief Medical Director advised of private sector developments in medical practice. (Source: Letter to OTA from David A. Cox, Sept. 21, 1987.)

implications of artificial intelligence, electronic storage of full medical records, including images);

6. consideration of alternative system architectures for providing second-generation automation, including fully decentralized, regionalized, fully centralized, and privately-provided options; and

7. prioritizing future automation needs in the VAMCs, and considering how these may be met in concert in a second-generation system.

Planning for medical information systems must also reintegrated with other agency information needs and automation plans, taking into account open system interconnection (OSI) standards and layered system architectures.

Role of Users in Planning

It is important to note that user involvement in the process of specifying and implementing an information system is critical to success. But it should also be pointed out that user involvement does not necessarily require in-house development of software. VA should be able to adapt its SIUG process to a contracting situation if it decides that it would be less costly to buy rather than build the next generation system. Such an approach may require some innovative thinking and innovative contract writing on the part of the agency, but could be successful if there is strong management commitment to making it work. It maybe instructive for VA to watch the progress of automation in hospitals in the State of Hesse, Federal Republic of Germany. The State has recently signed a contract with Shared Medical Systems for hospital information systems. Required by the contract is a user participation process that the Germans call 'the VA structure model," which gives SIUGs the responsibility for developing specifications and participating in the implementation of the software. While German contracting law is quite different from American, there may be lessons VA can learn from the German process (just as the Germans seem to have learned about SIUGs from VA).

VA's current process involves SIUGs in software development through the process of rapid prototyping. While rapid prototyping may also prove fruitful in the future for rapidly defining alternative system approaches and refining user needs, OTA notes that there are at least two philosophies of rapid prototyping.[27] To date, VA has followed one of these, iterating the rapid-prototyping system (in concert with user input through the

27. See: McGraw-Hill Encyclopedia of Science and Technology, 6th Ed., vol. 5 (New York/St. Louis/SanFrancisco: McGraw-Hill, 1987), p. 26.

SIUGs) to satisfy user needs and then using the outcome as production software. There is an alternative philosophy, which is to use the rapid-prototyping system to refine and test user requirements and specifications, but not to use the prototyping system to produce production software. In OTA% view, the latter philosophy could preserve the best of the VA% current SIUG/ISC development process, while freeing VA to develop production software through other means that might prove more flexible or cost-effective for the future. (These could include contracting out for production code, writing production software indifferent language than that used for prototyping, etc.).

Factors to reconsidered in Long Range Planning

By the same token, flexibility to tailor systems to individual hospital needs or make certain changes when required by law is a feature important to the VA's next generation. These, too, do not necessarily require in-house development of software. For example, at least two of the IHS systems tested by VA have capability for a certain amount of modification by authorized persons in the hospital, and considerable changes in the operation of the system can be made without touching the proprietary programming. Current contracts with the VA require that vendor employees make nearly all such changes, but private sector hospitals who using these same systems are often able to adapt to new insurance regulations or changes in State laws without asking the system vendor to make changes in the underlying software. The amount of system flexibility for hospital-or agency-defined modifications in IHS systems now under contract may not be sufficient for VA's needs, and OTA did not make a determination on this. The point is that in the next few years, the ability to make hospital- or agency-defined changes is likely to be even greater than it is today. VA should not reject the option of software developed in the commercial market for the next generation on the assumption that it is inflexible, but should actually look at what the technology and the market will make possible.

Although VA has currently rejected the idea of "regionalized" placement of computers (e.g., sharing a processor among several hospitals), the use of such an approach offers the possibility of large savings in equipment and facility management costs; this strategy should reconsidered by VA for its next generation. Properly designed, such a networked system can offer each hospital a level of flexibility and control similar to what can reachieved with a computer in each hospital. The behavior of the information system is the same from the end-user% point of view: it does not matter whether the actual computer is down the hall or across the state. Savings in

equipment and personnel would have to be compared to increased telecommunication costs, which may be quite different in a few years than they are now.

OTA FINDINGS

The DHCP Core Plus 8 modules, should they all work as promised, would appear to serve the immediate android-term needs of the Veterans Administration. In light of the limited options currently available to VA, OTA finds that continuing to deploy Core Plus 8 is a reasonable choice for ensuring that all VA hospitals have some of their basic automation needs met in the near term.

However, OTA recognizes that there are risks involved with this course of action. There is the possibility that the order-entry/results reporting function may not work as planned, especially in hospitals with high transaction volumes. In addition, only three of the eight enhanced modules are in the field, (one is in verification, two are in test, and two are still in development). It is not possible to determine whether all these applications will be deployed as scheduled or will work as planned. Problems with the integration of new modules into the system and performance in high-transaction environments may be more severe than VA has anticipated.

The options below offer to Congress some possible mechanisms for allowing VA to pursue its preferred course of action while at the same time insuring congressional oversight in the face of possible risk.

Finally, OTA believes that the issues of strategic planning and consideration of technological alternatives are of great importance before VA commits itself to a "next generation" hospital information system. These options give Congress mechanisms for encouraging VA to begin these important processes.

The two options explored here are:

1. Deploy the Core Plus 8 software systemwide, then cap hardware expenditures and freeze development of additional software modules. Allow VA to enter a "plateau" phase for strategic planning and evaluation of technological alternatives for its next-generation information system.

2. Continue deployment of Core Plus 8 and begin parallel efforts for strategic planning and evaluation of alternatives for the next generation system. Make release of additional funds contingent upon VA'S demonstration that: a) order-entry/results-reporting works satisfactorily in a production environment, and b) that suitable processes are created for strategic planning and evaluation of technological alternatives for the next-generation information system.

Both options have advantages and drawbacks. Option 1 assures some control over further expenditures for DHCP and provides a clean break from DHCP development

activities, helping ensure that the VA will devote agency attention to planning for the next generation. Its chief drawback, and a major one, is that it delays the start of the planning process for about 3years .

Option 2 allows the planning process to begin immediately, but there is risk that VA is too locked into its current development process to focus adequately on alternative strategies for the next generation.

The study% Advisory Panel members, reviewers, VA staff, and others suggest that delay is the overriding disadvantage. In this case, Option 2 is probably the preferred of the two, as discussed below.

Because planning and evaluation of alternatives are needed under both options, these topics are discussed first.

Strategic Planning and Assessment of Alternatives Needed Under Both Options

The current DHCP system, both hardware and software, will have a finite lifetime, despite VA'S vision of continuous evolution into the indefinite future. At some point, the 'next generation"' of hospital automation must be planned and developed. The whole field of hospital information system technology is new and is undergoing rapid change. It is not reasonable to assume that DHCP, based as it is on 1970s hardware and software technology, is necessarily the ideal platform for the information system VA will want in the 1990s. Analysis of technological alternatives for VA's next generation should begin soon. Many agencies are already planning for information systems they will not install until the late 1990s or even early 2000s.

VA should conduct a rigorous and comprehensive analysis of DM&S processes for long-term planning (for the mid-1990s and beyond), describing how hospital automation evolution will track and take advantage of technological and institutional changes in medical practice and information technologies.

Advances in information technology can be expected to continue to reduce the cost of computation and increase the power available to the end-user. Effective, multi-disciplinary, long-range planning for the evolution of VA'S hospital information system as a whole will help ensure that potential savings and capabilities are realized within VAMCs, and help VA% formulate decisions on next-generation development.

User involvement will be critical in this process. VA has already demonstrated that it can develop networks of users and involve them in developing the functional specifications of an automation system. The user-input and feedback processes that VA

has developed are perhaps even more valuable than software developed so far for applications beyond Core Plus 8. These processes should be maintained and built upon for system-level planning to span the next generations of information technology, whether that system is developed in-house or acquired from outside sources.

However, in addition to the disciplinary SIUGs, VA will want a group that is concerned with long-range agency goals, and with information system integration and evolution. If the process is to incorporate fresh perspectives into the long-range planning process, then VA should ensure that some members of this group are not stakeholders in current DHCP development, that the process is separate from DHCP, and that authority for the group is located in the appropriate level of VA hierarchy.

Most important, VA should defer the decision to move into production of its next generation of information technology -- whether the system is to be purchased, built in-house, or a hybrid -- until the agency has done a full assessment of the costs and risks of each option. System development or procurements would proceed only after this planning phase, and the plan should be reviewed and updated periodically by VA to ensure that the evolution of medical care information technology for the VAMCs stays on the most effective course in terms of quality of care and cost-effectiveness.

Option 1: Deploy Core Plus 8, Then Enter a Plateau Phase for Planning

Under this option, VA would purchase hardware and implement Core Plus 8 at all 169 hospitals, then enter a 'plateau" phase. (According to MIRMO, this would correspond to hardware acquisition and facilities described by fulfilling Stage 111 of the current RFP. According to VA DHCP budget figures, the cost for purchasing hardware through Stage 111 is $84.3 million. According to OTA estimates, based on VA system specifications, procurements through Stage 111 would correspond to between 63 and 65 percent of the quantity of additional facilities and computer capacity in a full Stage V purchase.)

Thus, after Stage 111 procurement VA should have the computer hardware they say they need to allow all VAMCs to run the applications VA considers to have top priority and that have been cost justified.[28] The costs of procurements through Stage III are indicated by fiscal year 1988, 1989, and 1990 estimates provided to OTA by VA. (See app. C and D).

28. Op. cit., GAO/IMTEC-87-28, Letter from the VA Administrator to GAO, p. 74.

The plateau approach would result in a near-term cap on hardware costs, since VA would purchase only Stage III hardware ($84.3 million) rather than have the option to make a full five-stage purchase.

This 'plateau" phase would have two purposes:

1. VA would have the opportunity to assess how well Core Plus 8 is working with all hospitals on line and make needed refinements. Users and system managers would also have time to ensure that all benefits from the current system are realized.
2. VA would have the opportunity to do strategic planning for the next generation of hardware and software.

The assessment process mentioned in the first item above may not be trivial. OTA% contractor suggests that development should be halted, at least temporarily, after the full Core Plus 8 is implemented, to thoroughly review the software in a systematic way. This recommendation is based, among other things, on the perception of problems with the intra-hospital communication function (order-entry/results-reporting), which may lead to very slow response times once many users are on the system and additional modules are added to the order-entry menu.

As "fCore Plus 8" moves into an operations and maintenance mode, DM&S resources would be diverted toward technology assessment and long-term system evolution and planning efforts. SIUGs would be adapted to maintain grassroots input for both operations and maintenance and for the planning process. MIRMO and the Information Systems Centers would be staffed to a level that is appropriate for operations and maintenance rather than development. This does not necessarily mean cutting staff, though VA may find this is the case. The continuing refinements that would be necessary for ongoing operation of a system as complex as DHCP should still offer challenging work for a programming staff, although the nature of the work will change as it does in all organizations when organizational needs change. Maintenance of software includes programming activities to correct errors, respond to environmental changes (such as congressional mandates for new medical programs or reporting requirements), or improve performance. [29]

Although the plateau approach is attractive because it allows a clear separation of the development and planning efforts, it also has disadvantages. One is possible adverse

29. See Shari L. Pfleeger: Software Engineering: The Production of Quality Software (New York: Macmillan Publishing Co., 1987), pp. 373-406.

affects on VA personnel and morale, so that VA would find it difficult to retain good ISC staff if there is a hiatus in development activities. The primary disadvantage, however, is that this approach would delay the beginning of the planning process for about 3 years.

Option 2: **Continue Deployment of Core Plus 8, Do Parallel** Planning Effort

While some members of the study% Advisory Panel preferred Option 1, OTA recognizes the difficulties of the ‘plateau” approach and is especially sensitive to the need for the planning effort to begin now, rather than waiting until until Core Plus 8 is fully deployed. In Option 2, VA would begin to purchase additional hardware to support deployment of Core Plus 8 and would begin parallel efforts to do strategic planning to examine technological alternatives for the next-generation hospital information system.

In OTA% view, it will take considerable organizational skill on the part of VA to make sure that a parallel planning effort meets all criteria discussed in the earlier sections on planning. In particular, a parallel planning effort should:

1. have support from the highest levels of VA management;
2. be administratively and operationally separated from ongoing DHCP production activities in order to protect the planning process from being biased; and
3. have mechanisms for assessing current and future needs of VA information users in order to prevent the planning process from becoming an empty intellectual exercise.

Point 1 above should help assure that activities in DM&S will have their proper priority in terms of overall agency goals and agency-wide plans with respect to information technology.

Points 2 and 3 above are in a sense contradictory, since they require the planning and technology alternatives groups to maintain close contact with current DHCP users without “buying into” the current approach for serving user needs. VA would be aided in maintaining a healthy tension between these two objectives by including some expertise from outside the agency in its planning and alternatives assessment processes.

Congress may wish to assure that VA's efforts in developing a parallel planning effort continue to be effective by making further funding of DHCP hardware purchases (beyond fiscal year 1988) contingent upon VA's demonstration of a suitable planning process, and on the continued efficacy of the process.

VA needs to continually assess how well its Core Plus 8 software is working in production environments. Rather than waiting until all of Core Plus 8 is deployed, an

early phase of such an assessment might focus on the performance of the modules OTA has pinpointed as having the highest risk of operational problems -- order-entry/results-reporting and nursing. VA may benefit from an outside review (by hospital systems experts) once these modules are implemented in a number of large VAMCSswith many on-line users and high transaction volumes. The outside experts could review response time and other measures of system performance to help VA determine whether these modules are working satisfactorily and whether the remaining modules proposed in Core Plus 8 software can be adequately supported.

A similar assessment process could be useful to help VA determine what benefits are being realized from the modules already deployed. In the near term, VA may also want to examine strategies for changes in job design, productivity policies, and human resources policies that may be needed as the organization adjusts to an automated information system.

Congress may also wish a demonstration from VA that an outside assessment of order-entry /results-reporting and nursing functions have taken place and that these high-risk modules are working well before appropriating funds beyond fiscal year 1988 for purchase of additional hardware.

APPENDIX A: SITE VISIT LOCATIONS

VENDORS

Digital Equipment Corp.
Boston, MA

Electronic Data Systems Corp.,
Dallas, TX

McDonnell Douglas Company,
Hazelwood, MO

Shared Medical Systems Corp,
Malvern, PA

HOSPITALS

Albany VAMC
Albany, NY

Big Spring VAMC
Big Spring, TX

Hines, VAMC
Hines, IL

Philadelphia VAMC
Philadelphia, PA

Saginaw VAMC
Saginaw, MI

Sioux Falls VAMC
Sioux Falls, SD

22D Strategic Hospital
March AFB, CA

William S. Middleton VA Hospital
Madison, WI

VA Medical Center-Westside
Chicago, IL

INFORMATION SYSTEMS CENTERS

Northeastern Region
Information Systems Center
Troy, NY

Mid-Atlantic Region
Information Systems Center
Washington, DC

Southeastern Region
Information Systems Center
Birmingham, AL

Great Lakes Region
Information Systems Center
Hines, IL

Midwestern Region
Information Systems Center
Salt Lake City, UT

Western Region
Information Systems Center
San Francisco, CA

VA CENTRAL OFFICE

Office of the Associate Deputy
Administrator for Management
Veterans Administration
Washington, DC

Office of the Chief Medical Director
Department of Medicine and Surgery
Veterans Administration
Washington, DC

Medical Information Resources
Management Office
Department of Medicine and Surgery
Veterans Administration
Washington, DC

APPENDIX B: DECENTRALIZED HOSPITAL COMPUTER PROGRAM MODULES

Software Development Approach – DHCP software is being developed incrementally in modules, using a rapid prototyping approach. The software is being written using the Massachusetts General Hospital Utility Multi-Programming System (MUMPS), an interpreted language. An American National Standards Institute (ANSI) standard for MUMPS was approved November 15, 1984 and adopted as a Federal Information Processing Standard (FIPS) effective May 1, 1987.[1] According to 'he Institute of Computer Sciences and Technology (ICST) at the National Bureau of Standards (NBS), however, MUMPS is not an active part of the current ICST technical program.[2]

According to NBS,

> The MUMPS standard has standardized the static syntax of the language, which consists of such things as the character set, definition of variables, literals, functions and language commands. The standard also presents the MUMPS dynamic syntax in transition diagram form. These diagrams serve as an implementation outline for the MUMPS language. The necessary operations are given, but their detailed implementation is left to the individual implementor.[3]

One useful characteristic of MUMPS is that implementation-specific (e.g. hardware- or operating-system-specific commands are readily identifiable because they contain the prefix 'Z'[f] and are referred to as "Z-calls". The VA software developers have attempted to minimize the amount of implementation-specific software and this code is isolated in the DHCP Kernel, mainly in the File Manager, Task Manager, and input/output control rout ines.[4]

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1. See: U.S. Department of Commerce, National Bureau of Standards FIPS Publication 125, Nov. 4, 1986 and American National Standard for Information Systems - Programming Language - MUMPS, ANSI/MDC X11.1-1984, Mumps Development Committee, 1984.
2. Letter to OTA from Allen L. Hankinson, NBS/ICST, Aug. 13, 1987.
3. Enclosure to Hankinson letter, op. cit.
4. See: VA RFP # 101-5-87, Mar. 9, 1987, pp. 122-123; and Amendment #5 of the RFP, June 6, 1987.
   In the Federal Republic of Germany, users report that they were able to install a subset of the DHCP software (including File Manager and the Kernel) on a personal computer within 2 days, using the VA-recommended installation procedure. These users reported that only 7 of 150 routines in File Manager, for example, were operating-system specific. See: G. Schuller, "Description of the Decision Process to Use the DHCP as Basis of a HCP at a German Medical School," in Procurement of Hospital Information Systems in the Federal Republic of Germany, Vincent M. Brannigan, OTA contractor report, September 1987.
   (continued)

Module Descriptions — Up until VA reduced the scope of DHCP in June 1987, DHCP consisted of four phases of software development, embodied in four classes[5] of software modules:

1. Initial Core, which was installed in the 169 VA medical centers using DHCP by 1984;

2. Full Core, which the VA plans to have installed in the 169 VA medical centers by the end of 1987;

3. Enhanced DHCP, which by June 1987 consisted of 22 modules to support clinical services and some hospital-wide administrative functions; and

4. Comprehensive DHCP, which by June 1987 consisted of 23 additional modules intended for optional use by medical centers to provide automation for clinical or support services.

In June 1987, DHCP was reduced in scope to include only the Initial and Full Core modules, numbering 4 and 2, respectively, plus 8 of the original 22 Enhanced modules. These eight Enhanced DHCP modules met the OMB investment criteria for net benefits over their 10-year lifecycle and thus were approved for nationwide implementation. According to VA, any of the remaining 14 Enhanced modules and the 23 Comprehensive modules would only be added to DHCP as they are considered to be cost-justified and approved by OMB.[6]

Thus, as of June 1987, the official scope of DHCP was defined as Core Plus 8, consisting of the following 14 modules:

CORE:

1. Registration -- patient registration at the VAMC, demographic data in patient file available to all system users;

2. Admission/Transfer Discharge -- admit, transfer, discharge patients, track patient status and location, bed census, ward rosters, generate patient gain and loss statistics;

3. Clinic Scheduling -- schedule inpatient and outpatient clinic visits, eliminate duplicate appointments and claims, identify no-shows, send form letters to patients;

4. Outpatient Pharmacy -- produce prescription labels, check drug interactions and drug profiles, generate drug control data and management reports;

5. See: Veterans' Administration, Department of Medicine and Surgery, Decentralized Hospital Computer Program, n.d.

6. See: U.S. General Accounting Office, Hospital Information Systems: VA Needs to Better Manage its Decentralized System Before Expansion, Appendix VI (Agency Comments), pp. 73, 82.

5. Clinical Laboratory -- support chemistry, hematology, microbiology, anatomic pathology, blood bank, order laboratory tests and receive results, patient laboratory profile, provide collection lists and specimen labels, work lists, report generation;

6. Inpatient Pharmacy-- unit dose, ward stock, and intravenous dispensing, tracks drugs, offers many of same functions as outpatient pharmacy;

ENHANCED MODULES:

(Note: Implementation schedules depend on development status, management priorities, funding, and available computer capacity.)

7. Radiology (available, scheduled for implementation in 1987);

8. Dietetics (available, scheduled for implementation in 1987);

9. Medical Records Tracking (under development, scheduled for implementation in 1987);

10. IFCAP (Fiscal and Supply -- in Beta test, scheduled for implementation in 1987);

11. Decentralized Medical Management System (DMMS --under development, scheduled for implementation in 1988);

12. Surgery (in Beta test, scheduled for implementation in 1988);

13. Mental Health (available, scheduled for implementation in 1989); and

14. Nursing (in verification, scheduled for implementation in 1989).

Appendix table B-1, reproduced from appendix 111 of the July 1987 GAO report on DHCP, shows the status of the previously-planned modules that are not included in Core Plus 8.

APPENDIx TABLE B-1

Modules by Priority	Status as of June 1987 When the Scope of the DHCP Program Was Reduced
Enhanced	
1. Management Support	Under development
2. Medicine	Under development
3. Department of Veterans Benefits Interface	Available
4. Fee Basis	Under development
5. Social Work	Available
6. Engineering	Available
7. Dentistry	Available
8. Rehabilitation Medicine	Under development
9. Extended Care/Geriatrics	Under development
10. Nuclear Medicine	Planned
11. Personnel	Under development
12. Readjustment Counseling/Outreach	Planned
13. Operating System Enhancements	Under development
14. Message Handling/Switching	Under development
Comprehensive	
1. Audiology and Speech Pathology	Planned
2. Prosthetics	Under development
3. Orthotics	Planned
4. Optometry	Planned
5. Podiatry	Planned
6. Library Service	In Beta test
7. Medical Media	Planned
8. Building Management	Planned
9. Voluntary Service	Planned
10. Recreation Service	Planned
11. Chaplain Service	Planned
12. Canteen Service	Planned
13. Gastroenterology	Planned
14. Oncology	Jnder development
15. Neurology	Planned
16. Pulmonary Service	Planned
17. Patient Monitoring	Planned
18. Pacemaker Registry	Under development
19. Space Management	Planned
20. Employee Health	Planned
21. Parking Management	Planned
22. Security/Police Service	Planned
23. Research Administrative Support	Under development

"prototype development of each DHCP application module is performed in ● medical facility designated ● s an Alpha test site. A subsequent Beta test is performed at ● other site(s) to evaluate the software n a production environment.

[b]Following the Beta test, the software rs verified for both technical ● nd functional adequacy by en Information Systems Center. other than the center that developed the software

SOURCE: U.S. General Accounting Office, Hospital ADP Systems: VA Needs to Better Manage Its Decentralized System Before Expansion, GAO/IMTEC-87-28, July 1987, D ,67,

APPENDIX C: VETERANS ADMINISTRATION LIFECYCLE COST ESTIMATES FOR DHCP

In response to an information request from OTA, the VA's Department of Medicine and Surgery provided the Decentralized Hospital Computer Program (DHCP) budget information for fiscal years 1983 through 1996 shown in appendix tables C-1, C-2, and C-3.[1] These budget estimates are categorized by costs for Initial and Full Core and for Enhanced DHCP. Table C-1 shows VA budget estimates for the six Initial and Full Core modules.[2] Table c-2 shows VA budget estimates for the eight Enhanced DHCP modules[3], and table C-3 shows the totals for Initial and Full Core and Enhanced DHCP (referred to herein as Core plus 8).

According to VA, the historical (sunk) costs for DHCP are reported as actual obligations for fiscal years 1983-86. The fiscal year 1987 data are the VA% most recent estimates of obligations to be incurred. The figures for fiscal year 1988 are based upon the Office of Management and Budget passback of fiscal year 1987 funds, and the figures for fiscal years 1989-96 are based upon VA% best estimates of obligations to be incurred.

The DHCP Core Plus 8 budget estimates provided to OTA (see table C-3) indicate 10-year lifecycle costs of some $884 million for the period fiscal years 1987-96. In comparing this figure with the two sets of lifecycle cost estimates provided to the General Accounting Office (GAO)[4], OTA determined that these new figures were roughly

1. Letter to OTA from David A. Cox, Associate Deputy Administrator for Management (enclosure A), Aug. 28, 1987.
2. The 'Initial Core" modules are Registration, Admission/Discharge/Transfer, Clinic Scheduling, and Outpatient Pharmacy; the "Full Core" modules add Clinical Laboratory and Outpatient Pharmacy. The six "Initial and Full Core" modules are referred to simply as "Core" in this document.
3. [n June 1987, the VA announced a reduction in scope of DHCP, to include only the 6 Core modules and 8 (of the original 22) Enhanced modules. The eight modules currently included in Enhanced DHCP are: Radiology, Dietetics, Medical Records tracking, IFCAP, DMMS, Surgery, Mental Health, and Nursing (see app. B).
4. See U.S. General Accounting Office, Hospital ADP Systems: VA Needs to Better Manage Its Decentralized System Before Expansion, GAO/IMTEC-87-28, July 1987.

   VA provided GAO with two revised Iifecycle cost estimates for DHCP Core Plus 8. The first is given in enclosure 2 of a letter from the VA Administrator to GAO (p. 93 of the GAO report). These estimates were developed using a fringe benefit rate of 16 per cent for fiscal year 1987 and 20 per cent for subsequent years; these are the rates the VA uses in its internal budgeting. The total estimated cost for fiscal years 1987 — 96 was about $878 million.

   A second revised lifecycle cost estimate was also developed using a fringe benefit rate of 34.35 per cent, to reflect the Government% full share of retirement costs, not just VA costs, per OMB Transmittal Bulletin 87-2. The total estimated cost for fiscal years 1987 – 96 was about $925 million, or about $46.7 million (continued)

comparable[5] to the earlier lifecycle cost estimate prepared using VA's internal fringe benefit rate of 16 percent for fiscal year 1987 and 20 percent for subsequent years. (VA Central Office personnel costs for an average of 20 full-time equivalent employees were not included in the DHCP cost data provided to OTA; these are less than 1 per cent of total estimated costs.)

Actual costs to the government would reflect the total government fringe benefit rate, determined by OMB Transmittal Bulletin 87-2 to be 34.35 percent annually. Comparing the two VA cost estimates (16 and 20 percent fringe benefit rates versus a 34.35 percent rate) shows a difference in 10-year lifecycle costs of about $46.7 million.

Therefore, for the purposes of this report, OTA uses lifecycle costs of some $930 million for the 10-year period, fiscal years 1987-96, to reflect total costs to the government.[6]

VA's cost estimates for additional and replacement computer equipment to support the Core amount to some $67 million over the 10-year period, fiscal years 1987-96 (see table C-l). VA estimates that additional and replacement equipment to support the eight Enhanced modules over the same 10-year interval will amount to some $89 million, with procurements during the period fiscal years 1988-96 (see table C-2). Thus, total computer equipment costs for Core Plus 8 are estimated by VA to be some $156 million (see table C-3).[7]

The request for proposals (RFP) currently at issue (VA RFP #101-5-87, March 9, 1987) provides for a 'mandatory' stage of hardware procurement for the largest VA

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higher due to the inclusion of additional fringe benefit costs (p. 104 of the GAO report).

5. The two sets of cost estimates showed relatively small differences in maintenance costs, miscellaneous contracts, telecommunications and utilities costs, etc.
6. Calculated by adding $46.7 million to the $883.7 million total shown in table C-3 for fiscal years 1987 – 96, yielding $930.4 million.

   Taking the total fringe benefit cost to the government into account, OTA also concludes that the actual cumulative cost to the government for Core Plus 8 over the period fiscal years 1983 — 96 is likely to be at least $50 million larger than the $1.068 billion indicated in table C-3, or about $1.1 billion.
7. Total cumulative computer equipment costs, including sunk costs, over the period are some $239 million, according to VA ($150 million to support the Core and $89 million to support the 8 Enhanced modules).

Medical Centers (VAMCs) and the Information Systems Centers (ISCs), plus options for increased quantity and four additional stages of procurement, and other options to extend the contract for up to a ten-year period and for additional features and technology upgrades (see section I-3 and Appendices I and II of the RFP).

According to the Medical Information Resources Management Office (MIRMO), completing Stage 111 of the procurement would provide enough computer hardware to run Core Plus 8 in the 169 VAMCs using DHCP. The cost of procuring additional hardware to run Core Plus 8 in the 169 VAMCs corresponds to the $84.3 million over fiscal years 1988-90 indicated in table C-2.[8] However, OTA notes that if **all** options in the RFP were to be exercised, then VA'S procurements (for Stages IV and V, or for additional features and upgrades) would exceed VA'S current budget estimate of $84.3 million.

Based on the RFP's system requirements information (see app. table D-l), OTA calculates that procurements sufficient to run Core Plus 8 in the 169 VAMCs using DHCP (i.e. procurements through Stage III) would correspond to between 60 and 65 percent of the computing capacity and facilities of the potential full (five-stage) procurement with all quantity options exercised. Based on the $84.3 million additional-equipment cost estimated by VA for a three-stage procurement (see app. table C-2), Stage IV and V procurements might amount to an additional $50 million. [f Stage IV and V procurements were made, total DHCP lifecycle costs would increase by more than $50 million, because there is a multiplier effect from additional computer hardware costs: additional hardware maintenance costs, ISC personnel costs for development of additional software beyond Core Plus 8 to take advantage of the Stage IV and V capacity, additional VAMC staff and application coordinator personnel costs to utilize additional software, etc. would also be important. For example, the VA'S DHCP budget estimates for Core Plus 8 (see app. table C-3) show that additional and replacement equipment costs over the period fiscal years 1983-96 amount to about 22 percent of total cumulative costs.

8. Letter to OTA from David A. Cox (enclosure B), Aug. 28, 1987.

APPENDIX TABLE C-1

D H C P BUDGET COS ESTIMATES - INITIAL AND FULL CORE (000)

AUGUST 14, 1987

DESCRIPTION	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
VAMC FTEE	(33)	(68)	(163)	(395)	(323)	(395)	(429)	(491)	(553)	(649)	(689)	(689)	(689)	(689)	(689)
VAMC PAY & BENEFITS	870	1,794	4,300	9,304	7,836	9,583	10,408	12,093	13,777	16,386	17,473	17,473	17,473	17,473	156,242
VAMC FRINGE BENEFITS	109	224	538	1,163	980	1,198	2,082	2,419	2,755	3,277	3,495	3,495	3,495	3,495	28,722
ISC FTEE	(95)	(127)	(127)	(182)	(201)	(210)	(210)	(210)	(210)	(210)	(210)	(210)	(210)	(210)	(210)
ISC PAY & BENEFITS	3,003	4,016	4,016	5,139	5,846	6,108	6,108	6,108	6,108	6,108	6,108	6,108	6,108	6,108	76,987
ISC FRINGE BENEFITS	375	502	502	642	731	763	1,222	1,222	1,222	1,222	1,222	1,222	1,222	1,222	13,288
SIUG FTEE					(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
SIUG PAY & BENEFITS					98	98	98	98	98	98	98	98	98	98	977
SIUG FRINGE BENEFITS					12	12	20	20	20	20	20	20	20	20	181
APPLICATION COORDINATORS FTE					(203)	(76)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)	(51)
APPL CORD PAY & BENEFITS					5,510	2,066	1,378	1,378	1,378	1,378	1,378	1,378	1,378	1,378	18,598
APPL CORD FRINGE BENEFITS					689	258	276	276	276	276	276	276	276	276	3,151
PROGRAM TRAVEL	665	1,280	1,189	874	786	908	959	1,052	1,145	1,289	1,349	1,349	1,349	1,349	15,538
TRAINING TRAVEL					49	41	41	41	41	41	41	41	41	41	416
SIUG TRAVEL					8	8	8	8	8	8	8	8	8	8	75
SYS ANAL & PROG	182			114											296
SOFTWARE MAINTENANCE			528	378	1,090	1,090	1,090	1,090	1,090	1,090	1,006	983	1,032	1,068	11,535
HARDWARE MAINTENANCE			5,779	8,837	8,529	9,836	9,836	9,836	9,836	9,836	9,074	8,110	7,581	7,377	104,466
MISC CONTRACTS	90	90	213	1,127	1,093	1,344	1,344	1,344	1,344	1,344	1,344	1,344	1,344	1,344	14,706
TRAINING - FED		622	1,113		122	102	102	102	102	102	102	102	102	102	2,775
TRAINING - COM				61	168	168	168	168	168	168	168	168	168	168	1,741
RECORDING MEDIA		0	2,004	1,997	372	213	213	213	213	213	213	213	213	213	6,291
OPERATING SUPPLIES		2,413	3,098	1,970	3,115	3,115	3,115	3,115	3,115	3,115	3,115	3,115	3,115	3,115	38,628
TELECOMMUNICATIONS					1,650	1,650	1,451	062	697	697	697	697	697	697	9,285
UTILITIES					2,460	2,460	2,164	1,285	1,040	1,040	1,040	1,040	1,040	1,040	13,848
ADDITIONAL EQUIPMENT	25,396	32,146	17,626	6,798							9,047	4,110	3,220	5,098	143,441
REPLACEMENT EQUIPMENT		178	403	526	528	578	578	574	574	574	529	518	543	562	6,664
SITE PREPARATION	1,440	23,557	5,259												30,256
TOTAL	32,130	66,822	46,567	38,930	41,671	41,103	41,880	43,299	45,003	48,218	67,798	71,862	60,517	S2,247	698,107
CUMULATIVE	32,130	98,952	145,519	184,449	226,121	267,223	309,104	352,403	397,406	445,683	513,481	585,344	645,860	698,107	

SOURCE: Veterans' Administration. Letter to OTA from David Cox, Associate Deputy Administrator for Management (Enclosure A), Aug. 28, 1987.

APPENDIX **TABLE C-2**

D H C P BUDGET COST ESTIMATES - ENHANCED (000) **AUGUST 14, 1987**

				1989	1990	1991	1992	1993	1994	1992	1996	TOTAL
VAMC FTEE				(72)	(72)	(120)	(144)	(163)	(163)	(163)	(163)	(163)	(163)	(163)
VAMC PAY & BENEFITS				1,747	1,747	3,051	3,703	4,219	4,219	4,219	4,219	4,219	4,219	32,565
VAMC FRINGE BENEFITS				218	218	610	741	844	844	844	844	844	844	6,851
ISC FTEE				(35)	(51)	(5I)	(51)	(51J	(51)	[50]	(so)	[49)	(49)	(491
ISC PAY & BENEFITS				1,140	1,661	(1,661)	1,661	1,661	1,661	1,628	1,628	1,596	1,596	15,893
ISC FRINGE BENEFITS				142	208	332	332	332	332	326	326	319	3	1 9
SIUG FTEE				(7)	(7)	(7)	[7)	(7)	(7)	(7)	(7)	(7)	(7)	(7)
SIUG PAY & BENEFITS				22a	22a	228	22a	22a	22a	22a	22a	22a	22a	2,280
SIUG FRINGE BENEFITS				2	8	46	46	46	46	46	46	46	*46*	*422*
APPLICATION COORDINATORS FTEE					(128)	(240)	(229)	(174)	(134)	(127)	(127)	(127)	(127)	(127)
APPL CORD PAY & BENEFITS					*3,478*	6,521	*6,222*	4,72a	3,641	3,451	1,451	3,431	3,451	38,394
APPL CORD FRINGE BENEFITS				*o*	435	1,304	1,244	946	72a	*690*	*690*	690	690	7,410
PROGRAM TRAVEL				161	185	257	287	315	315	313	313	312	312	*2,767*
TRAINING TRAVEL					124	37	*62*	50	42	27	27	27	27	424
SIUG TRAVEL				18	18	18	18	18	18	18	18	18	18	175
SYS ANAL & PROG														*o*
SOFTWARE MAINTENANCE					*294*	601	988	1,121	1,121	1,121	1,121	1,121	1,121	8,607
HARDWARE MAINTENANCE					1,487	5,423	8,911	10,111	10,111	10,111	10,111	10,111	10,111	*76,488*
MISC CONTRACTS				1,500	*365*	*365*	*365*	*365*	*365*	358	358	331	351	*4,746*
TRAINING - FED					310	92	155	126	106	68	68	68	68	1,061
TRAINING - COM					100	100	100	100	100	100	100	100	100	900
RECORDING MEDIA					268	1,175	*873*	*453*	*219*	219	219	219	219	3,865
OPERATING SUPPLIES					*859*	*1,717*	*2,822*	*3,202*	*3,202*	3,202	3,202	3,202	3,202	*24,609*
TELECOMMUNICATIONS					199	510	78a	953	953	953	953	953	953	7,215
UTILITIES					*296*	*761*	*1,175*	1,420	1,420	1,420	1,420	1,420	1,420	10,752
ADDITIONAL EQUIPMENT					4S,195	*29,064*	*10,000*							84,259
REPLACEMENT EQUIPMENT						*316*	*520*	590	590	590	390	590	590	4,373
SITE PREPARATION				15,000	15,000									30,000
TOTAL	0	0	0	0	20,182	72,702	54,190	41,240	31,827	30,261	29,931	29,931	29,884	.29,884	370,031
CUMULATIVE	*o*	*0*	0	0	20,182	92,884	147,074	188,314	220,141	250,401	280,333	310,264	340,14a	370,031	

SOURCE: Veterans' Administration. Letter to OTA from David Cox, Associate Deputy Administrator for Management (Enclosure A), Aug. 28, 1987.

APPENDIX TABLE C-3

D H C P BUDGET COST ESTIMATES - INITIAL/FULL CORE AND ENHANCED (000) AUGUST 14, 1987

DESCRIPTION	1983	1984	1985	1986	1987	1988	1989	two	1991	1992	1993	1994	1995	1996	TOTAL
VAMC FTEE	(33)	(68)	(163)	(395)	(395)	(467)	(549)	(635)	(716)	(812)	(852)	(852)	(852)	(852)	(852)
VAMC PAY & BENEFITS	870	1,794	4,300	9,304	9,583	11,330	13,459	15,796	17,996	20,605	21,692	21,692	21,692	21,692	191,805
VAMC FRINGE BENEFITS	109	224	538	1,163	1,198	1,416	2,692	3,160	3,599	4,121	4,339	4,339	4,339	4,339	35,576
ISC FTEE	(95)	(127)	(127)	(182)	(236)	(261)	(261)	(261)	(261)	(261)	(260)	(260)	(259)	(259)	(259)
ISC PAY & BENEFITS	3,003	4,016	4,016	5,139	6,986	7,769	7,769	7,769	7,769	7,769	7,736	7,736	7,704	7,704	92,885
ISC FRINGE BENEFITS	375	502	502	642	873	971	1,554	1,554	1,554	1,554	1,548	1,548	1,541	1,541	16,259
SIUE FTEE					(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
SIUE PAY & BENEFITS					326	326	326	326	326	326	326	326	326	326	3,260
SIUE FRINGE BENEFITS					40	40	66	66	66	66	66	66	66	66	608
APPLICATION COORDINATORS FTEE					(203)	(204)	(291)	(280)	(225)	(185)	(178)	(178)	(178)	(178)	(178)
APPL CORD PAY & BENEFITS					5,510	5,544	7,899	7,600	6,106	5,019	4,829	4,829	4,829	4,829	56,994
APPL CORD FRINGE BENEFITS					689	693	1,580	1,520	1,222	1,004	966	966	966	966	10,572
PROGRAM TRAVEL	665	1,280	1,188	874	947	1,093	1,216	1,339	1,460	1,604	1,662	1,662	1,661	1,661	18,312
TRAINING TRAVEL					49	165	78	103	91	83	68	68	68	68	841
SIUE TRAVEL					26	26	26	26	26	26	26	26	26	26	260
SYS ANAL & PROG	182			114											296
SOFTWARE MAINTENANCE			528	378	1,090	1,384	1,691	2,078	2,211	2,211	2,127	2,104	2,153	2,189	20,144
HARDWARE MAINTENANCE			5,779	8,837	8,529	11,323	15,259	18,747	19,947	19,947	19,185	18,221	17,692	17,488	180,954
MISC CONTRACTS	90	90	213	1,127	2,593	1,709	1,709	1,709	1,709	1,709	1,702	1,702	1,695	1,695	19,452
TRAINING - FED		622	1,113		122	412	194	257	228	208	170	170	170	170	3,836
TRAINING - COM				61	168	269	269	269	269	269	269	269	269	269	2,650
RECORDING MEDIA			2,004	1,997	372	481	1,388	1,086	666	432	432	432	432	432	10,154
OPERATING SUPPLIES		2,413	3,098	1,970	3,115	3,974	4,832	5,937	6,317	6,317	6,317	6,317	6,317	6,317	63,241
TELECOMMUNICATIONS					1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	16,500
UTILITIES					2,460	2,460	2,460	2,460	2,460	2,460	2,460	2,460	2,460	2,460	24,600
ADDITIONAL EQUIPMENT	25,396	32,146	17,626	6,798		45,195	29,064	10,000			19,047	24,110	13,220	5,098	227,700
REPLACEMENT EQUIPMENT		178	403	526	528	578	894	1,094	1,164	1,164	1,119	1,108	1,133	1,152	11,041
SITE PREPARATION	1,440	23,557	5,259		15,000	15,000									60,256
TOTAL	32,130	66,822	46,567	38,930	61,854	113,808	96,075	84,546	76,836	78,544	97,736	101,801	90,409	82,138	1,068,196
CUMULATIVE	32,130	98,952	145,519	184,449	246,303	360,111	456,186	540,732	617,568	696,112	793,848	895,649	986,058	1,068,196	

SOURCE: Veterans' Administration. Letter to OTA from David Cox, Associate Deputy Administrator for Management (Enclosure A), Aug. 28, 1987.

APPENDIX D: DHCP SYSTEM REQUIREMENTS FROM VA'S RFP

In March 1987, the Veterans Administration issued a request for proposals for additional computer hardware to support DHCP. The terms of the proposed procurement contract specified a mandatory quantity of equipment to be purchased in the first (Stage 1) of five procurement stages; Stages I through V specified additional quantities if the contract% options for additional quantities were exercised.

Appendix II of the RFP sets forth the delivery schedule for the mandatory and optional quantities, conditional on the availability of funds. Delivery of the mandatory, Stage I, quantities to the 31 largest VAMCs and to the ISCs would be completed 60 to 180 days after completion of acceptance testing. Delivery of optional quantities in Stages 11 through V of the procurement to VAMCs and ISCs would be completed between 240 and 720 days after acceptance testing. Delivery of hardware procured in Stages I through 111, sufficient to run Core Plus 8 in the 169 VAMCs using DHCP, would be complete by 450 days after acceptance testing.

Appendix I of the RFP, reproduced here as appendix table D-1, sets forth the generic system requirements for the proposed procurement, by stages and cumulatively. The requirements include computer facility square footage (SQUARE FOOT), throughput units (TUs -- a TU is a computing capacity equivalency unit defined by VA as the throughput of one DEC PDP11/44), disk storage capacity (DISK), number of active partitions (ACT PAR -- a partition is memory allocated to a given MUMPS job process), and number of peripheral device attachment points (ATTM **PTS).**

Based on VA data in table D-1, OTA calculates that procurements sufficient to run Core Plus 8 in the 169 VAMCs using DHCP (i.e. procurements through Stage 111) would correspond to between 60 and 65 per cent of the computer capacity and facilities of the potential (five-stage) procurement if all quantity options were exercised.

1. Veterans Administration Department of Medicine and Surgery Decentralized Hospital Computer Program. Request for Proposal for: Replacement Computer Configurations, RFP #101-5-87, Mar. 9, 1987.

APPENDIX TABLE D-1: DHCP System Requirements

APPENDIX I: SYSTEM REQUIREMENTS (cumulative values) FEB 18,1987 10:2/ PAGE 1

		STAGE I					STAGE II					STAGE III					STAGE IV					STAGE V				
		SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS
1	WEST LOS ANGELES, CA	650	13	4250	416	640	750	14	4500	448	800	850	17	5250	544	960	1150	22	6500	704	1224	1450	29	7300		1464
2	MIAMI, FL	650	12	4000	384	512	650	13	4250	416	640	850	16	5000	512	768	950	19	5750	608	936	1250	25	6500	800	1152
3	LONG BEACH, CA	550	11	3750	352	640	650	13	4250	416	800	850	16	5000	512	960	950	19	5750	608	1200	1350	26	6700	832	1464
4	HOUSTON, TX	550	11	3750	352	448	650	12	4000	384	560	750	15	4750	480	672	950	18	5500	576	864	1250	24	6300	768	1032
	LITTLE ROCK, (CONS)	550	11	3750	352	544	650	13	4250	416	680	850	16	5000	512	816	950	19	5750	608	1032	1250		6500	800	1248
6	DALLAS, TX	550	10	3500	320	512	550	11	3750	352	640	750	14	4500	448	768	850	17	5250	544	936	1150	22	5900	704	1128
7	HINES, IL	550	10	3500	320	576	650	12	4000	384	720	750	15	4750	480	864	950	18	5500	576	1056	1250	24	6300	768	1272
	MINNEAPOLIS,	550	10	3500	320	480	550	11	3750	352	600	750	14	4500	448	720	850	17	5250	544	936	1150	22	5900	704	1128
9	SAN JUAN, PR	550	10	3500	320	512	550	11	3750	352	640	750	14	4500	448	768	850	17	5250	544	1032	1150	22	5900	704	1272
10	NEW YORK, NY	550	10	3500	320	480	550	11	3750	352	600	750	14	4500	448	720	850	17	5250	544	864	1050	21	5700	672	1056
11	BROOKLYN, NY (CONS)	550	10	3500	320	480	550	11	3750	352	600	750	14	4500	448	720	850	17	5250	544	912	1150	22	5900	704	1104
12	CLEVELAND, (CONS)	550	10	3500	320	512	550	11	3750	352	640	750	14	4500	448	768	850	17	5250	544	936	1050	21	5700	672	1104
13	BOSTON, MA (CONS)	450	9	3250	288	480	550	11	3750	352	600	750	14	4500	448	720	850	17	5250	544	888	1150	22	5900	704	1056
14	TAMPA, FL	450	9	3250	288	512	550	11	3750	352	640	750	14	4500	448	768	850	17	5250	544	960	1050	21	5700	672	1176
15	ST LOUIS, MO (CONS)	450	9	3250	288	480	550	10	3500	320	600	650	12	4000	384	720	750	15	4750	480	864	1050	20	5500	640	1056
16	PALO ALTO, CA (CONS)	450	9	3250	288	512	550	10	3500	320	640	650	12	4000	384	768	750	15	4750	480	936	1050	20	5500	640	1104
17	PORTLAND, OR (CONS)	450	8	3000	256	512	550	10	3500	320	640	650	12	4000	384	768	750	15	4750	480	1056	1050	20	5500	640	1320
18	BAY PINES, FL	450	8	3000	256	512	550	10	3500	320	640	650	12	4000	384	768	750	15	4750	480	960	950	19	5300	608	1152
19	NEW ORLEANS, LA.	450	8	3000	256	384	450	9	3250	288	480	550	11	3750	352	576	750	14	4500	448	744	950	18	5100	576	912
20	BUFFALO, NY	450	8	3000	256	416	450	9	3250	288	520	550	11	3750	352	624	750	14	4500	448	744	950	18	5100	576	912
21	PITTSBURGH, PA (CONS)	450	8	3000	256	352	450	8	3000	256	440	550	10	3500	320		650	12	4000	384	648	850	16	4700	512	792
22	SAN ANTONIO, TX	450	8	3000	256	384	550	10	3500	320	480	650	12	000	384	576	750	15	4750	480	768	950	19	5300	608	936
23	RICHMOND, VA	450	8	3000	256	416	450	9	3250	288	520	550	11	3750	352	624	750	14	4500	448	792	950	18	5100	576	960
24	CHICAGO (WESTSIDE), IL	450	8	3000	256	352	450		3250	288	440	550		3750	352	528	750	6	4500	448	672	850	17	4900		816
25	EAST ORANGE, NJ	450	8	3000	256	384	450	9	3250	288	480	550	11	3750	352	576	750	14	4500	448	744	950	18	5100	576	912
26	WASHINGTON, DC	450	8	3000	256	384	550	10	3500	320	480	650	12	4000	384	576	750	15	4750	480	744	950	19	5300	608	912
27	SAN DIEGO, CA	450	8	3000	256	384	450	9	3250	288	480	550	11	3750	352	576	750	14	4500	448	720	850	17	4900	544	864
28	BROCKTON, MA (CONS)	450	8	3000	256	512	450	8	3000	256	640	550	10	3500	320	768	650	12	4000	384	888	850	16	4700	512	1056

Source: Veterans Administration RFP # 101-5-87, Appendix = (pp. 102-106) March 9, 987

APPENDIX TABLE D-1, cont'd.

APPENDIX I: SYSTEM REQUIREMENTS (cumulative values) FEB 18,1987 10:27 PAGE 2

		STAGE I SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	STAGE II SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	STAGE III SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	STAGE IV SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	STAGE V SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS
29	DECATUR, GA	450	*	3000	256	416	450	9	3250	288	520	550	11	3750	352	624	750	14	4500	448	792	850	17	4900	544	960
30	NORTHPORT, NY	450	8	3000	256	384	450	9	3250	288	480	550	11	3750	352	576	750	14	4500	448	768	950	18	5100	576	936
31	GAINESVILLE, FL	450	8	3000	256	512	450	9	3250	288	640	550	11	3750	352	768	750	14	4500	448	1008	950	18	5100	576	1248
32	PHILADELPHIA, PA	450	8	3000	256	352	450	9	3250	288	440	550	11	3750	352	528	650	13	4250	416	648	950	18	5100	576	768
33	WOOD, WI	450	8	3000	256	384	450	8	3000	256	480	550	11	3750	352	576	650	13	4250	416	744	950	18	5100	576	912
34	MEMPHIS, TN	450	8	3000	256	448	450	*	3000	256	560	550	11	3750	352	672	650	13	4250	416	864	850	17	4900	544	1032
35	ALLEN PARK, MI	450	8	3000	256	352	450	8	3000	256	440	550	11	3750	352	528	650	13	4250	416	672	850	17	4900	544	816
36	LEXINGTON, KY (CONS)	350	7	2750	224	384	450	8	3000	256	480	550	10	3500	320	576	650	12	4000	384	768	850	16	4700	512	936
37	BRONX, NY	350	7	2750	224	384	450	8	3000	256	480	550	10	3500	320	576	650	12	4000	384	696	850	16	4700	512	840
38	OKLAHOMA CITY, OK	350	7	2750	224	320	450	8	3000	256	400	550	10	3500	320	480	650	12	4000	384	600	850	16	4700	512	720
39	INDIANAPOLIS, IN (CONS)	350	7	2750	224	384	450	8	3000	256	480	550	10	3500	320	576	650	12	4000	384	744	750	15	4500	480	912
40	SEATTLE, WA	350	7	2750	224	416	450	8	3000	256	520	550	10	3500	320	624	650	12	4000	384	840	750	15	4500	480	1056
41	AUGUSTA, GA (CONS)	350	7	2750	224	384	450	8	3000	256	480	550	10	3500	320	576	650	12	4000	384	720	750	15	4500	480	888
42	SEPULVEDA, CA	350	7	2750	224	352	450	8	3000	256	440	550	10	3500	320	528	650	12	4000	384	672	750	15	4500	480	816
43	NASHVILLE, TN	350	7	2750	224	320	450	8	3000	256	400	550	10	3500	320	480	650	12	4000	384	600	750	15	4500	480	720
44	DENVER, CO	350	7	2750	224	384	450	8	3000	256	480	550	10	3500	320	576	650	12	4000	384	768	750	15	4500	480	936
45	SAN FRANCISCO, CA	350	6	2500	192	352	350	7	2750	224	440	450	9	3250	288	528	550	10	3500	320	672	750	14	4300	448	816
46	ARBOR	350	6	2500	192	352	350		2750	224	440	450	9	3250	288	528	550	10	3500	320	648	750	14	4300	448	792
47	PHOENIX, AZ	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	576	750	14	4300	448	720
48	TEMPLE, TX	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	624	750	14	4300	448	744
49	LOMA LINDA, CA	350	6	2500	192	288	350	7	2750	224	360	450	9	3250	288	432	550	10	3500	320	576	750	14	4300	448	720
50	CHICAGO (LAKESIDE), IL	350	6	2500	192	288	350	7	2750	224	360	450	9	3250	288	432	550	10	3500	320	576	750	14	4300	448	720
51	DURHAM, NC	350	6	2500	192	288	350	7	2750	224	360	450	9	3250	288	432	550	10	3500	320	552	750	14	4300	448	672
52	JACKSON, MS	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	600	750	14	4300	448	720
53	SALEM, VA	350	6	2500	192	352	350	7	2750	224	440	450	9	3250	288	528	550	10	3500	320	648	650	13	4100	416	792
54	ALBANY, NY	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	600	650	13	4100	416	720
55	MARTINEZ, CA	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	500	320	600	650	13	4100	416	720
56	BIRMINGHAM, AL.	350	6	2500	192	256	350	7	2750	224	320	450	9	3250	288	384	550	10	3500	320	504	650	13	4100	416	624

APPENDIX [illegible] A1, cont d.

APPENDIX I SYSTEM REQUIREMENTS (cumulative values) FEB 18,1987 10:2> PAGE 1

		STAGE I SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	STAGE II SQUARE FOOT	TU	SK	ACT PAR	ATTN PTS	STAGE III SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	STAGE IV SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS	STAGE V SQUARE FOOT	TU	DISK	ACT PAR	ATTN PTS
57	DAYTON, OH	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	600	650	13	4100	416	720
58	WEST HAVEN, CT	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	600	650	13	4100	416	696
59	KANSAS CITY, MO	350	6	2500	192	288	350	7	2750	224	360	450	9	3250	288	432	550	10	3500	320	552	650	13	4100	416	672
60	ALBUQUERQUE, NM	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	624	650	13	4100	416	768
61	SALT LAKE CITY, UT	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	624	650	13	4100	416	744
62	CINCINNATI, OH	350	6	2500	192	288	350	7	2750	224	360	450	9	3250	288	432	550	10	3500	320	552	650	13	4100	416	672
63	BILOXI, MS (CONS)	350	6	2500	192	320	350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	648	650	13	4100	416	792
64	COLUMBIA, SC	350	<	2500	192		350	7	2750	224	400	450	9	3250	288	480	550	10	3500	320	576	650	13	4100	416	696
65	NORTH CHICAGO, IL	250	5	2250	160	384	350	6	2500	192	480	350	7	2750	224	576	450	9	3250		696	650	12	3900	384	816
66	WILKES BARRE, PA	250	5	2250	160	288	350	6	2500	192	360	350	7	2750	224	432	450	9	3250		576	650	12	3900	384	696
67	HAMPTON, VA.	250	5	2250	160	320	350	6	2500	192	400	350	7	2750	224	480	450	9	3250	:=	600	650	12	3900	384	744
68	MOUNTAIN HOME, TN	250	5	2250	160	320	350	6	2500	192	400	350	7	2750	224	480	450	9	3250	288	648	650	12	3900	384	792
69	TUCSON, AZ	250	5	2250	160	288	350	6	2500	192	360	350	7	2750	224	432	450	9	3250	288	528	650	12	3900	384	648
70	BALTIMORE, MD	250	5	2250	160	256	350	6	2500	192	320	350	7	2750	224	384	450	9	3250	288	456	550	11	3700	352	552
71	DANVILLE, IL	250	5	2250	160	288	350		2500	192	360	350	7	2750	224	432	450	9	3250	288	552	550	11	3700	352	672
72	PROVIDENCE, RI	250	5	2250	160	256	350	6	2500	192	320	350	7	2750	224	384	450	9	3250	288	480	550	11	3700	352	576
73	SALISBURY, NC	250	5	2250	160	320	350	6	2500	192	400	350	7	2750	224	480	450	9	3250	288	576	550	11	3700	352	696
74	LOUISVILLE, KY.	250	5	2250	160	256	350	6	2500	192	320	350	7	2750	224	384	450	9	3250	288	504	550	11	3700	352	624
75	IOWA CITY, IA	250	5	2250	160	256	350	6	2500	192	320	350	7	2750	224	384	450	9	3250	288	480	550	11	3700	352	576
76	SHREVEPORT, LA						250	5	2250	160	320	350	6	2500	192	384	450	8	3000	256	456	550	10	3500	320	552
77	SYRACUSE, NY						250	5	2250	160	320	350		2500	192	384	450	8	3000	256	504	550	10	3500	320	600
78	TOPEKA, KS						250		2250	160	360	350	6	2500	192	432	450	8	3000	256	504	550	10	3500	320	600
79	WACO, TX						250		2250	160	360	350	6	2500	192	432	450	8	3000	256	528	550	10	3500	320	648
80	ASHEVILLE, NC						250	*	2250	160	320	350	6	2500	192	384	450	8	3000	256	456	550	10	3500	320	552
81	LYONS, NJ						250	5	2250	160	360	350	6	2500	192	432	450	8	3000	256	552	550	10	3500	320	672
82	BEDFORD, MA						250	5	2250	160	320	350	6	2500	192	384	450	8	3000	256	480	550	10	3500	320	576
83	OMAHA, NE						250	5	2250	160	280	350	6	2500	192	336	450	8	3000	256	456	550	10	3500	320	528
84	BATTLE CREEK, MI						250	5	2250	160	320	350	6	2500	192	384	450	8	3000	256	504	450	9	3300	288	600

APPENDIX TABLE D-1, cent'd.

85						250	5	2250	160	320	350	6	2500	192	384	450	8	3000	256	456	450	9	3300	288	576
86						250	5	2250	160	280	350	6	2500	192	336	450	8	3000	256	432	450	9	3300	288	528
87						250	5	2250	160	320	350	6	2500	192	384	450	8	3000	256	456	450	9	3300	288	552
88						250	5	2250	160	360	350	6	2500	192	432	450	8	3000	256	528	450	9	3300	288	624
89						250	5	2250	160	280	350	6	2500	192	336	450	8	3000	256	432	450	9	3300	288	528
90						250	5	2250	160	360	350	6	2500	192	432	450	8	3000	256	528	450	9	3300	288	648
91						250	5	2250	160	360	350	6	2500	192	432	450	8	3000	256	552	450	9	3300	288	672
92						250	5	2250	160	240	350	6	2500	192	288	450	8	3000	256	408	450	9	3300	288	480
93						250	5	2250	160	280	350	6	2500	192	336	450	8	3000	256	432	450	9	3300	288	528
94						250	5	2250	160	240	350	6	2500	192	288	450	8	3000	256	408	450	9	3300	288	480
95						250	5	2250	160	280	350	6	2500	192	336	450	8	3000	256	432	450	9	3300	us	528
96						250	5	2250	160	320	350	6	2500	192	384	450	8	3000	256	504	450	9	3300	288	600
97						250	5	2250	160	320	350	6	2500	192	384	450	8	3000	256	456	450	9	3300	288	552
98																					250	5	2500	160	192
99																					250	5	2500	160	192
100																					250	5	2500	160	192
101																					250	5	2500	160	192
102																					250	5	2500	160	192
103																					250	5	2500	160	192
104																					250	5	2500	160	192
TOTAL	30050	554	213500	17728	28992	38850	743	182750	23776	33160	48550	921	327250	29472	51792	59550	1126	378500	36032	65472	76100	1477	431400	47264	80736
COUNT	75	75	75	75	75	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	104	104	104	104	104
MEAN	401	7	2847	236	387	401	8	2915	245	445	501	9	3374	304	534	614	12	3902	371	675	732	14	4340	454	776

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