TRENDS IN REMOTE DIAGNOSTICS

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TRENDS IN REMOTE DIAGNOSTICS

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I INTRODUCTION

I INTRODUCTION

A. SCOPE AND PURPOSE

- One of the major objectives of this study is to offer the industry a set of standard terms relating to the subject of remote diagnostics.

  - As reported in INPUT's 1980 Field Service Annual Report, the term "remote diagnostics" has a very elusive definition.

  - Part of Chapter III develops the background of remote diagnostics.

  - The Glossary in Appendix A derives some "consensus" definitions.

  - The "consensus" in this study refers to the vendors surveyed and their general agreement on common usage of terms.

- A second major objective was to examine and report on vendors' reasons for developing remote diagnostics, financial impact and various methods of delivery.

  - Chapter V deals with the direct results of the vendor survey.

  - Chapter IV provides some examples of remote diagnostic techniques.

- A third major objective was to measure user knowledge about, and attitudes toward, remote diagnostics. The results of the user survey are reported in Chapter VI.

B. METHODOLOGY

- Extensive research was conducted through the INPUT library and other cooperative research organizations, involving all current writing on the subject of remote diagnostics.

- The research and writing team for this report thoroughly reviewed the development of the European INPUT report Remote Diagnostics in Western Europe.

- Vendors were selected for on-site and telephone interviews, stratified according to the reported mixes of vendors with remote diagnostics installed and those planning near-term implementation.

- Users were selected from INPUT's user panel for telephone interviews - a cross-section of over 900 managers of data processing installations.

- Field engineering personnel known to INPUT staff were informally interviewed for corroboration of certain reported attitudes about remote diagnostics among field engineering personnel.

- Data collected by the above methods were then analyzed and discussed among senior members of the INPUT staff intimately familiar with the developments in field service technical support.

  - A topical and working outline was produced by the senior staff panel.

- The senior staff consultant most familiar with field service management through personal experience assembled the data and produced the final report.

C. ORGANIZATION OF THE REPORT

- The "Executive Summary," Chapter II, is a short overview of the most important issues and conclusions drawn in more detail throughout the report.

- Chapter III is dedicated to the development of relevant background information, a cross-section of vendor/user/field engineer issues, and some specific recommendations.

- Chapters IV and V report in detail on the vendor and user surveys.

- Appendix A is a topical glossary, including a discussion of the derivation of definitions.

- Appendix B contains copies of the questionnaires used in the vendor and user surveys.

II EXECUTIVE SUMMARY

II EXECUTIVE SUMMARY

A. BACKGROUND

- Although remote diagnostics have been available for years in the general computer maintenance environment, vendors are just beginning to exploit its potential to significantly improve maintenance services and reduce costs.

- The concept of remote assistance to field engineers is not new. What is new are the methods of delivery and control.

  - Remote assistance began as "lists" of the most qualified trouble-shooters in an organization. By the mid-1960s, it was run by organized staff personnel with rigid procedures and controls.

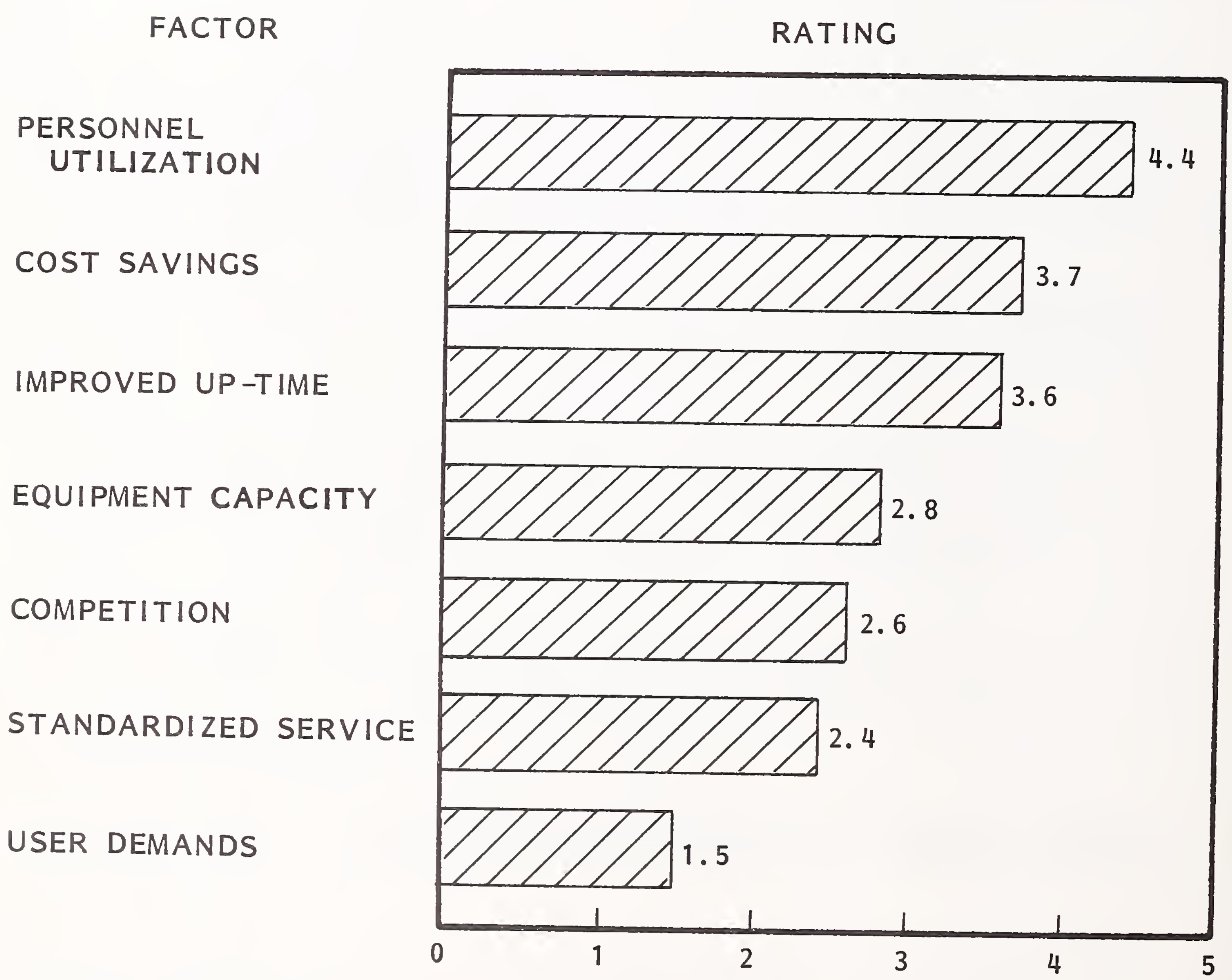
  - Remote diagnostics represents one of the logical extensions in the development of tools used in technical support.

B. VENDOR DRIVING FORCES IN REMOTE DIAGNOSTICS

- The consensus of all vendors surveyed is that personnel utilization is the primary driving force behind the development of remote diagnostics. Survey results are shown in Exhibit II-1.

EXHIBIT II-1

VENDORS' RATINGS OF FACTORS RELATIVE TO REMOTE DIAGNOSTICS



RATING: 0 = NO IMPORTANCE
5 = MAXIMUM IMPORTANCE

NUMBER OF RESPONDENTS = 14

- Vendors are clearly designing equipment and maintenance plans around the obstacles created by shortages of field engineering skills, or by a desire to retard growth in field engineering forces.

- Vendors are taking the position that they have historically played more of a passive role in the evolution of field engineering, and they now want to play a more active role.

- Practically tied for second place as driving forces were "expected cost savings" and "improved equipment availability."

  - The clear majority of vendors expect to save expenses by using remote diagnostics, and this expectation is reflected in the plans of some vendors to impose penalties on users electing not to use the remote capabilities.

  - The majority of maintenance vendors also recognize that the "product" they sell is equipment up-time, and this attitude is reflected in their reporting availability as a key driving force behind remote diagnostics.

- Only two of 15 vendors identified equipment complexity as the primary driving force behind remote diagnostics.

- Only one vendor reported that standardization of service levels throughout the country was the primary reason for implementing a remote diagnostic capability.

- Although respondent vendors gave little emphasis to competitive pressures as a driving force, INPUT predicts a change of emphasis in the near future, as vendors recognize the value of appealing to the user with an explanation of the benefits of new diagnostic systems.

- The fact that users are exerting almost no pressure for remote diagnostics is reflected in the low rating of "user demands" as a factor.

- Because little time has passed to collect and isolate cost data on new systems, details are not available on the capital investment issues surrounding remote diagnostics. Some general guidelines, however, are available.

  - Most vendors require an 18-month to 30-month payback on this type of investment.

  - All of the vendors reporting expected paybacks say that they are on target.

  - The range of estimated remote diagnostics development cost is from 2% to 15% of the equipment development cost.

- Field engineering management has been successful, in most cases, in passing on the most significant operating expenses associated with remote diagnostics to the customer or to sales margins.

- Only one vendor reported a 10% surcharge to the user for remote diagnostics. Several vendors reported that they would make a punitive adjustment to maintenance contracts for those users who refused to allow the implementation of remote diagnostics available to them.

- All vendors reported some involvement of field engineering in the design of remote diagnostics.

C. IMPACT ON FIELD ENGINEERING PERSONNEL

- Field engineering personnel attitudes are being adversely affected by the implications of remote diagnostics.

  - Many experienced field engineers feel a loss of control over customer satisfaction.

- Effective management communications with field engineers is lacking.

- Management does not appear to be aware of the true attitudes of field engineers toward remote diagnostics.

- The remote diagnostic issue has the potential of being a "threshold" event in labor union organization efforts. Unions may find field engineers receptive to their organization efforts as job security is threatened.

D. USERS' ATTITUDES TOWARD REMOTE DIAGNOSTICS

- Overall, users have positive attitudes toward remote diagnostics. However, there are users who have a negative view, shown in the rating of factors in Exhibit II-2.

- Users have some concern with signs that the personal touch in maintenance is fading away. Frequency of FE contact is rated as the number-one factor relative to remote diagnostics.

- As reflected in other INPUT surveys, users are not focusing their attention on maintenance issues.

- They are not very interested in getting involved with the details of maintenance except where alternatives are very clear and graphic.

    - This is evidenced by the high frequency of "not applicable" responses to questions involving user involvement in maintenance.

    - Over half of the user respondents were not involved in depot repair, shipping parts or exchanging parts.

EXHIBIT II-2

USERS' RATINGS OF FACTORS RELATIVE TO REMOTE DIAGNOSTICS

FACTOR	NUMBER OF RESPONSES				
	NEGATIVE RATING	NEUTRAL RATING	POSITIVE RATING	N/A	AVERAGE RATING
FREQUENCY OF FE CONTACT	2	3	12	3	2.2
SHIPPING PARTS TO REPAIR DEPOT	0	1	6	13	2.1
DATA SECURITY	1	5	10	4	2.1
OVERALL CONCEPT OF REMOTE DIAGNOSTICS	4	2	13	1	1.9
USER LOADING DIAGNOSTICS	3	2	7	8	1.6
EXCHANGING PARTS	3	1	5	11	1.6
SOFTWARE PATCHES BY REMOTE CONTROL	2	2	6	10	1.5
USER RELAYING INFORMATION	4	1	9	6	1.1
CHANGING SWITCHES, VOLTAGES, ETC.	2	1	7	10	1.1

RATING: -5 = TOTAL OBJECTION
+5 = ENTHUSIASTIC ACCEPTANCE
0 = NEUTRAL/INDIFFERENT
N/A = NOT APPLICABLE

NUMBER OF RESPONSES = 20

- When discussed as an additional field engineering tool designed to keep the equipment performing to expected standards, remote diagnostics are perceived positively by users.

- The most remote users, geographically speaking, are the most pleased with remote diagnostics. Because of the longer inherent response time at remote locations, these users perceive they have the most to gain.

- Many users are not even aware that remote diagnostics are being used at their locations, a reflection of the fact that some vendors have not publicized their use.

E. IMPACT OF TECHNOLOGY ON REMOTE DIAGNOSTICS

- The state of the art in remote diagnostics is well ahead of the human capacity to adapt to change. This is evidenced by the wide discrepancy between the current state of remote diagnostics, and the users' perceptions of remote diagnostics.

- Current models of remote diagnostics range from electronically "looking over the shoulder of the local field engineer" to completely automated check-out of terminals with operator prompting.

  - Technology contributed earlier to developments in remote diagnostics as a "push" factor in that the growing complexity of equipment created a requirement for better tools, and vendors were pushed into development.

  - More recently, technological advances are "pulling" vendors toward the use of remote diagnostics because of the relatively inexpensive addition of microprocessing intelligence to remote units.

- The recent announcement by Hewlett-Packard of a maintenance agreement that specifies 99% hardware up-time is a dramatic example of the impact of technology.

  - More reliable hardware is largely technologically driven.

  - The new HP 3000 Series 44 computer system, on which the offer is made, features a control and maintenance processor that makes extensive diagnostics available, and remotely accessible.

  - Prime reliance for maintenance is still on local support, however, with the guarantee offer restricted to installations within 100 miles of an HP Primary-Service-Responsible office (SRO).

- Remote Diagnostics also tend to be used on smaller mainframes. IBM's General Systems Division recently announced a Remote Testing Service for its System 38 small business computer, which is primarily an implementation aid for users converting from the older System 3. An IBM remote support representative can access programs, test data and observe program execution.

F. RECOMMENDATIONS

- Management must recognize the emerging negative feelings many field engineers have toward remote diagnostics. Structured communications with field engineers based on independent attitude surveys will offset many potential personnel problems.

  - The point must be made that remote diagnostics are not intended to replace the current field force.

  - The potential benefits to the field engineer, such as reduced travel and more efficient use of time, should be stressed.

- Remote diagnostics must be presented in terms of user benefits. This will increase the price levels that can be charged for remote diagnostics, and the resultant return on investment.

  - A key benefit is increased up-time potential.

  - An emerging benefit is the ability to deal more effectively with distributed data processing applications.

- Remote center personnel must be trained in two major areas of "stage presence":

  - The art of projecting a sense of urgency to users by telephone.

  - Supporting the image of the local field engineer in the eyes of the users.

- Vendors should enlist the active involvement of the sales forces in their organizations to publicize the benefits of remote diagnostics. The voids left by inadequate education are being filled with negative attitudes among some users.

- Management should utilize the potential in remote diagnostics for improved reporting systems.

  - Data on mean time between failures, response times and repair times will be more available.

  - These data can be used to utilize the field force more effectively, and to better identify problem installations.

  - Improvements in efficiency should be communicated to users as evidence that they are receiving the benefits of remote diagnostics.

III TRENDS IN REMOTE DIAGNOSTICS

III TRENDS IN REMOTE DIAGNOSTICS

A. EVOLUTION OF REMOTE DIAGNOSTIC CONCEPTS

1. HISTORICAL SKETCH OF TECHNICAL SUPPORT CENTERS

- An understanding of remote diagnostics must begin with a review of the evolutionary process that has been going on for the past 25 years.

- The concept of remote assistance in the diagnosis of equipment failure symptoms was developed over the years on both real and imaginary premises:

  - The real premise was that somewhere beyond the local area there existed reservoirs of total knowledge about the design and operation of data processing equipment.

    - The first presumption was that the expert knowledge was in the manufacturing plants.

    - Since the late fifties, it has become more and more evident that effective maintenance knowledge resided in the field, not in the plants.

    - To create the framework of an effective technical support function, expertise in the diagnosis of certain equipment types, which resided in field locations, was coordinated with the intimate design knowledge resident in the plants.

- Lines of communication were established between manufacturing plant technical operations specialists and experienced field diagnostic or "trouble-shooting" specialists.

- Credibility and mutual respect between the groups, while sometimes lacking, was absolutely necessary to the success of such structures.

- Titles of "Region Specialist," "District Specialist," etc. became goals of aspiring field engineers in the fifties and sixties.

- The imaginary premise was an outgrowth of the real premise and developed concurrently with it.

  - Early on, it became evident to many local sales and field engineering managers that users regarded almost any confident field service person from "out-of-town" as an expert.

  - "Out-of-town" experts (or specialists) could get users to give up equipment for extensive reworking or even to change their usage habits significantly.

  - Local management in sales and service learned to manipulate certain situations by playing on the imaginary or psychological aspects of remote assistance in diagnosis.

  - This over-emphasis on out-of-town expertise created local image problems and became a significant force behind subsequent directions in the evolutionary process.

- Early remote diagnosis assistance was characterized by the physical presence of assistance brought in from a remote (as opposed to a local) location.

    - Most "specialists" retained territorial reponsibilities within their local branch offices.

    - Support hierarchies were usually established, as shown in Exhibit III-1.

    - Successively higher levels of specialization in trouble-shooting techniques would be brought into the user's facility until problems were resolved.

    - The ultimate level of support would normally be a product test technician from the manufacturing plant with intimate knowledge of a specific unit or section of the equipment.

    - On very rare occasions, a design engineer would be consulted.

- Another characteristic of early models of remote assistance in problem diagnosis was the increased level of efficiency in telephone discussions as the problem escalated up the hierarchy.

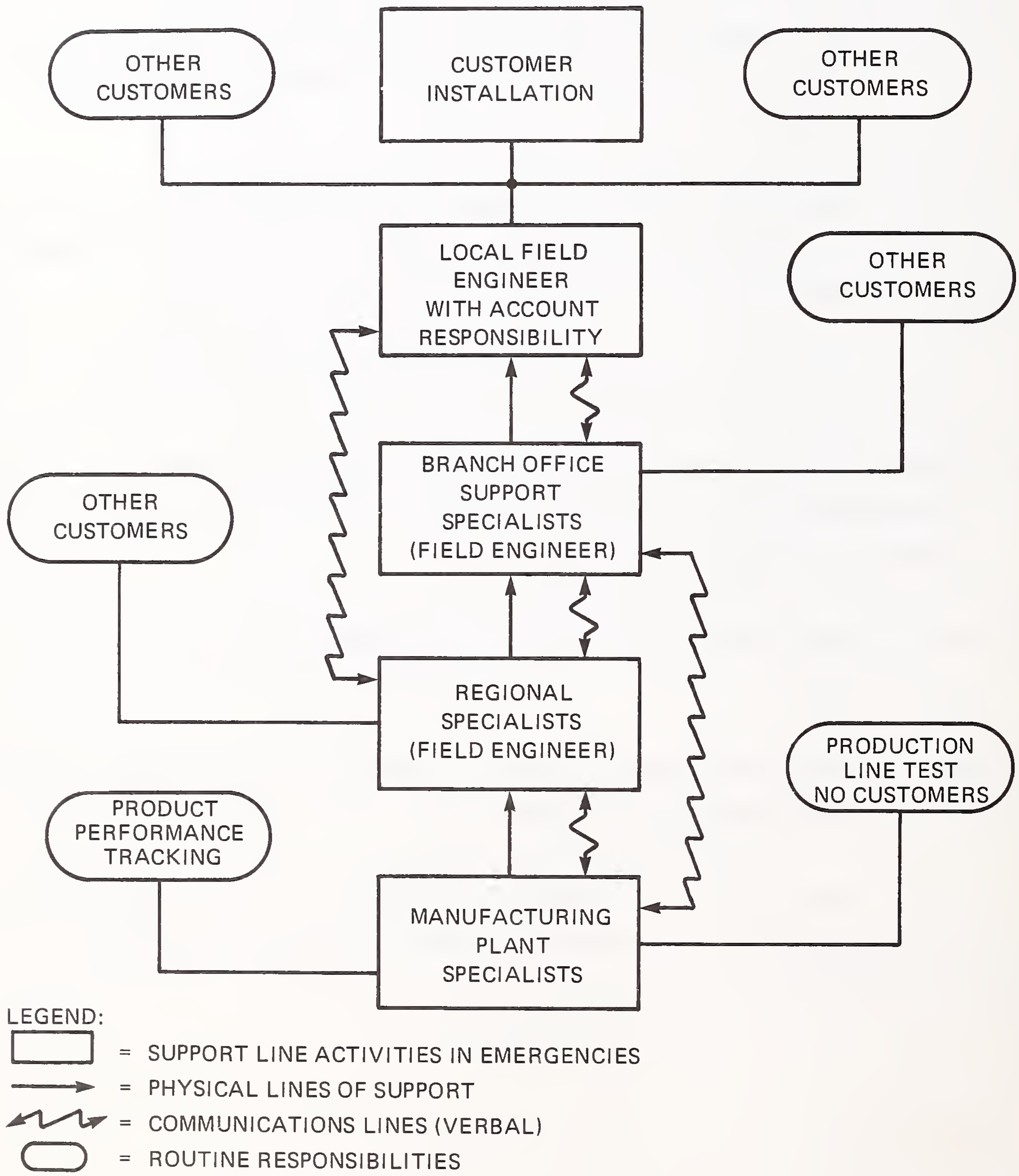
    - Mutual respect and credibility increased in proportion to hierarchical levels.

    - Experience in collecting relevant information to exchange by telephone was evident at higher levels.

    - Higher levels of incentive to avoid another trip away from home contributed to the efficiency of remote diagnosis by telephone.

EXHIBIT III-1

TYPICAL FIELD ENGINEERING
TECHNICAL SUPPORT HIERARCHY
PRIOR TO 1964



- The early models discussed above represent the current level of technical support development in many field service organizations. Any need to develop beyond this stage is dependent on many variables not present in all companies at this time:

  - Maintenance philosophy concerning personal contact with customers.

  - Size of maintenance organization.

  - Complexity of equipment.

  - Maturity of field force.

  - Equipment availability guarantees and performance objectives.

  - Volume of centralized information.

  - Volume of equipment engineering changes.

  - Permutations of equipment configurations.

  - Competition within segments of the industry.

  - General user expectations.

  - Frequency of calls for physical assistance or diagnostic assistance.

- The next stage of development in remote assistance with problem diagnosis became more pronounced in the mid-sixties with the proliferation of "third-generation" equipment such as the IBM 360 systems.

  - The distinguishing characteristics of this phase were:

- Regional support centers staffed with specialists reporting to no specific branch or customer location.

- Procedural requirements to attempt diagnosis through telephone conversations at the first level prior to the dispatch of physical assistance, as seen in Exhibit III-2

- Centralized data sources on symptoms and fixes, usually somewhat primitive and in the form of personal notes of the various regional specialists.

- The integration of remote diagnosis support with other technical support functions:

  - Physical planning support.

  - Configuration/systems assurance.

  - Operating system software support.

  - Field education programs.

  - Engineering change controls.

  - "Alert" system and monitoring efforts.

  - Asset controls in tools and test equipment.

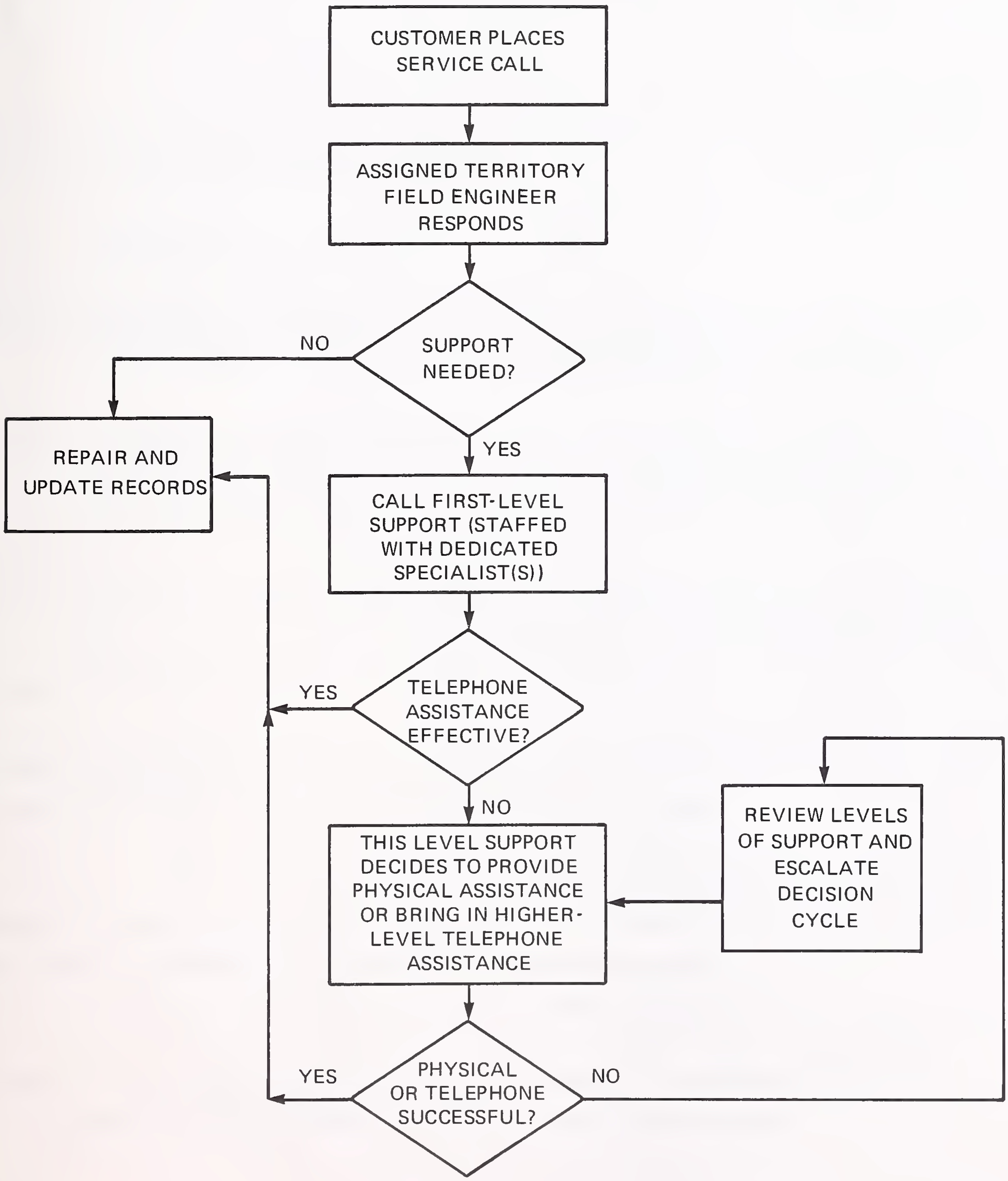
  - Product performance tracking.

  - Maintenance-level component failure analysis.

  - Technical information dissemination control.

EXHIBIT III-2

TYPICAL DEDICATED TECHNICAL SUPPORT HIERARCHY AFTER 1964



        - A higher level of functional authority vested in the technical support managers.

        - Formal/procedural relationships between field support locations and manufacturing plant technical operations.

- The driving forces in the mid-sixties included:

    - Earlier abuse of specialists resulting in mounting resistance to travel without management support of first attempting telephone resolutions.

    - A technological explosion that suddenly blurred the lines of responsibility for hardware, firmware and system control software maintenance.

    - Competitive pressures forcing products to market before traditionally adequate testing and training could be performed.

        - Vendors forced into multitiered training levels to meet shipping schedules.

        - A major leap in the level of engineering change activities.

    - Faster circuit timings introduced new dimensions of problems associated with transmission line lengths, cable lengths, delays caused by chemical impurities in connectors, etc.

    - Isolation of users from basic hardware through vendor-controlled systems programs created a sudden dependence on very short supplies of experienced systems software specialists.

- This stage of development established the basic model of support centers existing today, refined according to vendor requirements.

- In most cases, it took nearly a decade to bring the support center concepts to maturity.

- The most important concept established by technical support centers over the past 15 years is that effective diagnosis can be performed remotely with proper communications linkages.

- Variations of the basic model run from robotics, to user involvement, to the local FE maintaining traditional control of the trouble-shooting activity.

2. DEVELOPMENT OF REMOTE DIAGNOSTICS

- While remote diagnosis have been performed effectively for well over two decades, the concept of the tool "remote diagnostics" is relatively modern.

- In the case of older, established service organizations like IBM, a remote diagnostic capability has evolved naturally as a logical extension of the tools used by progressive technical support centers.

- In the case of some younger companies like Amdahl and Basic Timesharing Inc. (BTI), startup maintenance philosophies included, and were indeed predicated on, at least a minimal remote diagnostic capability.

- Technological advances in microelectronics have played a key role in the development of remote diagnostic capabilities.

  - The "pull" influence of technology has been significant as the incremental cost of using microprocessors to create remote control systems has become more affordable.

  - The "push" factor of technology has been almost as significant by creating complexities in systems requiring more expertise than is normally available locally.

- Equipment reliability has paradoxically created a need for remote diagnostics as well as for more reliable diagnostics generally.

  - The evolution of reliability in equipment, following design principals developed for aeronautics and space programs, and employing redundancy and backup systems, has proved to be a two-edged sword in maintenance.

  - Experience levels and learning rates of field engineers have traditionally relied on positive reinforcement derived from trouble-shooting natural failures. The field engineers' retention of knowledge is inversely and exponentially proportional to the reliability of the equipment.

  - With more reliable equipment, therefore, the field engineer has less practice with failures, and can lose individual proficiency.

- As with most scientific developments during the past two decades, hardware capabilities in remote diagnostics have outpaced the human capacity to adapt. There is evidence of resistance in two areas:

  - Field engineers tend to see the proliferation of remote diagnostics as a threat to their traditional role as "Customer Engineers."

  - Users are not generally ready to accept intangible evidence of service during the course of trouble-shooting, and want to see "their" FE on-site.

- The development of remote diagnostics is, and has been, an evolutionary process, fundamentally as a logical extension to the organizational developments in technical support. More detailed models are discussed in Chapter III.

B. CURRENT STATUS OF REMOTE DIAGNOSTICS

- Only 10% of a sample of vendors used for the 1980 Field Service Annual Report indicated no immediate plans for remote diagnostics.

  - Of the remaining 90%, approximately one-half had implemented some remote diagnostic capability.

  - The other half had firm plans to implement remote diagnostics on new products, with scattered reports of retrofitting the capabilities to existing equipment.

- In the technological sense, the limiting factor is not in the robot and communications segment, but in the quality and reliability of the diagnostics themselves.

  - Remote access and control of operator and maintenance consoles is a relatively simple electronic achievement.

  - Remote control, however, can add no amount of reliability to the interrogative and data-reporting capabilities of the diagnostics.

- At present the value added in most instances is the quicker introduction of interpretive capabilities to the local situation via remote hook-up.

  - One company reports that as many as 15% of the calls on peripherals are now avoidable because of their remote verification process, which aids the dispatch center in directing users to call their mainframe maintenance vendor in those cases where the fault lies with the mainframe.

- Another company in Europe reported that it would require three to four times the support staff to cover situations it now covers by "looking over the shoulder of the local field engineer on-site."

- The current feeling seems to reflect the attitude that field service has just got its feet wet, and likes the feel of the water.

C. MAJOR VENDOR ISSUES

1. THE TYPICAL VENDOR'S POINT OF VIEW

- Vendors view remote diagnostics primarily as a means to improve their own efficiency.

  - In the vendor survey carried out as part of this study, "personnel utilization" and the related factor of "cost saving" were the major considerations relative to remote diagnostics.

  - "Personnel utilization" was mentioned most frequently (eight out of 14 responses) as the most important factor.

- User demands, on the other hand, rated last among a list of seven factors (presented earlier in Exhibit II-1).

  - This clearly reveals the typical vendor's point of view: remote diagnostics is based on vendor considerations rather than user considerations.

  - Some of this point of view may be inadvertantly communicated to users, as evidenced by the mixed reception remote diagnostics is receiving from them. This fact is discussed in the user survey described in a later section of this report.

- Responding vendors do give a high rating to one user-oriented factor, that of "improved up-time."

  - Hewlett-Packard's recent announcement of "guaranteed up-time" on the new HP 3000 Series 44 Computer is one example of a vendor spotlighting the up-time of its product.

  - Remote diagnostics are an integral part of the new HP offering.

2. CAPITAL INVESTMENT CONSIDERATION

- Respondent vendors, as a group, make capital commitments to developments such as remote diagnostics with the expectation of 18 to 30 months' payback.

- Remote diagnostics are generally integrated into the overall remote support activity, making it infeasible, in most cases, to isolate the incremental cost/benefit relationships.

  - Central computer facilities can have multiple purposes even within the field service function:

    - Centralized, automated dispatch.

    - Management information for asset controls:

      - Tools and test equipment status.

      - Parts inventory controls.

    - Engineering feedback:

      - Product performance data.

      - Statistical data for failure analysis.

. Depending on the size and complexity of the central system, it could run other management information systems reports in the background, thereby reducing the incremental cost of individual activities.

- Communications linkage with user sites provides support possibilities beyond the specific use or purpose of remote diagnostics:

  . Analysis of performance data, machine engineering change levels and error logs to assist in the optimization of scheduled maintenance activities.

  . Transmission of software changes required by users on an expedited basis.

  . Installation and system configuration validation for administrative records, billing and tax reporting.

- Sophisticated remote service processors dedicated to field service offer the potential for backup systems to circumvent console failures, a fact that provides some additional justification to charge the development and manufacturing cost to the equipment price.

- Separation of the diagnostics development costs from remote diagnostics costs is done by most vendors.

  - System and unit diagnostics are required, whether local or remote.

  - Isolating present costs of developing portions of diagnostics exclusively for remote purposes is virtually impossible.

- Remote diagnostic development cost estimates range from 2% to 15% of the development cost of the system.

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- Remote diagnostic development cost estimates range from 2% to 15% of the development cost of the system.

- The lower ranges result from attempts to isolate the incremental cost of providing remote diagnostics from all other benefits.

- The higher ranges reflect an allocation of all costs, including diagnostic development, to remote diagnostics.

• Respondent vendors replied with estimates as diverse as 100 person-years, $500,000 and $6 million invested in remote diagnostics.

• The bottom line in the survey on capital requirements is that there is really no consistency among vendors as to the proper allocation and justification of remote diagnostic development and implementation costs.

3. OPERATING EXPENSES AND P&L IMPLICATIONS

• Vendors also disagree among themselves as to the sharing of communications expenses with users and/or other departments within the vendor organizations.

  - If there is an "average" method, it is that the user invests in the required modem or other installation-oriented charges, while the vendor picks up the tab on monthly line costs.

  - This method is at least consistent with the tendency of most vendors to transfer capital expenditures in exchange for operating expenses, which are more easily measured against current revenues.

• Respondent vendors have not isolated the monthly support center expenses due to remote diagnostics.

  - Field engineeing specialists are expected to be "on-call" anyway.

  - Specialists have been available during normal hours at support centers prior to the implementation of remote diagnostics.

- Most centralized computers are not dedicated to remote diagnostics and would be justified otherwise.

- Vendors have felt no requirement to date to implement cost accounting methods that allocate central operating expenses to various support activities.

- The general vendor approach has been to say that the remote diagnostic capability now exists. Therefore, in order to gain maximum benefit, the support center will require so many fixed and portable terminals for specialists.

• In most field service organizations operating on a P&L measurement basis, a percentage of total projected service revenues is allocated to field support to cover operating expenses.

  - Field support is an overhead function.

  - Support activities desired by management are prioritized among the various interests.

  - Activities are implemented and/or enhanced according to priorities, until the budget limit is reached.

  - A remote diagnostics capability is a current "hot issue" high on the priority list of most vendors, which pushes other items down the stack.

  - In order to push new activities, such as remote diagnostics, up to the top of the priority stack without eliminating traditional services and without increasing field support overhead, field locations usually find themselves being charged for more easily identifiable expenses such as "student days" in field engineering training.

- Transfer of traditional overhead expenses to field operating statements to make room for new services like remote diagnostics is justified on more than one basis:

  . The incentive to manage more efficiently with the new tools is passed to the field, where new programs must be ultimately successful.

  . The practice avoids the nuisance and expense of rigid cost accounting methods.

4. MAINTENANCE PRICING IMPLICATIONS

- While a few vendors offer a clean option to the user to "purchase" the remote diagnostic capability for a slight premium, most vendors take a harder line.

  - Premiums are on the order of 10% in magnitude.

  - "Punitive" charges for <u>not</u> using the remote diagnostics are quoted at up to 50% of the base maintenance.

- Most vendors expect significant improvements in total personnel utilization once they commit to remote diagnostics and other modern centralized support activities, and they will not realize the benefits if users exercise options not to use the facility. Therefore, they are hesitant to charge a significant premium.

5. FE INVOLVEMENT IN REMOTE DIAGNOSTIC DESIGN

- All respondent vendors report some involvement of field engineering specialists in the design of remote diagnostics.

- One vendor reported that its limited success with its present remote diagnostic is directly attributable to the fact that engineering designed the system without FE involvement. This vendor field service organization is intimately involved with the remote diagnostic system now under development.

- One vendor reported that field engineering personnel designed the remote diagnostic system themselves.

- Most companies reported significant field engineering involvement in design.

  - FE product support specialists and technical support management write the design specifications for maintenance aids, including the remote diagnostic hardware requirements.

  - Product specialists are assigned to phase review panels to assure formal checkpoints for maintainability design during development.

  - Technical support management and specialists maintain advisory-level working relationships with design engineering staff members to provide insight into modern maintenance requirements.

6. IMPACT ON FIELD ENGINEERING PERSONNEL

- The negative impact of remote diagnostics on field engineers' attitudes is yet to be felt on a large scale.

- One large vendor reported that its field engineers really appreciated the added assistance they received through remote diagnostics.

  - Informal conversations with a small sample of this vendor's field personnel provided evidence to the contrary. The FEs resented the intrusion by "big brother" into their traditional role of managing customer service locally.

  - Managers of competitive vendors that had success in recruiting field service personnel from this vendor cited the remote diagnostic factor as the primary cause of its vulnerability. FEs in this case were willing to change jobs to get away from an environment with emphasis on remote diagnostics.

- Five of eight vendors planning to implement remote diagnostics sampled their FE attitudes toward the idea.

  - These informal samples of opinion were all taken through biased feedback networks.

  - There is no evidence from INPUT's surveys indicating that FEs' attitudes are being scientifically sampled or seriously considered.

- If early indications are correct, FE management could be facing the most serious threat ever of organized labor penetrating field ranks in significant numbers.

  - Remote diagnostics will be one of the major issues in labor contracts if field service becomes unionized.

  - Remote diagnostics could be the rallying point for union organization efforts.

    . Remote diagnostics strike at the core of the increasing alienation of field service personnel from management, the continued invasion of privacy and privileged contact with local customers.

    . There are other more logical issues for FEs to rally around (the use of personal cars in the present state of energy crisis, for example); but remote diagnostics offer an emotional issue, the substance of labor organization.

- Field engineers (and field management) have been complaining for years about "creeping bureaucracy" in their environment.

- Prior to remote diagnostics, local personnel maintained customer control with the hierarchy of support (in theory at least), representing a resource which could be tapped under local control. This fiction has preserved user respect for the local FE organization.

- Remote diagnostics represent the threshold of bureaucratic encroachment, a reversal of roles in which the local organization is subordinate to the unseen remote control center.

- Older field engineers, and younger ones who have embodied the traditions of customer engineering, will not abdicate their perceived responsibility roles easily, and will cause the most trouble. This is unfortunate because they represent the type of personnel whose dwindling numbers have been the primary driving force for remote diagnostics developments.

• The personnel impact is an unhappy dilemma for FE management, one that most vendors do not appear to be consciously aware of at present.

D. MAJOR USER ISSUES

I. FORCES OF RESISTANCE

• Those users with remote diagnostics installed expressed generally strong opinions regarding lack of contact with the local field engineer.

  - In most cases they rate the issue high because the local field engineer still takes the first call.

  - The users' concern is with the prospect of not seeing the field engineer on-site handling everything first.

- Users are apprehensive about becoming involved in maintenance beyond throwing a switch and setting up the communications interface.

- Some users are not even aware that remote diagnostics are being used because the field engineer takes the call as always.

2. FORCES OF ACCEPTANCE

- Users like the idea of remote diagnostics as an additional tool to be used by the local field engineer. They want field engineers to be in charge of maintenance, not their operators.

- Users in geographically remote locations welcome remote diagnostics, and tend to cooperate more willingly in user self-maintenance.

- Distributed data processing users see remote diagnostics as the key to the feasibility of their systems' maintainenance. They believe that remote diagnostics make DDP possible now.

3. USER/VENDOR COMMUNICATIONS

- Except for vendors who rely completely on remote diagnostics and user involvement, there appears to be a lack of communication regarding the user benefits available with a coordinated involvement in remote diagnostics.

- As with the field engineers, vendor management is leaving a communication void that naturally fills itself with negative thoughts and apprehensions.

    - Most users do not know whether they must train their operators for maintenance involvement.

    - They do not know whether they will have options or whether they must pay a premium to use remote diagnotics.

- As reported earlier, users are very apprehensive about the prospects of losing local control over maintenance activities.

E. COMPARING U.S. TO EUROPEAN SYSTEMS

- Respondent users and vendors alike reported no significant differences between the basic operation of remote diagnostics in the U.S. and in Europe.

- The most prevalent remark about differences was in the legalities involved in shipping live data across international boundaries.

    - The import/export problem with data has greater national security implications than taxing implications.

    - Europe's "haven" or freeport for data seems to be established in London, a situation analogous to Amsterdam's status in spare parts logistics.

F. FUTURE PROSPECTS FOR REMOTE DIAGNOSTICS

- Full exploitation of the data collection potential inherent in remote diagnostics is yet to be recognized.

- Diagnostics running live under control of a minicomputer, and time-slicing probes for collecting signature patterns to be transmitted for signature analysis, will be more common in the very near future.

- IBM has announced that the "H" series will incorporate a diagnostic system that is automatically invoked by unusual conditions to simultaneously prompt operators and set up diagnostic data communications via the separate CE service processor.

- Integration of statistical data from error logs, performance data from previous fixes, and live background diagnostics will be more prevalent within analysis (Master Diagnostic) programs to effectively create automated remote diagnostics, eliminating the need for specialists on the first call.

- Total integration of Master Remote Diagnostic centers with automated dispatch could have local field engineers dispatched with repair parts before the user or anyone else was even aware that the system had malfunctioned.

  - This will be possible with fully automated remote diagnostic systems capable of switching in backup, standby or redundant circuits.

  - When automated remote diagnostics reach this level of sophistication, the local field engineer will come full circle and will again be the first human aware of the cause of most problems.

- Data processing networks offer a greater potential for relief with user involvement, on the one hand, and competition from third-party maintenance organizations, on the other. For example:

  - With users involved in setting up their own hierarchy of support using remote diagnostics internally on their networks, discounts should be possible.

  - Unless diagnostics can be classified as proprietary to the maintenance division, rather than owned by the purchaser of the system, third-party maintenance companies will be able to set up their own remote diagnostic networks to compete for the business.

- One respondent vendor already has provisions in place for DDP users to pay a monthly fee for automated dial-up remote diagnostics for their local equipment. Plans are in place for network users to interrogate the vendor system with passwords for feedback of maintenance activities in the user branches.

- One large vendor organization has already announced plans to move the evolution of remote support, including remote diagnostics, into a "revolutionary" rate of development.

  - The management has established objectives for continued growth in equipment sales with a field service population stabilized at current levels or lower with attrition.

  - Near-term plans are for large numbers of field service personnel to respond to automated dispatch from their homes, thereby eliminating significant field office overhead.

  - Design philosophy in this company is to deemphasize maintenance skills - indeed, to eliminate the requirement wherever possible.

  - If this company is successful in producing price/performance-competitive equipment with their announced maintenance philosophy, current field engineering diagnostic skills will become surplus as current systems become obsolete.

- As in other field service developments, the trend in remote diagnostics is for field service organizations to copy the developments of competitors without confessing that "competition" itself is a strong driving force.

  - Field service organizations have a tradition of being part of competitive companies while remaining somewhat detached from competition in specific service techniques.

  - Until now, the tradition of sharing professional know-how in service management techniques has been stronger than the competitive pressures between companies.

  - INPUT predicts that the cooperative trend among field service managers will reverse to a visible competitive awareness during the 1980s.

- Maintenance continues to increase in importance in the purchasing decisions of users.

- Competitive advantages in such hot issues as remote diagnostic techniques will become more critical to survival over the next decade.

G. RECOMMENDATIONS

- As stated earlier, the state of the art in remote diagnostics is well in advance of the human capacity to adapt. The limiting factor in optimum development now is in the communication of potential benefits to all affected parties, not just to the bottom line of next year's operating P&L statement in the field service division.

- Practically speaking, it will be some time before the transition to remote controls will significantly reduce the requirements for traditional local customer service as provided by skilled "customer engineers."

  - Unionization of field engineers in large numbers would create chaos any time during the transition.

  - Even foot-dragging or half-hearted efforts on the part of most field engineers would create severe obstacles to transition.

  - Field engineers should be recruited into the transition phase by communicating the potential benefits of remote diagnostics to them.

    - Solicit their suggestions and modifications to plans for implementation.

- The customer-oriented FEs should be told that remote diagnostics will allow them more time with more customers.

- Certain field engineers with aptitudes for software maintenance and/or development will be able to take advantage of career expansion opportunities in software.

- Machine-oriented FEs are logical choices to recruit for rotational assignments into remote support centers.

- Get field engineers to understand that remote diagnostics are developed for the purpose of allowing continued growth of equipment sales without an equal growth rate requirement in numbers of FEs. This can have the effect of stabilizing the current force.

- Manage the attitudes and presentation of support center specialists to keep the local FE as the focal point in customer service.

- Employ good, professional advertising agencies to enhance the service image of the local FEs <u>supported</u> by remote centers in their primary customer responsibilities.

- Get current on true attitudes of your employees with unbiased surveys.

• This study has uncovered the fact that vendors, for the most part, have neither perceived nor communicated user benefits from remote diagnostics.

- Internal FE driving forces dominate the rankings, as might be expected.

- Users do not accept improved personnel utilization as a direct benefit, unless they understand the alternative.

  - The alternative (slower response time) is a negative, the absence of which is not a benefit.

  - The positive benefit is improved response time over present performance - delivered as promised.

  - A lower skill requirement on-site is negative - not a benefit.

  - Quicker repairs regardless of who is on-site is positive - a benefit.

- Users do not accept FE cost savings and improved FE profit margins as a benefit.

  - Users perceive the receipt of the same level of service at a discount as a benefit.

  - Users consider improved service at the current price a benefit.

- Users do accept standardization of service as a benefit as long as their service is not lowered to meet the standard.

- Users accept improved up-time as a benefit when the availability quotient is calculated consistently with the users' accepted definition of "available."

- In those cases where the first contact for remote diagnostics will be initiated by the user, it is advisable to train remote support center personnel in the art of transmitting a sense of urgency over the telephone.

- One respondent vendor, whose plans to implement remote diagnostics already tested at greater than 99% reliability, will continue to dispatch a skilled field engineer concurrently with the remote support center diagnostics.

  - The dispatch call will be delayed in phase two after the user has gained confidence in the remote diagnostics.

  - This phased, versus abrupt, approach to delaying local support is recommended in all cases of introducing remote diagnostics for the first time.

- Finally, it is recommended that the sales professionals be involved in selling the desired image regarding new capabilities like remote diagnostics.

  - Request that they sell the support in "remote support," as it enhances the local ability to service.

  - INPUT also recommends that professional salespersons be used to assist in communicating benefits.

IV TYPICAL MODELS OF REMOTE DIAGNOSTICS

IV TYPICAL MODELS OF REMOTE DIAGNOSTICS

A. EXAMPLE OF PLUG COMPATIBLE PERIPHERAL EQUIPMENT

1. CONFIGURATION

- The configuration of a typical peripheral remote diagnostics system for plug compatible equipment is diagrammed in Exhibit IV-1.

- A microprocessor is added to the peripheral subsystem controller.

    - The microprocessor is connected to a remote terminal device via a dial-up line and acoustic coupler operating at 300 baud.

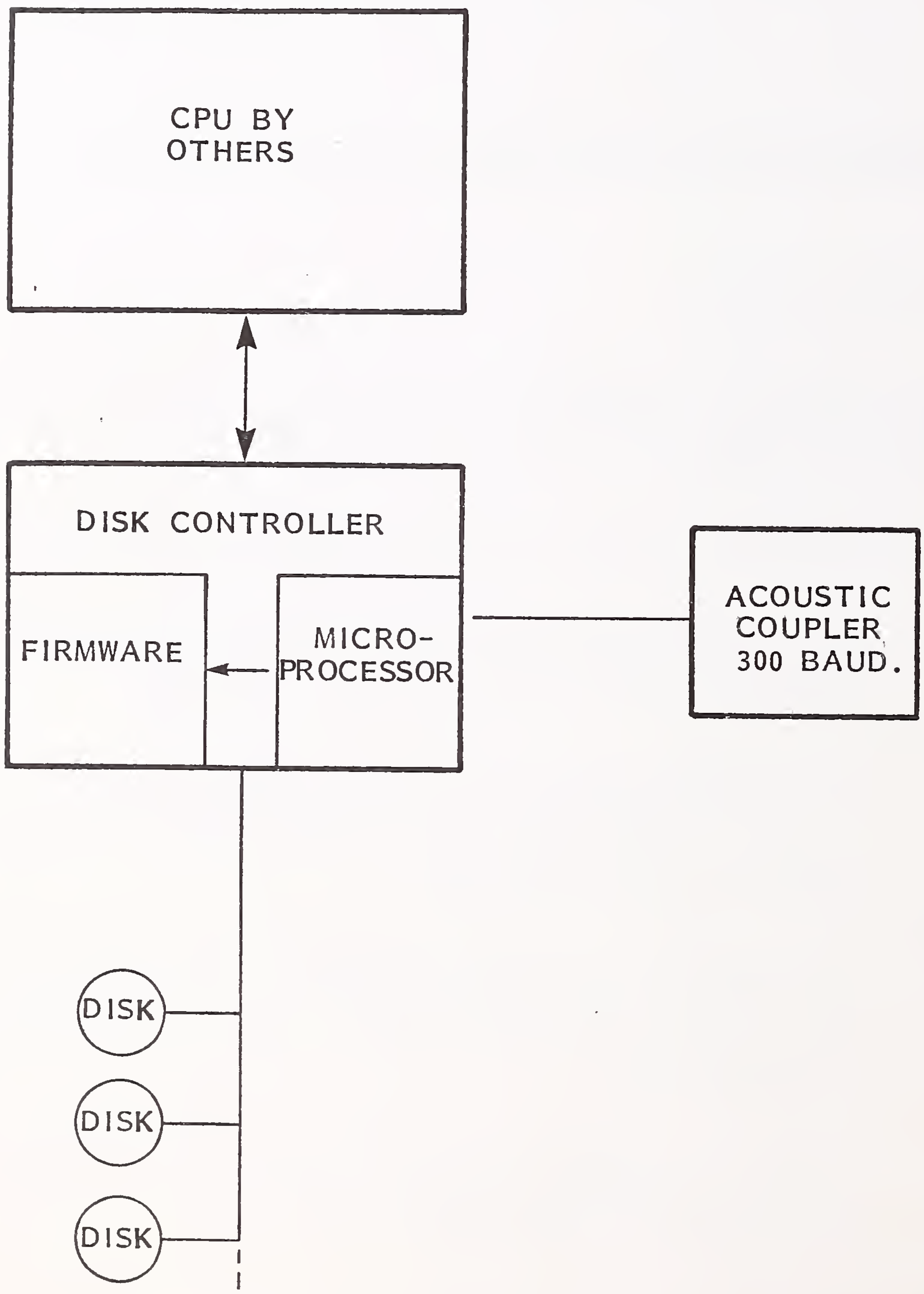
    - The microprocessor is hard-wired to interface directly with the controller firmware, driving the controller's internal operating microprocessor and internal diagnostics.

    - The remote field engineering specialist has access to the subsystem firmware via the remote terminal, the acoustic coupler and the microprocessor.

    - Using the interfaces provided, the remote field engineer is able to exercise the controller and/or associated devices.

EXHIBIT IV-1

PLUG COMPATIBLE EQUIPMENT VENDOR
SYSTEM - SCHEMATIC



- Results of the tests and exercises can then be transmitted to the remote terminal for analysis.

2. SUPPORT SYSTEM OPERATION

- A user with a suspected problem calls the field engineer on duty to discuss the symptoms.

- The field engineer instructs the user operator to:

  - Remove media from devices to be tested.

  - Mount scratch packs or CE test packs as required.

  - Connect the telephone to the acoustic coupler and enable the remote diagnostic switch.

- The field engineer then tests the subsystem via remote hookup.

- If results displayed on the remote terminal verify that the subsystem is operating correctly, the field engineer informs the user to contact the host CPU maintenance vendor.

- If negative results are received, the field engineer arranges for a local field service representative to be dispatched who has been given considerable diagnostic information about the problem in advance.

3. BENEFITS

- This system, according to one vendor using it, reduces calls approximately 15% by eliminating the problems caused by the host CPU or interference from other vendor products on the same I/O channel interfaces.

- Users like the system because it helps reduce the total response time in multiple-vendor operations.

- Field engineers like the system because it reduces the times they are called out unnecessarily.

B. EXAMPLE OF DISTRIBUTED PROCESSOR

1. CONFIGURATION

- Exhibit IV-2 represents a typical configuration of a distributed processor employing remote diagnostics.

- Distributed processors lend themselves naturally to remote diagnostics due to the loosely coupled networks inherent in the operational design of the systems configurations.

- Access to the system is via modem to the system's communication network multiple subsystem.

  - The subsystem is linked via a data channel coupler to the host system.

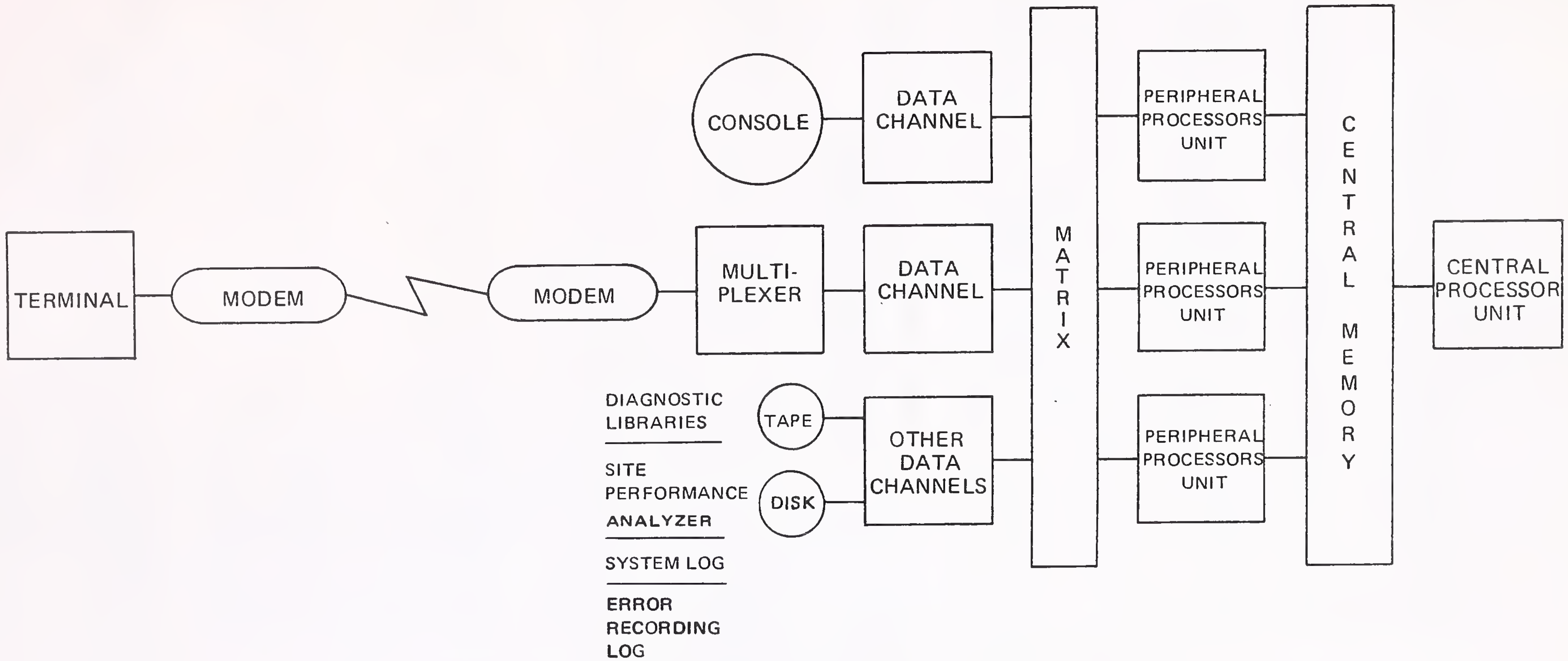
  - The data channel connects to a peripheral processor unit via a matrix switch, and the peripheral processor has access to central memory and the central CPU.

  - Any compatible terminal device, usually a SILENT 700 with an acoustic coupler, may be used to gain access to this type of system.

  - Access is established using normal protocol and security passwords.

EXHIBIT IV-2

REMOTE DIAGNOSTICS ON A DISTRIBUTED PROCESSOR



- Users have the power to inhibit the running of remote diagnostics by software switches.

- Diagnostics can be run as normal user jobs in the job stream.

- The operator is usually notified of data exposures, and is able to lock out the affected user by software switches or masks.

2. SUPPORT SYSTEM OPERATION

- Exhibit IV-3 illustrates a typical hierarchy of support procedure associated with this system.

- The customer will call a dispatching number to have the trouble logged in and to have the remote diagnostic process initiated.

- The field engineer responsible for the customer group uses remote diagnostics to interrogate the system's error log analyzer, the operator log and the performance history analyzer.

  - Systems error logs contain statistical data from parity errors, unusual condition interrupts, system degradation, etc.

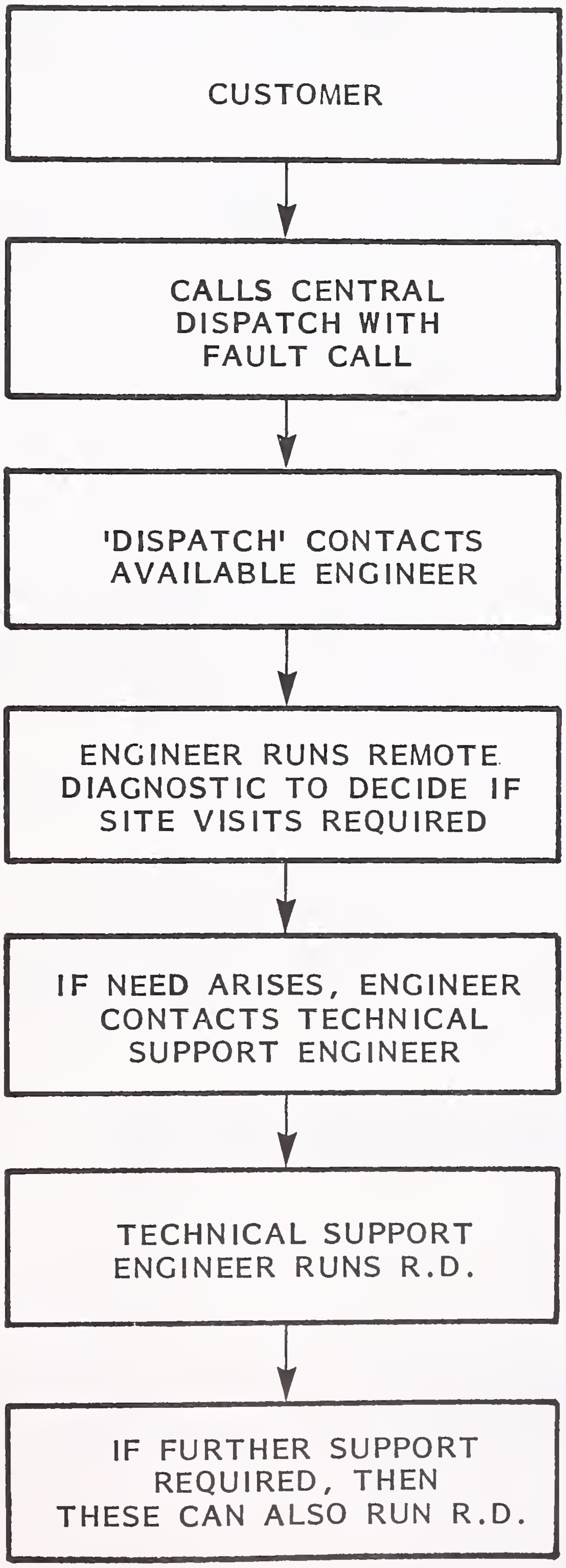
  - The operator log contains information entered by operators regarding various types of cold starts, warm starts, and other recovery procedures.

  - The performance history files contain information on system configuration, details of past failures, unresolved problems, mean time to failure statistics, etc.

- The field engineer can use portions of the current maintenance/diagnostics library routines to exercise system components as a user.

EXHIBIT IV-3

DISTRIBUTED DATA PROCESSING OPERATIONAL PROCEDURE



- Depending entirely on the field engineer's and operator's judgment, other users can be locked out during the tests to assure data integrity.

- If necessary, the field engineer can take over the entire system to run dedicated diagnostics. In this mode, the field engineer can normally run voltage margins remotely as well.

  - Appropriate information is normally available at this point to follow through with the normal support procedural decisions.

- Higher levels of support also have access to remote diagnostics if called in to support the local field engineer.

3. BENEFITS

- Diagnostics designed for distributed processors to isolate problems to networks, matrices, peripheral processors, intelligent terminals or other constituents of the system can now be invoked remotely as a job entry.

- Field engineers are able to work from any location in which they have access to a terminal, even at home.

- This system supports a decentralization of talent giving additional mobility to the field service organization and reducing branch office overhead.

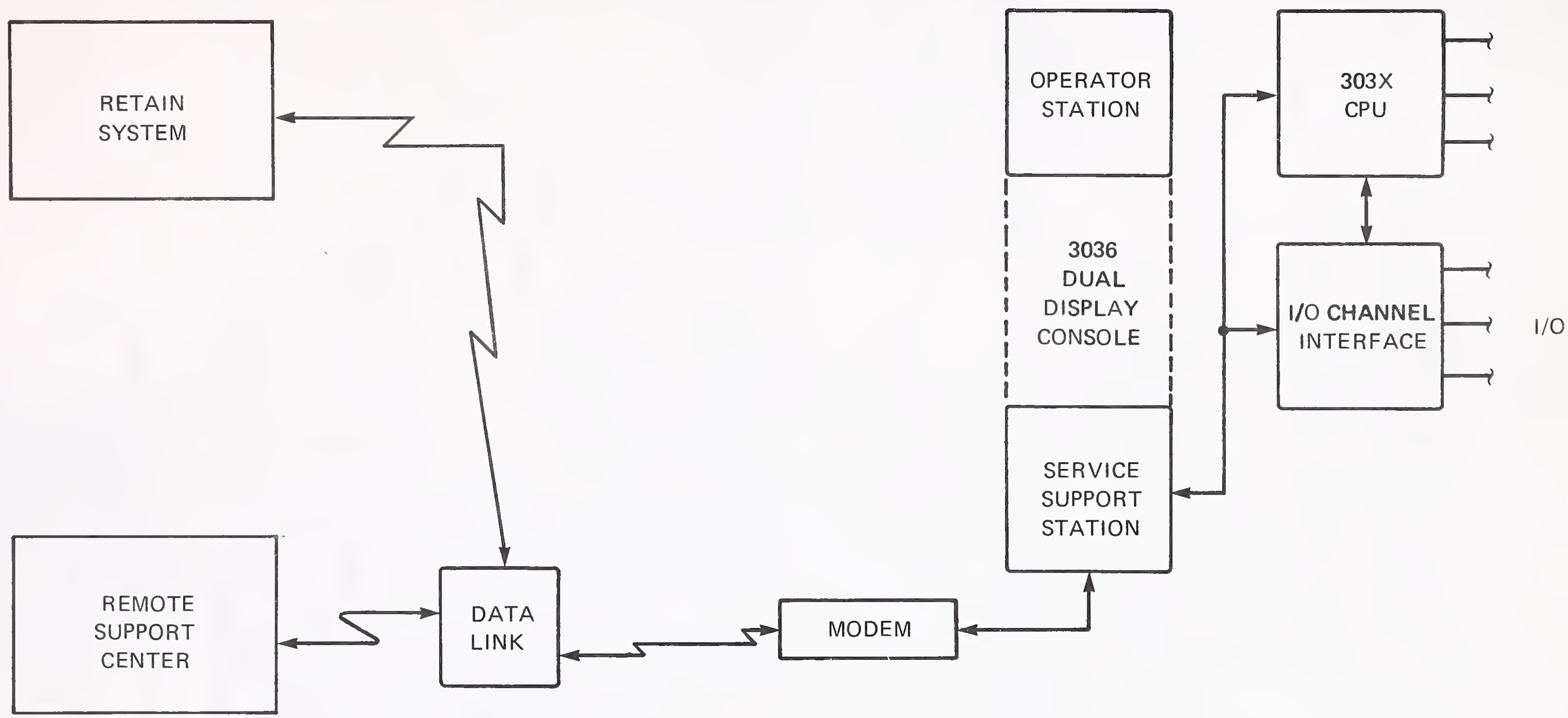
C. EXAMPLE OF LARGE MAINFRAME - IBM 303X

1. CONFIGURATION

- The remote diagnostics system is linked through the 3036 "Dual Display Console" on the IBM 303X, as shown in Exhibit IV-4.

EXHIBIT IV-4

IBM 303X REMOTE DIAGNOSTIC SYSTEM



- The modem and linkage operate at 1200 baud.

- The IBM "RETAIN" system, the data base used by the support system, is linked into the network along with technical support center personnel.

- The on-site field engineer, the remote assistance engineer (when required), and the RETAIN system are integrated to form a complete diagnostic aid, remote diagnostics, and remote assistance network.

- The 3036 console is controlled by two interchangeable microprocessors, each with dedicated CRT, keyboard, floppy disk and I/O interface channel.

  - The operator station is used for normal operator interface with the system.

  - The service support station is used primarily for maintenance. It can display system status, error logs, system failures and other faults. It is used to run and control diagnostic routines.

2. REMOTE SUPPORT SYSTEM OPERATION

- The IBM support system currently operates on the premise that the field engineer will be on-site.

- The RETAIN system is a data base system and diagnostic aid accessible to field engineers prior to remote diagnostics.

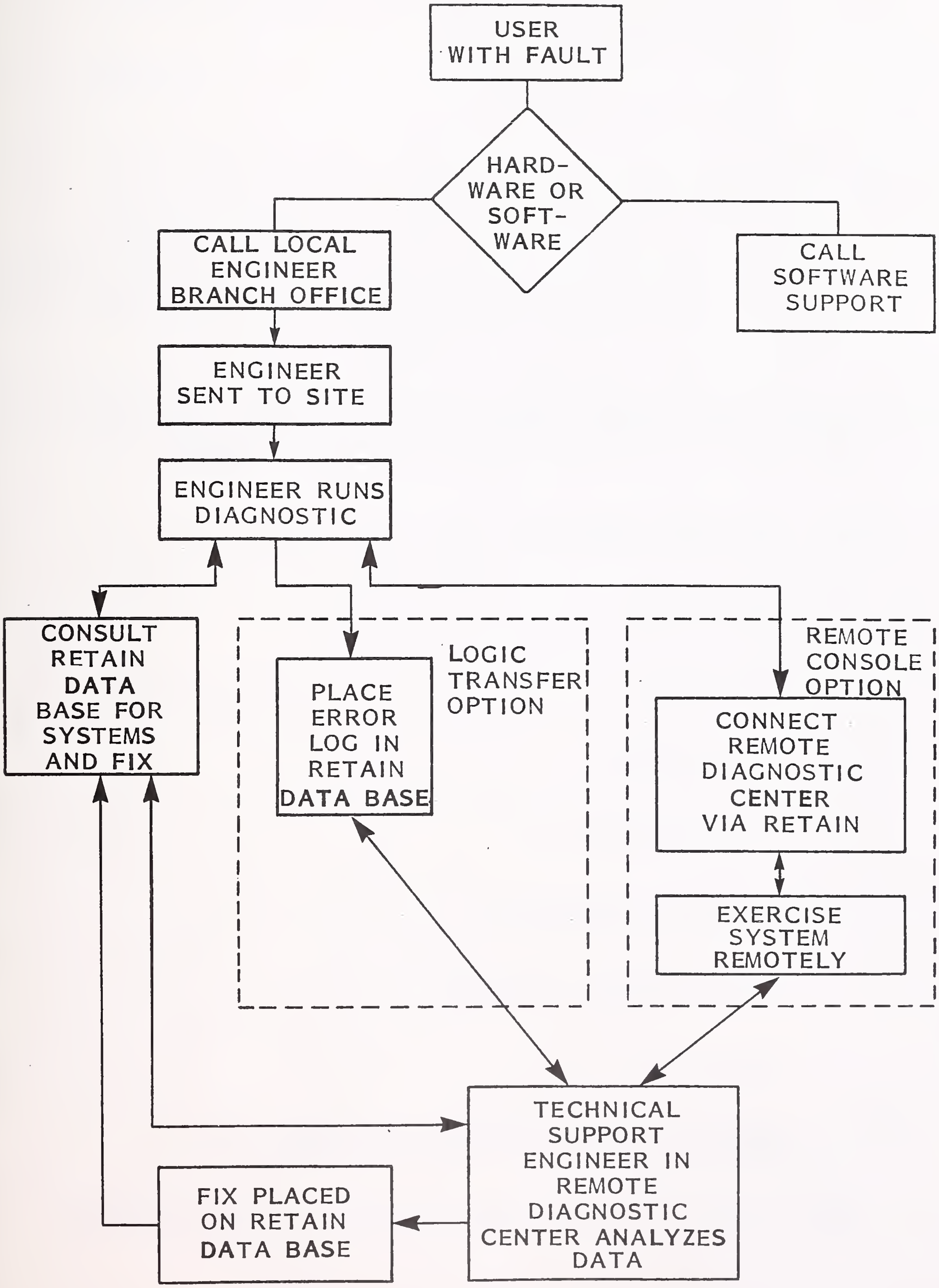
- The RETAIN system, outlined in Exhibit IV-5, contains the following information and options:

  - Information on fault symptoms.

  - Fixes.

EXHIBIT IV-5

IBM "RETAIN" SYSTEM SCHEMATIC



- Service techniques.
- Engineering change information.
- Customer log transfer option.
- Remote console operation option.

- The remote console operation option creates the remote diagnostic capability, while the customer log option further increases the capabilities of remote diagnostic assistance by technical specialists.

- By exercising the remote console option, the remote support specialist can take control of a dedicated system and perform the following:

  - Run system diagnostics.
  - System reset.
  - Clear memory.
  - Step single cycle.
  - Perform on-line tests.
  - Measure and vary voltages.
  - Check system status indicators.
  - Display logs.
  - Scan data banks at RETAIN for similar faults.

- When the fault is located and repaired, RETAIN data bases are updated.

- Exercising the log transfer option prior to running diagnostics is normally done to allow other remote research to be performed, matching data with RETAIN symptom indices, etc., concurrently with remote diagnostics.

3. BENEFITS

- The integration of remote diagnostics with other remote maintenance aids available through RETAIN provides the local field engineer with maximum support while enhancing customer respect for local control.

- Quick involvement of remote analysis significantly reduces outage.

- Error log dumps into the RETAIN data base allows multiple, specialized involvement and interaction with the latest historical information for the local field engineer.

- International "RETAIN" data bases are updated immediately to avoid "re-inventing the wheel" on similar problems.

D. OTHER EXAMPLES

- Variations of the preceding examples by category are presently installed.

  - One large mainframe vendor has a support system that allows support specialists to monitor outputs from diagnostics being run by the on-site field engineer. The added dimension of visual, real-time interface with the system under repair creates a synergistic and productive effect that qualifies the system as "remote diagnostics."

  - The DEC PDP 11/70 remote diagnostics system operates very much like the IBM 303X, with or without a local field engineer on-site.

- A small business system and distributed data processing system vendor is providing customers with the capability to dial up automated remote diagnostics with operator prompting.

    - The central diagnostic control system is programmed to give the user an appropriate message that a call for service should be placed.

    - This system is not currently integrated with central dispatch to anticipate calls for service.

- Most vendors plan for remote diagnostics in the next generation to facilitate users' involvement.

    - Direct dial-up capabilities are anticipated to allow remote monitoring of "live" diagnostics running in the background.

    - More automated systems are planned with the capability of prompting users with steps to take as they proceed through the remote diagnostic routines.

V RESULTS OF VENDOR SURVEY

V RESULTS OF VENDOR SURVEY

A. VENDOR PROFILES

- A total of 14 vendors were surveyed using the questionnaire reproduced in Appendix B.

  - Five vendors were interviewed on-site.

    - Two vendor organizations were interviewed in meetings with more than six key persons in attendance.

    - Three were interviews with individuals.

    - On-site interviews averaged two hours in length.

  - Nine telephone interviews were conducted, averaging 40 minutes each.

- Vendors were evenly divided between those who had some form of remote diagnostics and those who planned to implement the capability in the very near future.

  - The selection criteria were designed to provide a cross-section resembling the proportions reported in the 1980 Field Service Annual Report.

- One vendor who was selected as experienced in remote diagnostics preferred to respond relative to its plans for the next generation of equipment.

  . For statistical purposes, the report reflects this vendor's information in the "planning-to-install" category.

  . Feedback on the current system and the vendor's expressed feeling that this system was below its standards, did provide additional insight as background material supporting other statements within this report.

- The reporting of vendor responses is therefore based on a proportion of six vendors with experience in using remote diagnostics and eight with immediate plans for implementation.

● Persons interviewed held key positions in:

  - Technical support.

  - Service planning.

  - Operations planning.

  - Diagnostic software development.

  - Engineering.

  - General management.

● The cross-section of vendors surveyed by equipment type is displayed in Exhibit V-1.

EXHIBIT V-1

PROFILE OF VENDORS SURVEYED, BY EQUIPMENT TYPE

TYPE EQUIPMENT	CURRENTLY USING REMOTE DIAGNOSTICS	PLANNING TO INSTALL	TOTAL
GENERAL-PURPOSE AND MAINFRAMES	2	1	3
TERMINALS	2	1	3
MINICOMPUTERS	1	1	2
DDP AND SMALL BUSINESS SYSTEMS	1	3	4
PERIPHERALS	0	2	2
TOTAL	6	8	14

- Except for those vendors identified in INPUT's European report on remote diagnostics (IBM, DEC, CDC), none is identified by company name. While some vendors expressed no concern over being identified, INPUT has refrained from identifying vendors in order to protect those who wished to remain anonymous.

  - Information collected from U.S. vendors in the European study has been used as background within the text of this report.

B. FACTORS IMPORTANT TO VENDORS' DECISIONS TO IMPLEMENT REMOTE DIAGNOSTICS

- The average weighted importance of personnel utilization led all other factors in the fundamental reasons for implementing remote diagnostics, as shown in Exhibit V-2.

  - Except for higher expectations of improved equipment availability held by vendors installing remote dignostics earlier, there is general agreement between experienced vendors and those planning to use remote diagnostics.

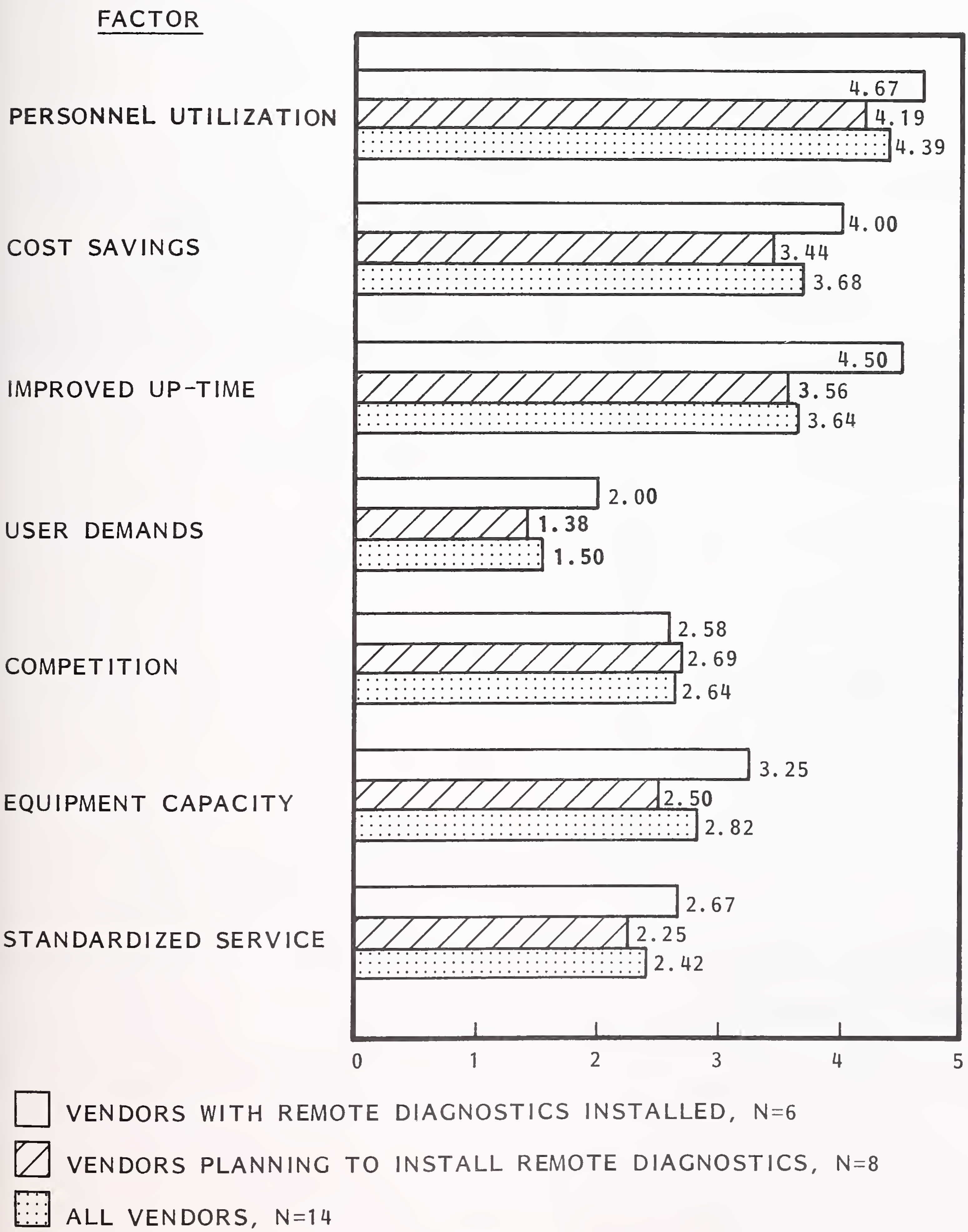
  - Users' demands and competition carry little weight in the decisions to use remote diagnostics.

- The survey results provide clear evidence that vendors rank personnel utilization number one and cost savings number two when deciding to develop a remote diagnostic capability, as shown in Exhibit V-3.

  - Although cost savings and improved up-time were practically tied in the rating of importance, there was no contest when vendors were asked to rank the factors.

EXHIBIT V-2

IMPORTANCE OF FACTORS IN VENDORS' DECISIONS TO IMPLEMENT REMOTE DIAGNOSTICS



RATING: 0 = NO IMPORTANCE, 5 = MAXIMUM IMPORTANCE

EXHIBIT V-3

VENDORS' RANKINGS OF FACTORS IN DECISIONS TO IMPLEMENT REMOTE DIAGNOSTICS

FACTOR	NUMBER OF TIMES RANKED			
	#1	#2	#3	N/A OR >3
PERSONNEL UTILIZATION	8	3	-	3
COST SAVINGS	-	9	1	4
UP TIME	2	1	5	6
USER DEMANDS	-	-	1	13
COMPETITION	-	-	2	12
EQUIPMENT COMPLEXITY	2	-	1	11
STANDARDIZED SERVICE	1	-	-	13
OTHER	1*	-	-	13

*MORE EQUIPMENT NOW LOCATED REMOTELY

NUMBER OF RESPONSES = 14

- The top three factors far outweighed the importance of all others as rated and ranked by vendors.

- Some comments vendors made regarding factors relevant to their decisions were:

  - "Personnel utilization is absolutely important to a small company. We just can't compete in remote locations without using tools to spread our talents over large geographical bases."

  - "When the original decision was made, cost savings were of little importance. It would rate a four now in importance for the next generation of equipment."

  - "Remote diagnostics are not as important to the standardization of service, which is important in itself, because we address that problem in our standardized hiring practices."

  - "We see remote diagnostics as a necessary evil - takes a lot of effort to get it going."

  - "Because of IBM's 4300 announcement, our peripheral remote locations have increased significantly. We have to implement remote diagnostics to meet the challenge."

C. VENDORS' PERCEPTIONS OF USERS' ACCEPTANCE OF REMOTE DIAGNOSTICS

- When asked to comment on and rate their perceptions of users' attitudes towards the various factors associated with remote diagnostics, most vendors showed a great deal of reluctance to being pinned down.

- There is considerable evidence to support the general conclusion that vendors are not really aware of their users' attitudes toward remote diagnostics.

- This general lack of awareness is evidenced by general speculation about users' attitudes, rather than by firm statements.

- The fact that most vendors are not aware of actual users' attitudes is consistent with the ranking of internal vendor driving forces discussed earlier.

- Vendors who plan to install the capability exhibit more concern than the experienced vendors for the prospect of user rejection in two areas.

  - All but one vendor believed that users are seriously concerned about the loss of personal contact with the local FE.

  - They also feel that data security is a psychological obstacle that must be overcome.

  - These vendors are quick to point out that users' attitudes can be managed to achieve positive acceptance after an initial negative reaction.

- All respondent vendors believe that, on balance, the concept of remote diagnostics is enthusiastically embraced by users.

- Some vendors' comments on users' attitudes:

  - "Users of small-medium systems are very excited and pleased about remote diagnostics. We have shown them it really can increase availability. Users want to visually inspect our tech centers and see what this great place looks like."

- "Users weren't concerned about data security until we asked them if they were concerned. Then they figured they must have something to be concerned about."

- "Remote diagnostics will be good for the customers. They just don't know it yet."

- "They are concerned about losing daily contact with 'warm bodies.' We just have to wean them."

- Only one of eight vendors planning to implement remote diagnostics has conducted an attitude survey of users.

- Vendors recognize that users often want protection against unauthorized access to their systems. Manual intervention by the user was required in almost all cases. Typical methods were:

  - The user flicks a switch before the technical center can gain access. The user can stop the process at any time by turning the switch off.

  - A security locking device must be unlocked by the user before the remote diagnostic process can begin.

  - The user flips three switches.

  - The user loads disks and prepares the system for auto-test.

  - The user enables a modem, turns a key and issues a command.

D. PERCEIVED DIFFERENCES BETWEEN THE U.S. AND EUROPE

- Half the vendors surveyed have European operations either with remote diagnostics installed, or immediate plans to install them.

  - No technical differences were reported.

  - Minor operational differences were reported, such as:

    . A company with remote diagnostics covering all first calls in the U.S. retains dual functions in Europe; i.e., on-site coverage mixed with remote diagnostics.

    . Relatively more remote centers are required in Europe to compensate for languages and problems shipping data across international borders.

    . A U.S.-based vendor believes that the European field engineers are more sluggish in accepting remote diagnostics because they tend to resent the international "interference" with their activities. (This is an international example of the sense of isolation felt by field engineers in general, as reported earlier within this study.)

E. FIELD ENGINEERINGS' INVOLVEMENT IN DESIGN

- Every vendor reported that field engineering was involved in some way with the design of remote diagnostics.

- Some comments from vendors provide clues as to the ranges of FE involvement:

- "One-hundred percent development effort of the customer service department from design, implementation and manufacturing."

- "Totally - FE designs the remote diagnostics and this allows ultimately for better implementation."

- "Still are involved in philosophy and work together - also field engineering must sign off on remote diagnostic designs."

- "Phase reviews, the whole nine yards."

- "Engineering needs FE approval for final sign-off."

- "We tell product engineering what we want and need to run remote diagnostics; they do the actual designs."

- "Field service leads the design process, writes the specifications and negotiates financials. Several engineers come to us to do the designing."

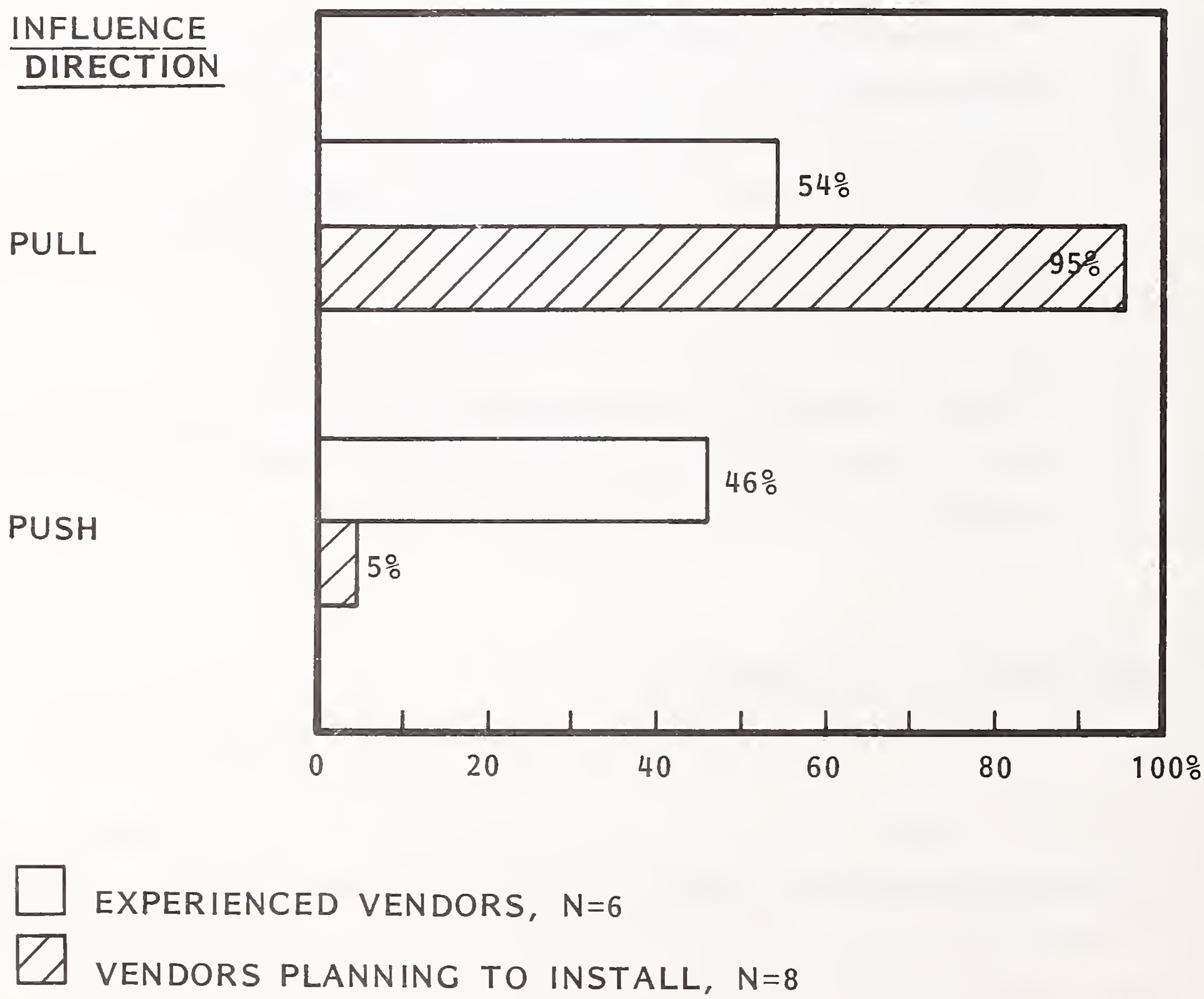
- "We're in the design of the next product because the real problem with remote diagnostics in the current product is that we were not consulted!"

F. INFLUENCE OF TECHNOLOGY

- Pioneering vendors felt that, on the average, the forces of technology were almost evenly balanced between "pushing" the vendor into remote diagnostics because of the complexities of new systems (46%), and "pulling" vendors into the capability with more attractive microprocessing capacity (54%), as shown in Exhibit V-4.

EXHIBIT V-4

INFLUENCE OF TECHNOLOGY ON
REMOTE DIAGNOSTIC DEVELOPMENTS



PULL = TECHNOLOGY IS ATTRACTIVE
PUSH = COMPLEXITY REQUIRES REMOTE DIAGNOSTICS

- Vendors with plans to follow the leaders, on the other hand, perceive the attraction of less expensive technology to far outweigh the complexities that would force them into such innovations, by a ratio of 95% to 5%.

G. FINANCIAL RESPONSES OF VENDORS

- Vendors are inconsistent in methods of recording and allocating costs of the implementation of remote diagnostics.

  - The consistent pattern is that the field service departments generally negotiate to have all development costs of maintenance aids capitalized into the development and manufacture of equipment.

  - This method passes development costs through to the purchaser or to sales by reducing gross margins.

  - This method requires little field service management in capital expenditure analysis and justification.

  - By passing the burden of justification to sales profits, field service implies a competitive edge with remote diagnostics.

- Vendors who reported some idea of development costs varied in the expression of amounts. For example:

  - "Ten to fifteen percent of system cost."

  - "One hundred person-years."

  - "A lot of money."

  - "One-half million dollars (or more)."

- "Six million dollars in future equipment."

- "Fifteen percent of our current field service operating budget."

- Seven of 14 vendors declared that all investments should have from 18- to 30-month paybacks, but none quantified the payback benefits for this study.

- None of the respondent vendors reported using a discounted present-value analysis to analyze returns on invested capital.

- While all but one vendor responded that remote diagnostics were justified on the basis of increased profits, none of the vendors identified the sources or relative amounts of those profits.

- Vendors who reported arrangements to share expenses with customers responded that users would invest in the line installation charges and modems, while the maintenance vendors would pay the monthly line costs.

- Only one vendor reported a premium charged to users for remote diagnostics.

  - The others reported no discount in maintenance rates to users of remote diagnostics.

  - Several vendors responded that they would increase maintenance rates up to 50% as a punitive measure if users do not allow them to use remote diagnostics.

H. SOFTWARE AND REMOTE DIAGNOSTICS

- Twelve of fourteen vendors surveyed address software problems with remote diagnostics.

- Some vendors' comments regarding software maintenance with remote diagnostics were:

  - "Users very pleased. We are able to update releases automatically and prevent faults by fixing them before they happen."

  - "We can use the remote diagnostic capability to dump applications upline."

I. VENDORS' PERCEPTIONS OF FEs' ATTITUDES

- Five of eight vendors planning to implement remote diagnostics indicated that they had generated feedback from field engineers regarding their acceptance of the changes.

- The three vendors who did not survey field engineers' attitudes all felt from experience that the older professionals would have the toughest time adjusting. Comments suggested a loss of pride in craftsmanship.

- None of the companies conducted a formal survey to sample field engineers' attitudes, but rather relied on biased feedback systems to form their conclusions.

- Comments ranged from totally enthusiastic support of the changes to apprehension about loss of job enrichment possibilities.

- When asked about programs in place to offset personnel problems, vendors responded with the following examples:

  - "We will offset through familiarization and education."

  - "We don't anticipate any problems."

- "It is a concern, but we haven't done anything yet. We'll take a 'wait-and-see' attitude - really don't want to elaborate."

- "We are trying to show them that remote diagnostics is a tool for them that will eliminate much of their routine clerical recordkeeping, and that they will be spending more time refining their skills and will eventually deal with higher-level, complex problem solving."

- "Those ambitious FEs can become the diagnostic specialists manning the diagnostic center."

- Among those vendors who were asked, all believed that their field engineers had the same attitudes as management's toward remote diagnostics.

J. EQUIPMENT PERFORMANCE

- All vendors expect remote diagnostics to improve system availability, but none reported measurements that isolated the contributions made by the introduction or hypothetical absence of remote diagnostics.

- No vendors were willing to report on measured reliability of the remote diagnostics either to isolate problems or to prompt personnel for proper actions such as:

  - Circumvention in degraded performance.

  - Delivery of correct parts.

  - Dispatching other vendors.

VI RESULTS OF USER SURVEY

VI RESULTS OF USER SURVEY

A. USER PROFILE

- As shown in Exhibit VI-1, telephone interviews were conducted with 30 users, 20 of whom had experience in using remote diagnostics, six with plans to install in the near future, and four whose vendors are not expected to offer remote diagnostic capabilities soon.
  - Thirteen maintenance vendors were mentioned as primary or secondary shop vendors by the respondent users.
  - All of the vendors (except one terminal vendor) with remote diagnostics installed at users' sites were mentioned at least once by the users.
  - The 20 users with remote diagnostics installed collectively mentioned nine different maintenance vendors as primary or secondary sources of maintenance.
  - The six users with plans to install remote diagnostics mentioned five different vendors.
  - The four users with no known plans to install named three different vendors.

EXHIBIT VI-1

USER SURVEY PROFILE

CATEGORY	REMOTE DIAG-NOSTICS INSTALLED	PLANS TO INSTALL	NO PLANS FOR NEAR FUTURE	TOTAL
USERS	20	6	4	30
MAINTENANCE VENDORS MENTIONED	9	5	3	13*
AVERAGE NUMBER OF USERS PER VENDOR MENTIONED	2.2	1.2	1.3	2.3*
MAXIMUM USERS PER VENDOR MENTIONED	7	2	2	7

*SOME VENDORS MENTIONED MORE THAN ONCE

- An interesting observation within the user profile is the fact that one vendor that had remote diagnostics installed on the type of equipment at the users' sites, was mentioned once by three different users:

  - One knew he had the capability.

  - One didn't know he had it, but expected it to be installed.

  - The third didn't know he had it already installed and had no knowledge of any plans for the vendor ever to install remote diagnostics.

- Due to the infancy of remote diagnostics and to the vague terminology, telephone interviews averaged 45 minutes, some 15 minutes longer than typical telephone interviews.

- Individuals responding to the user survey held the following responsibilities:

  - Computer Operations Manager.

  - MIS Manager.

  - Technical Director.

  - Operations Services Manager.

  - Systems Engineer.

  - DP Manager.

  - Systems Programmer.

  - Director, MIS Planning.

  - Chief, Computer Branch.

- Vice President, Data Processing.

- Exhibit VI-2 shows the industries represented by the user survey, and Exhibit VI-3 gives a view of the geographical distribution.

B. RESPONDENT USERS' ATTITUDES TOWARD MAJOR ASPECTS OF REMOTE DIAGNOSTICS

- Users generally accept the conditions associated with remote diagnostics, as shown in Exhibit VI-4.

    - An average of 40% of the total number of questions asked to the total number of users received the response: "not applicable."

    - When asked to comment on the prospects of assuming responsibility for the currently "not applicable" situations, users indicated a strong dislike of the possibilities of getting too involved with maintenance.

    - Those who are now performing certain traditional FE activities are generally accepting the role.

    - Some distortion exists in Exhibit VI-4 due to the fact that several users insisted on giving a high positive rating because they did not have to perform the function.

        - An example: "Frequency of personal contact with the FE is rated +5 because he is on-site as he always was before remote diagnostics."

        - Another user insisted on rating all categories very high because the FE performed everything.

EXHIBIT VI-2

USER PROFILE, BY INDUSTRY

INDUSTRY TYPE	NUMBER OF USERS SURVEYED
DISCRETE MANUFACTURING	5
PROCESS MANUFACTURING	4
GOVERNMENT	2
RETAIL	3
SERVICES	3
EDUCATION	5
TRANSPORTATION	1
CONSTRUCTION	2
INSURANCE	2
UTILITIES	1
SHIPBUILDING	1
WHOLESALE	1
TOTAL	30

EXHIBIT VI-3

GEOGRAPHIC PROFILE OF RESPONDENT USERS

REGION	NUMBER OF USERS SURVEYED
NORTHEAST	7
SOUTHEAST	3
MIDWEST	7
SOUTHWEST	7
NORTHWEST	6
TOTAL	30

EXHIBIT VI-4

ATTITUDES OF USERS EXPERIENCED WITH REMOTE DIAGNOSTICS

CONDITION OR PROPOSED CONDITION / RATING	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	N/A	AVERAGE
FREQUENCY OF FE CONTACT	2	-	-	-	-	3	1	-	2	5	4	3	+2.2
USER LOADING DIAGNOSTICS	-	-	1	1	1	2	-	1	3	1	2	8	+1.5
USER RELAYING INFORMATION	1	1	1	1	-	1	-	3	3	1	2	6	+1.1
CHANGING SWITCHES, VOLTAGES, ETC.	-	-	2	-	-	1	-	1	2	3	1	10	+1.9
EXCHANGING PARTS	-	-	1	1	1	1	-	1	1	-	3	11	+1.6
SHIPPING PARTS TO REPAIR DEPOT	-	-	-	-	-	1	1	3	1	-	1	13	+2.1
SOFTWARE PATCHES BY REMOTE CONTROL	1	-	-	1	-	2	-	1	1	3	1	10	+1.5
DATA SECURITY	1	-	-	-	-	5	-	1	2	5	2	4	+2.1
OVERALL CONCEPT OF REMOTE DIAGNOSTICS	2	-	2	-	-	2	-	1	2	6	4	1	+1.9

N/A = NOT APPLICABLE
RATING: (-5) = TOTAL OBJECTION, (+5) = ENTHUSIASTIC ACCEPTANCE, (0) = NEUTRAL, INDIFFERENT
NUMBER OF RESPONSES = 20

. Indirectly, these users are rejecting the idea that they may become involved later. Consequently, the reader is cautioned against resting comfortably with the indicated level of user acceptance shown in Exhibit VI-4.

- Although vendors are not identified in the exhibit, there is a very strong correlation between the level of user acceptance and the particular vendor involved: some vendors are more widely accepted than others.

  - High marks were given in cases where it is known that communications about remote diagnostics between the vendor and user are a matter of procedure in the buy/sell negotiation phase.

  - Neutral marks and negative marks tended to cluster around vendors that do not communicate about remote diagnostics.

  - The remarks suggest that the causes of users' attitudes originate in the vendor's organizational approach toward, and communications about, remote diagnostics, not in the technology or equipment reliability.

- Users generally feel that their availability is better as a result of remote diagnostics.

  - Estimates ranged from 1% to 10% better.

  - Four of 20 users (20%) believe that they have worse availability because of the vendor's procedure to run the remote diagnostics before sending an FE.

- Fourteen of twenty users (70%) adjust their measurement of availability to reflect degraded performance. They employ a factor that reflects the percentage of normal throughput available to them.

C. BUSINESS EFFECTS OF REMOTE DIAGNOSTICS, AS PERCEIVED BY USERS

- Fourteen of 26 users (54%) said that the availability of remote diagnostics would carry some weight in their next decision regarding equipment and maintenance vendor.

  - The most frequently mentioned weight was 10%.

  - One user said 90% of his decision would be related to remote diagnostics.

  - One user said that the weight was negative - that he would prefer no remote diagnostics.

  - Typical users' comments are listed in Exhibit VI-5.

- Only two of 26 users know of price adjustments relative to their option to use remote diagnostics.

  - One user did not know what the adjustment was, but knew there was one.

  - The other user was paying 10% for remote diagnostics.

  - Most users, according to the survey sample, are unaware of any "punitive" measures planned by vendors for those users who elect not to use available remote diagnostics.

- Users generally refuse to answer the questions on willingness to pay more for maintenance that provides greater availability.

EXHIBIT VI-5

USERS' COMMENTS REGARDING IMPORTANCE OF REMOTE DIAGNOSTICS

WEIGHT GIVEN TO REMOTE DIAGNOSTICS IN NEXT PURCHASING DECISION	USERS' COMMENTS
35%	"We are in a remote location - far from repair centers."
LESS THAN 5%	"Right now IBM gives us two-hour response time, and we are satisfied."
N/A	"It depends on how well our experience with remote diagnostics turns out. It will be a real plus if it increases machine availability."
0	"It's not a factor. Our management agreed to it only because the vendor said it would reduce our maintenance fees."
10%	"Reliability is our major concern. We like to know that remote diagnostics is available as a backup."
10%	"We want remote diagnostics, but wouldn't make it a major part of our decision."
N/A	"We want to have the choice. All other things being equal, we would go with a vendor who did not require remote diagnostics."
"A LOT"	"In Alabama, it's almost essential to have remote diagnostics - only IBM has enough field support."
90%	"Because the diagnostic function helps to reduce down time."
N/A	"I believe it is the coming thing. I think we will get it whether we want it or not."

N/A = NOT APPLICABLE. THE USER DID NOT GIVE AN ESTIMATE.

- Comments suggest that reliability and availability are part of the sale, and field engineering charges what it must to meet the original commitments.

- Users are not overly price sensitive to maintenance issues, but indicate that they would pay more (or less) for clear alternatives.

- Users of distributed processing credit remote diagnostics with making certain decisions easier, but they are careful to say that they expect maintenance organizations to handle the details of meeting sales commitments.

- Users perceived a mixed, although generally positive, reception of remote diagnostics by the field engineer, as shown in Exhibit VI-6.

- Most vendors were unconcerned about the level of training their personnel received in the use of remote diagnostics. A couple of exceptions to the general rule gave the following comments:

  - "They just left a typewritten list of instructions to follow, with no explanation."

  - "We really got too much training for our needs, too detailed and too complex; we just are not interested in maintenance problems that much."

- The few users who are pleased are those who have experienced quick turnaround on fixes to software problems detected via remote diagnostics. This sort of maintenance effort is one with which the user can identify.

- The user survey reveals, more than anything else, that users are quite unaware of the capabilities of remote diagnostics within their own installations. Whether this is due to a lack of vendor communications, or to apathy on the part of the users, remains to be seen.

EXHIBIT VI-6

USERS' IMPRESSIONS OF FIELD ENGINEERS' ATTITUDES TOWARD REMOTE DIAGNOSTICS

USERS' IMPRESSIONS REGARDING ANY CHANGE IN FEs' ATTITUDE DUE TO REMOTE DIAGNOSTICS
"No change. He's always had remote diagnostics."
"We have an on-site FE. Remote diagnostics has increased his effectiveness. His attitude has not changed."
"There is no change in attitude. I still have to tell them what to check when remote diagnostics hasn't isolated the problem."
"It was so new, it was a curiosity item. There was no resentment towards remote diagnostics on the part of the FEs especially since they couldn't really use it, and had to do things the old way, anyway."
"The FE seems less pleased. He has less specific training on the machine as a result of remote diagnostics. He just follows steps 1 through N. It doesn't require as much thinking."
"He feels better about it. He can call for help and get answers."

APPENDIX A: DEFINITIONS

APPENDIX A: DEFINITIONS

A. DERIVATION OF COMMON TERMS

- As with most evolutionary processes, definitions are difficult to nail down.

- INPUT has interviewed literally hundreds of vendors, users and field engineers with dozens of conceptual definitions of remote diagnostics.

  - People within the same departments of the same companies disagree on the meaning of remote diagnostics.

  - During interviews for this report, INPUT variously offered and requested definitions.

  - Invariably, when three or more persons were involved in the "definitions" exercises, at least one person would become frustrated.

- The purpose of this section of the report and the Glossary is to offer "consensus" definitions of key terms associated with the subject of remote diagnostics.

- The first term to define is "diagnostics."

- While vendors are not unanimous in their definitions of the term "diagnostics," there is a much tighter consensus than is the case with "remote diagnostics."

- The term "diagnostics" is generally perceived in the industry as a generic term that takes on a much broader meaning than Webster's ". . . the art and practice of diagnosis."

- A consensus definition requires that we recognize common usage of terms within certain groups that attribute human traits to machines and software systems.

- Generically, within vendor organizations, "diagnostics" are programmed exercises that are run on equipment to verify functional integrity or to isolate fault when failures occur.

- One problem in isolating definitions acceptable to most of the industry is a direct result of the tendency of the industry to create terms giving programs and machines human qualities.

  - By accepting the generic term "diagnostics" to describe a collection of programmed exercises, we must then limit the term within the context of industry usage.

  - The true human side, which is the art and practice of diagnosis, must now be described as an activity; i.e., "diagnosis."

- For the purposes of this report, and within the context of the field service profession, the terms are then separated as follows:

  - "Diagnosis" - What field service personnel perform when they diagnose problems with equipment. A process performed by human beings on machines and on information about machines.

- "Diagnostics" - 1) Programmed exercises that may be run on equipment to verify functional integrity or to isolate failing components. Performed by a machine on itself or on other machines. 2) Tools used by humans to collect data helpful in diagnosis.

  . "Diagnostic aids" - Programs, instructions, special tools, special data collection devices, support centers, manuals, C.E. panels, etc., which enhance the field engineer's ability to diagnose failures. The list includes "diagnostics," as defined above.

• To settle on a consensus definition of "remote diagnostics" based on the preceding definition of "diagnostics," we must remove more gray area and find a generally acceptable set of criteria to separate the process of remote diagnosis from the tool, remote diagnostics. We must also define "remote" within the context of this activity.

- First of all, "remote" means more than just "separated from" or "detached."

  . "Far away" is associated with "remote" in all cases.

  . "Remote" must be far enough away that it would require a significant effort to transfer the person or entity into the same facility. In this sense, outside a time-locked bank vault could be considered "remote" in a requirement to diagnose problems within it.

- To qualify as a "remote diagnostic," it is not required that the diagnostic routines reside remotely, but only that their control - or direct, real-time observation - be performed remotely.

- While the "uploading" of storage dumps might be a handy diagnostic aid to the support center, this activity alone could not qualify as remote diagnostics.

- If a person in a remote location could invoke certain routines remotely to cause a storage dump to be passed up-line after trapping conditions associated with a forced failure, he or she would be exercising a remote diagnostic, by consensus definition.

- If a person remotely requested a storage dump, even through direct remote control not associated with diagnostic routines, he or she would not be using a remote diagnostic capability, by consensus definition.

- The consensus of opinion is that there should be some interaction between local and remote in a real-time sense in order for there to be a bona fide remote diagnostic capability.

  - At the threshold of this definition is a system that allows visual observation of the diagnostic results in real time, even if all remote commands must be verbalized to a local operator or field engineer.

  - The "interaction," in this loosest sense, is derived from the accepted fact that the added dimension of real-time observation significantly enhances the support center specialist's ability to diagnose equipment failure remotely.

  - Visual impact adds the advantages of intuition and instincts at an exponential rate when a specialist is attempting to diagnose a problem remotely.

- The "interaction" criteria may be satisfied by other than visual means, according to the consensus, as long as other control combinations are in place.

  - For example, feedback might be by certain sounds to signify that certain remotely controlled diagnostics were run successfully.

- Another example would be a peripheral controller with an acoustically coupled communications device accessible remotely. The "diagnostic" effort in this case might be limited to verification that a local field engineer is or is not required. Verification is a bona fide diagnostic function.

- The "real-time" constraint on feedback is traditional by consensus. There is no tradition that demands that diagnostic results be displayed immediately on a monitor or on LED panels. On the contrary, tradition allows for a reasonable time to see the results, such as removing a tape or disk pack to an off-line system for spooling or direct printing.

  - While the constraint disallows mailing the results, it does extend to allow the transmission of data to remote storage devices for later display in the remote facility.

  - The exception to this extended "real-time" constraint would be in the first example, where the support center could only look over the shoulder of the local field engineer and observe the video screen. If this is the only interaction, it should be truly real time, according to the consensus.

- The ability to interrogate error logs might be a part of a complete remote diagnostic system, but does not qualify as a remote diagnostic in its own right, according to the consensus of opinion.

  - Error recording and sorted outputs are properly classified as "diagnostic aids."

  - The capability to examine error logs remotely is normally an additional benefit derived from installing a remote diagnostic control capability.

- Most error logs are statistical in nature, capturing the fact that random errors occur along with other available data, which may later correlate to causes of errors.

- If error recording is performed concurrently with the running of diagnostics controlled remotely, the recording module is a part of the diagnostic, not the diagnostic itself.

- While remote observation of error logs may facilitate remote diagnosis, this activity fails to satisfy the consensus definition of "diagnostics."

- To summarize, in order to be called "remote diagnostics," the tool used must meet certain criteria, according to the consensus:

  - The "diagnostic" definition must be satisfied.

  - The "remote" definition must be satisfied.

  - There should be remote interaction with the diagnostic routine, either by real-time observation or by passing control over diagnostic routines to the remote facility.

  - There are no constraints as to who is involved at the local level (user, field engineer or no one at all).

  - The remote facility may be under the control of another machine ("automated remote diagnostics") or a person.

B. GLOSSARY

- **DIAGNOSTICS** - Programmed routines used to verify the functional integrity of computer equipment, to force failures, report on failure patterns, and to isolate faults through fault-locating techniques.

- **FLTs** - A specialized diagnostic package designed to isolate fault in a failing computer device. The abbreviation of "Fault-Locating Tests."

- **REMOTE DIAGNOSTICS** - Diagnostics that may be controlled and/or observed remotely, with real-time interaction between a remote assistance center and the local equipment.

- **AUTOMATED REMOTE DIAGNOSTICS** - A remote diagnostic system that interfaces with an automated analysis routine at the remote assistance center.

- **DIAGNOSTIC AIDS** - Various devices and resources that assist in the effort to diagnose equipment problems. Some examples are: diagnostics, remote diagnostics, error logs (manual), on-board statistical error logs, documentation, special test equipment, FE panels, etc.

- **BRING-UP DIAGNOSTICS** - Specialized diagnostics designed during the equipment development phase to verify the functional integrity of various stages of design. Usually incorporated into the field diagnostic package as verification routines.

- **QUALITY ASSURANCE DIAGNOSTICS** - Combinations of manual tests and algorithms run under variable conditions of environmental stress to assure that equipment runs properly at and beyond specified condition limits. Seldom used by field engineers and only recommended in extreme cases within the user's environment.

APPENDIX B: QUESTIONNAIRES

CATALOG NO. FRDR□□□

REMOTE DIAGNOSTICS

USER QUESTIONNAIRE

1. Please list your maintenance vendors:

Vendor	Equipment Type

2. Do any of your maintenance vendors offer remote diagnostics?

□ Yes □ No

If "yes," go to Section I

3. Have any of your maintenance vendors announced their intentions to offer remote diagnostics?

☐ Yes ☐ No

If "yes," go to Section II

If "no," go to Section III

I USERS WITH REMOTE DIAGNOSTICS INSTALLED

Note to Research Analyst: If multiple vendors are using remote diagnostics, be prepared to fill out multiple questionnaires. Make certain that the most significant maintenance vendor's remote diagnostic system is surveyed completely; i.e., assure that the user's attitude toward the most significant vendor is measured.

Should you have the opportunity to choose between vendors we are surveying and others, select the ones we have questioned in the vendor survey.

1. Please indicate the level of your satisfaction (or dissatisfaction) with the following characteristics of remote diagnostics. Use a scale of −5 for high level of dissatisfaction or rejection to +5 for enthusiastic acceptance or total satisfaction. A zero on this scale would indicate an indifferent or balanced attitude.

Factor	Rate (−5 to +5)
a) Frequency of personal contact with service personnel	
b) Involvement in loading diagnostics	
c) Involvement in relaying information to diagnostic center	
d) Involvement: setting switches, changing voltage and clock margins	
e) Involvement exchanging parts	
f) Involvement shipping parts to repair centers	
g) Software patches by telephone	
h) Data security	
i) Overall concept	
j) Other ______________	
k) Other ______________	

2. Do you experience a greater or lesser availability of your equipment as a result of remote diagnostics?

   greater ________ % available versus ________ %

   lesser ________ % available versus ________ %

3. In measuring availability, do you account for degraded system performance?

   ☐ Yes ☐ No

   How so? ____

   ____

   ____

   ____

4. Is your remote diagnostics system optional to you?

   ☐ Yes ☐ No

   a) If "yes," is there an adjustment in the price of your maintenance contract?

      (+/-) ________ %

   b) If "yes," what were your major reasons for accepting remote diagnostics?

      ____

      ____

      ____

      ____

   c) If a vendor offered increased up-time with remote diagnostics, how much more would you pay for maintenance?

      1) For 1% more up-time, ______ % more maintenance

      2) For 5% more up-time, ______ % more maintenance

      3) For 10% more up-time, ______ % more maintenance

5. Does the remote diagnostics center support software?

☐ Yes ☐ No

a) If "yes," please describe services: ______________________

____

____

____

b) If "no," does this vendor offer a system support center service for software support?

☐ Yes ☐ No

If "yes," please describe the support activity: ______________

____

____

____

____

6. Does the remote diagnostic system operate under your operating system, or is manual intervention required?

☐ Operating system ________ %

☐ Manual intervention ________ %

☐ Both 100 %

7. Were you required to train personnel to use the remote diagnostics?

☐ Yes ☐ No

a) If "yes," did the vendor supply adequate training?

☐ Yes ☐ No

Please comment: ______________________________

____

____

____

7. b) If "yes," was your investment in training significant?

☐ Yes ☐ No

If "yes," how significant? $ ______________

8. In your next purchasing decision, how much weight will you give to the availability of remote diagnostics?

__________ %

Comments: ____

____

____

____

9. Do you sense a change in your field service engineer's attitude since the implementation of remote diagnostics?

☐ Yes ☐ No

If "yes," please comment: ____

____

____

____

10. Do you have foreign installations supported by remote diagnostics?

☐ Yes ☐ No

a) If "yes," do you experience any significant differences between foreign and domestic service?

☐ Yes ☐ No

b) Please comment: ____

____

____

____

11. Has the availability of remote diagnostics had any effect on your decisions regarding distributed data processing?

☐ Yes ☐ No ☐ N/A

Please comment: ______________________________

12. Please briefly describe the operation of remote diagnostics as perceived by your operations personnel:

13. Please indicate the apparent reliability of remote diagnostics by the average percentage of times the following levels of problem resolution is reached via the remote diagnostic effort (0-100%).

Resolution Level	Reliability (0-100%)
a) Detect and allow circumvention a degraded performance level	
b) Isolate to module or part replaceable by user	
c) Detect and dispatch a local field engineer with correct part	
d) Detect software problem and provide a patch	
e) Detect and correct user operation errors	
f) Detect a potential failure and schedule preventive maintenance	
g) Isolate other vendor problem	
h) Provides no useful information	

THANK YOU!

II USERS WITH PLANS TO INSTALL REMOTE DIAGNOSTICS IN THE USER FUTURE

1. Have you been contacted regarding a schedule for training your personnel in the use of remote diagnostics?

☐ Yes ☐ No

2. Do you have the option of accepting or rejecting remote diagnostics?

☐ Yes ☐ No

a) If "yes," on what basis did you decide? ______________________

____

____

____

b) If "yes," is there an adjustment in the price of your maintenance contract?

(+/-) ________ %

3. Will your remote diagnostics run under your operating system or by manual intervention?

☐ Operating system ________ %

☐ Manual ________ %

☐ Both 100 %

4. Will your system provide remote support in software problems?

☐ Yes ☐ No

Please comment: ______________________________

____

____

____

5. Will your personnel be involved in:

	Yes	No
a) Loading diagnostics?	☐	☐
b) Alteration of margins (voltage, clocks, etc.)?	☐	☐
c) Replacing parts?	☐	☐
d) Shipping parts to repair centers?	☐	☐

6. Do you have adequate assurance that your data security is protected by the remote diagnostic system to be installed?

☐ Yes ☐ No

Please comment: ______________________________

____

____

____

7. Do you anticipate a significant investment in training personnel or other areas to incorporate remote diagnostics?

☐ Yes ☐ No

If "yes," how do you compute the payback on your investment?

____

____

____

____

8. In your purchasing decisions, how much weight do you expect to give to the availability of remote diagnostics?

_________ %

Comments: ____

____

____

____

9. Do you have foreign installations that will also be installing remote diagnostics?

☐ Yes ☐ No

If "yes," are there any significant differences between foreign and domestic implementation?

Comments: ____

____

____

____

10. Has the availability of remote diagnostics had any effect on your decisions regarding distributed data processing?

☐ Yes ☐ No

Comments: ____

____

____

____

11. Please briefly describe your understanding of the operation of the remote diagnostics system you are to install:

____

____

____

____

____

____

____

____

THANK YOU!

III USERS WITH NO REMOTE DIAGNOSTICS OR PLANS TO INSTALL

1. Have you had the option to install remote diagnostics?

   ☐ Yes ☐ No

   If "yes," why did you turn it down? ______________________________

   ____

   ____

   ____

2. Are you familiar with remote diagnostics in other installations?

   ☐ Yes ☐ No

   If "yes," have you heard favorable or unfavorable comments?

   Please comment: ______________________________

   ____

   ____

   ____

3. Will your next purchasing decision give any significant weight to the availability of remote diagnostics?

   ☐ Yes ☐ No

   How much? __________ %

4. Would you be willing to use remote diagnostics if they could be installed on your equipment? (please indicate your level of interest on a scale of 0-5; 0 = no willingness, 5 = great desire)

   (0-5) __________

5. Have you heard any vendor field service personnel comment on remote diagnostics?

☐ Yes ☐ No

Please comment: ______________________________

____

____

____

____

____

THANK YOU VERY MUCH!

REMOTE DIAGNOSTICS

VENDOR QUESTIONNAIRE

Note: Within this questionnaire you may find any of the following scales for rating or ranking attitudes or perceived levels of importance:

a) (-5 to +5) - This scale is used in questions addressing issues which may have rejection, indifference or acceptance as perceived by respondents. -5 = vocal or high rejection, 0 = an indifferent or mixed (balanced) attitude while +5 = enthusiastic acceptance.

b) (0-5) - 0 = no importance or not accepted, 1 = little importance or acceptance and 5 = great importance or total acceptance.

c) (0-100%) - This scale is used to allocate weight factors or to distribute resources; for example, "The decision to buy a computer was based 30% on service, 30% on software support and 40% on price/performance." (A total of 100%.) This scale (0-100%) is also used to express probabilities.

d) Ranking of selected items may be requested with the number one representing the most important in the list. Ranking terminates at the number where differences become insignificant. If known, the <u>least</u> significant item in the list should be ranked with a number given by the questionnaire, usually equal to the number of items in the list.

1. Do you have remote diagnostics installed?

☐ Yes - Go to <u>Section I</u>

2. Do you have plans to implement remote diagnostics in the near future?

☐ Yes - Go to <u>Section II</u>

☐ No - Go to <u>Section III</u>

I VENDORS WHO HAVE REMOTE DIAGNOSTICS IMPLEMENTED

1. On the following items, please rate user acceptance (or rejection) of your remote diagnostics on a scale of -5 to +5.

Factor	Rate (-5 to +5)
a) Frequency of personal contact with field engineer	
b) User involvement loading diagnostics	
c) User involvement relaying information not observable at diagnostic center	
d) User involvement changing switch settings, voltages, clock speed, etc.	
e) User involvement in exchanging modules or circuit boards to effect repairs	
f) User involvement in shipping modules or components to repair centers	
g) Software patches installed via remote diagnostics	
h) Data security	
i) Overall concept	

2. What is the average percentage up time (availability) of systems using remote diagnostics?

_________ %

Note to Research Analyst: Availability is the ratio of time available to the total of time available plus elapsed down time; i.e., percentage available = available time available time + elapsed down time. This measurement is sometimes computed by dividing Mean Time Between Failure (MTBF) by MTBF plus the Mean Time to Repair (MTTR).

3. What would you expect the percentage availability to be without remote diagnostics?

_________ %

4. In measuring availability, do you account for degraded performance?

☐ Yes ☐ No

How? ______________________________

____

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5. Do you perceive any change in personnel utilization due to remote diagnostics?

☐ Yes ☐ No

How much ± _________ %

Compare to expectations ± _________ %

6. Do you perceive a difference in the cost of providing maintenance with remote diagnostics?

☐ Yes ☐ No

How much ± _________ %

Compare to expectations ± _________ %

7. Are remote diagnostics optional to the user?

☐ Yes ☐ No

a) If "yes," is there a maintenance contract price adjustment related to the option?

☐ Yes ☐ No

b) If "yes," how much? ± _________ %

8. Do you use regional remote diagnostic centers?

☐ Yes ☐ No

Where are they located? ______________________________

____

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____

9. Are your remote diagnostics centers aligned with centralized or automated call response centers?

☐ Yes ☐ No

10. Does your remote diagnostic technique require the presence of a trained field engineer on-site?

☐ Yes ☐ No

Comments: ______________________________

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11. Can you access diagnostics remotely under the user's operating system?

☐ Yes ☐ No

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12. Does your technique in remote diagnostics require manual intervention by the user?

☐ Yes ☐ No

If "yes," how so? ____________________

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13. What would you say is your investment in remote diagnostics development and implementation?

$ ____________

a) How does this investment compare to the average annual cost of maintenance it is designed to support?

________ %

b) Do you project a payback period for your investment?

☐ Yes ☐ No

c) If "yes," what is the payback period? ____________________

d) Are you on target?

☐ Yes ☐ No ________ %

e) Did you compute a net present value of the benefits derived from using remote diagnostics?

☐ Yes ☐ No

14. Please rate the importance of the following relative to your decision to implement remote diagnostics. The list will be repeated for you to rank the items after rating them on a scale of 0-5.

Factor in Decision	Importance (0-5)	Rank 1 = First
a) Personnel utilization		
b) Cost savings		
c) Improved up time		
d) User demands and pressure		
e) Competition		
f) Engineering decision, not field service		
g) Equipment complexity		
h) Standardization of service		
i) Other ______________________		

15. Please rate the perceived attitudes of your field service personnel as to their acceptance or rejection of remote diagnostic concepts. (Scale -5 to +5)

Concept	Rate (-5 to +5)
a) Decreased personal contact with users	
b) User involvement in early diagnosis	
c) Centralized scheduling of P.M.	
d) User "fixes" to equipment	
e) Reduced training requirements	
f) Centralized or remote direction in parts deliveries and repairs	
g) Ability to cover more territory	
h) Other ______	
i) Other ______	

16. Do you have remote diagnostics in foreign countries?

☐ Yes ☐ No

a) If "yes," what are the significant differences in operations?

______

______

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______

16. b) Have you detected any significant differences between foreign user attitudes and those of domestic users?

☐ Yes ☐ No

What differences? ______

______

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______

c) Are there any significant differences between foreign and domestic field service engineers' attitudes?

☐ Yes ☐ No

Please specify: ______

______

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______

17. In your case, has Distributed Data Processing (DDP) been a significant driving force in the development of remote diagnostics?

☐ Yes ☐ No

18. Alternatively, do you perceive developments in remote diagnostics to open more opportunities to service DDP?

☐ Yes ☐ No

19. Please comment on the mutual impact of DDP and remote diagnostics on each other:

______

______

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______

20. Has the field engineering department been directly involved in the design of remote diagnostics?

☐ Yes ☐ No

In what respects? ______________________________

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21. Do you visualize advances in technology as emphasizing a "push" or "pull" factor in remote diagnostics? That is to say; are advances in technology making remote diagnostics more available at reasonable cost (pull), or advances in technology creating greater demands on a limited pool of diagnostic skills?

☐ Pull ________ %

☐ Push ________ %

☐ Both 100 %

22. Are remote diagnostics justified on the basis of increased revenues and profit margins?

☐ Yes ☐ No

a) If "yes," would you please quantify either by percentage or in absolute terms?

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b) If "no," please comment on the intangible benefits and/or justifications as you perceive them:

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23. Does your remote diagnostic system address software problems as well as hardware?

☐ Yes ☐ No

24. Please briefly describe the operation of your remote diagnostic system:

25. How reliable is your remote diagnostic system?

Resolution Level	Percentage Successful (0-100%)
a) Detect and circumvent with degraded performance	
b) Isolate to module, replaceable by user	
c) Detect and dispatch local field service representative with correct part for repair	
d) Detect and provide software patch for software problems	
e) Detect preventable failure and repair on P.M.	
f) Detect and correct user operation errors	
g) Others ______	

26. Would you like to receive a summary of our findings?

☐ Yes ☐ No

To whom should we send it? ______________________

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27. We are surveying attitudes of field service engineers and users. Would you be willing to supply us with lists of your field engineers and users from which we may draw a random sample for testing their attitudes toward the general subject of remote diagnostics?

Users	☐	Yes	☐	No
FE's	☐	Yes	☐	No

*Research Analyst - Take separate lists of names and phone numbers to be sampled.

THANK YOU!

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II FOR VENDORS WITH COMMITMENT TO IMPLEMENT REMOTE DIAGNOSTICS IN THE NEAR FUTURE

1. Please rate the factors relevant to your decision to implement remote diagnostics. After rating the following list on a scale of 0 to 5 indicating the relative importance of the factor, please rank the list from 1 for most important to higher numbers for progressively less importance in rank.

Decision Factor	Importance (0-5)	Rank 1 = First
a) Personnel utilization		
b) Cost savings		
c) Improved up time		
d) User demands		
e) Competition		
f) Engineering decision, not field service		
g) Complexity of equipment		
h) Standardization of service		
i) Other ______________________		
j) Other ______________________		

2. Do you expect an improvement in personnel utilization?

☐ Yes ☐ No

How much? (+/-) ________ %

3. Do you expect a cost reduction?

☐ Yes ☐ No

How much? (+/-) ________ %

4. Will remote diagnostics be optional to the user?

☐ Yes ☐ No

a) If "yes," will there be a price adjustment in the maintenance contract?

☐ Yes ☐ No

How much? (+/-) ________ %

b) If "no," what are the user's perceived benefits?

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5. How large is your anticipated capital investment in remote diagnostics relative to the expected annual cost of maintaining the same equipment?

________ % or $ ____________

$ ____________

6. Have you projected a payback period for the capital investment in remote diagnostics?

☐ Yes ☐ No

If "yes," how long? ________________________

7. Have you projected a stream of benefits discounted to a net present value as justification for your investment?

☐ Yes ☐ No

If "yes," how great is the net present value relative to the capital investment?

(+/-) __________ %

and, at what discount rate? __________ %

8. In calculating financial benefits to justify remote diagnostics, did you quantify intangible benefits such as improved service image related to greater system availability?

☐ Yes ☐ No

Please comment: ____

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9. Do you expect an increase in profit margins as a result of remote diagnostics?

☐ Yes ☐ No

How much? (+/-) __________ %

10. Is the field service department involved in the design of remote diagnostics?

☐ Yes ☐ No

a) If "yes," how so? ____

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b) If "no," why not? ____

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11. Have you conducted a user survey to anticipate the acceptance level of remote diagnostics?

☐ Yes ☐ No

12. What do you perceive the user acceptance level to be after implementation regarding: (please rate from -5 for total rejection to +5 for enthusiastic acceptance.)

Factor	Rating (-5 to +5)
a) Frequency of personal contact with field engineers	
b) User involvement loading diagnostics	
c) User involvement relaying information not observable at diagnostic center	
d) User changing switch settings and margins of clocks, voltages, etc.	
e) User exchanging modules or circuit boards	
f) User shipping components to repair centers	
g) Software patches installed via remote diagnostic center	
h) Data security	
i) Overall concept	
j) Other ______________________	
k) Other ______________________	

13. Will your remote diagnostics support software remotely?

☐ Yes ☐ No

14. Have you surveyed your field engineers to anticipate their attitudes toward remote diagnostics?

☐ Yes ☐ No

Please comment: ______________________________

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15. How do you plan to offset problems with field service personnel concerns about remote diagnostics?

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16. Do you expect a change in equipment availability?

☐ Yes ☐ No

If "yes," from an average of ________ % to ________ %

17. Do you, or will you, account for system performance degradation in your calculations of availability, mean time to fail and mean time to repair?

☐ Yes ☐ No

If "yes," how? ______________________________

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18. Will you use regional remote diagnostic centers?

☐ Yes ☐ No

19. Will your remote diagnostic center(s) be aligned or integrated with centralized/automated response centers?

☐ Yes ☐ No

20. Will your remote diagnostic system require the presence of a trained field engineer?

☐ Yes ☐ No

Comments: ______________________________

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21. Will you be able to access diagnostic routines remotely under the system control progrmas, or must they be loaded by manual intervention?

☐ System control program

☐ Manual

☐ Both

Comments: ______________________________

22. Do you now have, or will you be implementing, remote diagnostics in foreign countries?

☐ Yes ☐ No

a) If "yes," do you anticipate operational differences?

☐ Yes ☐ No

Comments: ______________________________

b) If "yes," do you expect differences in foreign and domestic attitudes?

☐ Yes ☐ No

Users: ______________________________

22. b) Field Engineers: ______________________

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23. Has distributed data processing been a significant driving force in your decision to implement remote diagnostics?

☐ Yes ☐ No

Please comment: ______________________

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24. Do you see advances in technology as a "push" or "pull" factor in remote diagnostics? That is to say; are advances in technology making remote diagnostics more available (pull), or are advances in technology creating greater demands on a limited pool of diagnostic skills (push)?

Pull ________ % Push ________ % Both 100 %

Comments: ______________________

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25. Would you like a summary of the findings of this survey?

☐ Yes ☐ No

To whom should we send it? ______________________

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26. If you have announced your intentions to implement remote diagnostics, would you care to provide INPUT with a list of users and/or field service engineers from which we may draw a random sample for additional survey questions?

Users ________ Separate list

FE's ________ Separate list

THANK YOU!

III FOR VENDORS WITH NO PLANS TO IMPLEMENT REMOTE DIAGNOSTICS

1. Have you performed an in-depth evaluation of remote diagnostics?

☐ Yes ☐ No

If "yes," please rate the factors as to their importance in your decision not to develop a remote diagnostic capability on a scale of -5 to +5 with -5 indicating level of rejection.

Decision Factor	Rate (-5 to +5)
a) Personal contect with user	
b) Personnel utilization	
c) Cost reduction	
d) Improved profits	
e) Greater system utilization by user	
f) Competitive pressure	
g) User demands for remote diagnostics	
h) Not a departmental decision	
i) Other ______________________	
j) Other ______________________	

2. Were there other significant reasons for deciding against remote diagnostics?

☐ Yes ☐ No

Please comment: ____________________

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3. Do you foresee any possible changes in the industry or technology which would alter your decision not to develop remote diagnostic capabilities?

☐ Yes ☐ No

Please comment: ____________________

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THANK YOU VERY MUCH!