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S. M. THESIS PROPOSAL: The Computer Utility as a Marketplace for
Computer Services

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Abstract: Shared computer systems offer an environment in which services may be easily provided. Within the marketplace of a computer utility, small and large vendors can provide many diverse services to users. The current computer service offerings are limited when compared with the potentials of these services. This thesis will present a model (and a possible implementation) of a computer utility as a marketplace and will investigate the difficulties arising from such an environment.

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1. Introduction

Traditionally computers have been viewed as rather powerful calculators and data processors. With the increasing use of computers by nonprofessionals it has become more important to view computer systems in terms of the services they provide than in terms of the details of the computations.

With the advent of companies that provide access to complete computer systems it has become possible for entrepreneurs to purchase computer time and, in turn, sell services to their own clients. The entrepreneurs need be concerned with the host computer system only to the extent that they must interface with it to provide their service. The entrepreneur's clients need not be aware of the details of the computations at all. This is particularly true for companies providing interactive computer services. The clients need only have a computer terminal that can be used to connect to the computer. Once the user has established a connection with the computer system, he is under the control of the entrepreneur's service. The client may use his terminal to access a number of different computer based services. In fact, he may view the computer system itself as a marketplace in which he may select and purchase diverse services.

The development of computer systems has not yet reached the point where a large number of services are easily available to the users. Instead services are available in a piecemeal fashion. The thesis will explore an implementation of a computer

utility as a basis for a marketplace for services. A model will be given of such a marketplace and the services that may be offered. The issues arising from such a model will then be investigated. For example, how does one deal with many services, who is responsible for services and financial transactions, and how are disputes between participants settled. Once the model has been explored, a specific implementation (for the Mltics system) will be given to illustrate the feasibility of the model. The model will then be extended to a distributed system in which there may be multiple marketplaces from which services may be purchased through a common interface.

2. A Model of A Marketplace for Computer Services.

There are three primary participants in the marketplace: the installation manager, the service vendor, and the user of the services. The installation manager is responsible for providing the computer system itself, including such basic services as the hardware, the operating system, resource management and system integrity. He is also responsible for providing services which can best be provided centrally, either for security reasons (such as auditing) or because coordination is desirable (such as accounting records). The service vendor (the entrepreneur) makes use of the basic services of the system and the services of other vendors to create new services. The user is the consumer of services. The vendor is, in fact, both a seller of services to other users and a buyer when he purchases the basic service from which he creates his new service. The installation manager can also be considered a vendor when he is selling his basic services to others.

The vendors compete with other vendors in selling their services; thus to succeed in the marketplace the services must be attractive to users. In particular, the emphasis is on providing services which meet the user's needs and which are economical as measured against the value of the service. The vendor would be encouraged to provide a complete product and take complete responsibility for his service. As a result the user need only deal with the vendor from whom he is purchasing a particular

service. The vendor himself is responsible for any problems with his suppliers.

Paying for services received is fundamental in the marketplace. For each user-service combination, an arrangement for payments must exist. While it is possible for each user to make arrangements with each vendor, it is preferable to centralize the accounting for service usage to prevent a proliferation of different arrangements that would effectively prevent the user from being able to manage his accounts. (A more detailed explanation is given below). The installation management would therefore provide a central accounting service in order to provide a uniform financial interface. Unlike most credit card services, the user would still maintain control over individual transactions (i.e. be able to decide which bills he wants to pay and which he doesn't); with the installation management would be acting as a clearinghouse for bills, rather than simply aggregating them.

3. Discussion of Major Issues

A characteristic of the computer marketplace is the ease with which services can be offered. As a result, it can be expected that the user may casually access many services and that these, in turn, would draw on additional services. Furthermore, small entrepreneurs can easily provide a service in such a marketplace because of the low capital costs. The large number of services makes it difficult for the user to manage his use. In particular, it is hard to keep track of the accounts for many services and to pursue disputes when necessary. The primary method of simplifying the user's interface with these services is to view each service as a "black box". Thus the user need only be aware of the services he has explicitly requested, and since he is only required to deal with services with which he is familiar, he is in a position to effectively manage his accounts. The main incentive to the vendor for providing the service as a unit is the importance of providing an attractive interface to the users in the competitive environment of the marketplace. The number of services the user requests explicitly may be very large considering that the use of a service may be no more difficult than placing a telephone call. To further reduce the work involved in managing one's accounts, the installation manager (or some other vendor) can provide additional services. For example, the user may be able to concern himself only with exceptional transactions and automatically process the normal ones (according to his own definition of normal). The importance of simplifying

the user's interface cannot be overemphasised, as a user is apt to make default decisions, and deny himself protection against errors and malicious vendors.

Basic to the operation of the marketplace is the assignment of responsibility. It has already been suggested that it is desirable for the vendor to take complete responsibility for the service he is providing, to relieve the user of the burden of knowing about the details of the secondary services that are invoked. Also important is the need to limit the deferring of responsibility (i.e. there must be a point where the buck stops being passed). Even when the responsibility can be eventually determined, the costs involved might make it uneconomical in many cases. The converse of the determination of responsibility is the limitation of liability. Both the vendor and the user must have means of specifying the limits of their liabilities, the user by specifying a spending limit and the vendor by explicitly specifying the limit to which he will be legally responsible for damages to the user of a service. service.

The marketplace is a heterogeneous environment with many vendors and users interacting. As such, disputes will arise frequently and must be handled smoothly. A technique basic to settling disputes is limiting the number of parties. Once again, the principle of considering a service to be an indivisible entity can be used to reduce the number of parties to the dispute. Typically the dispute can arise from a disagreement

over the service provided, or from an error in record keeping. For the former case, arbitration may provide a settlement. For the later, it may be necessary for the installation management to maintain auditing data to enable it to track down the difference. In practice, these records may be confidential, and the installation manager would have to peruse them as a disinterested third party at the request of the two participants. The participants both must have a bargaining ability in the dispute -- the vendor can deny further service to the user and the user can withhold payment to the vendor.

4. Additional Issues

These issues are considered secondary with respect to the thesis. The topics of regulation, copyright protection and the implications of a cashless society, however, require much more thorough treatment in themselves than would be possible within the context of the thesis.

The manager of a computer installation is in a privileged position both in his access to the security mechanisms of the system and in his position as manager of system resources. He is also providing services which cannot be easily duplicated by vendors because of the large capital investment that may be necessary. Also much of the value of a computer utility is in its ability to provide an environment in which a number of vendors may cooperate, thereby preventing an independent entrepreneur from providing a service on an independent computer system. As with many other suppliers of utility services such as the common carriers and power companies some degree of regulation may be necessary for the computer utility. The vendors need to be protected from unfair competition from the installation manager and the users of services need to be protected from being denied access to the utility (as opposed to individual services).

Unlike more traditional, labor-intensive, services, the important aspects of a computer service may be embodied in computer software, or simply in the design of the user's interface to the service. It is unclear how traditional protections of

copyrights and patents can be extended to services. Attempts are being made to apply these protections to computer programs, but protection of the individual computer programs composing a service are not necessarily appropriate, or effective for protecting computer services.

By serving as a clearinghouse for bills and payments, the management of the computer utility is, in effect, implementing an electronic fund transfer system. To what extent can, and should, traditional forms of financial transactions be available within the system? For example, how does a user maintain his account balance, how does he establish and maintain credit, how does he authorize payment, how does a vendor make a claim against an account, and, of course, what protections are implemented to prevent and correct for errors?

5. The Implementation of the Computer Utility on Multics.

Multics [1] can provide a basis for an implementation of the computer utility. The installation manager of the utility is the system administrator of the Multics system. Both users and vendors access Multics in the same manner. It is only in a transaction, when a service is purchased that a distinction need be made between the two.

There are a number of ways of implementing services on Multics, the choice of method being made on the basis of cost of use versus the requirements for security. In the current Multics implementation, a service may be provided as a program to which the user has read-execute access and which runs with the access of the users. This choice provides minimal security, but permits use of the service at a low cost. This is desirable for simple services which may be used as subroutines by user programs. A more secure approach is for the vendor to provide a process that performs the service. The process would run with the vendor's access. An alternative to this is to permit the process to be created for the user on demand, though the process still runs with the vendor's access and is charged to the vendor's account. Currently this can only be done by requiring the user to login to a special account. Multics can easily be extended to permit the

(1) Multics (Multiplexed Information and Computing Service) is the result of a joint effort by Project MAC of MIT, Honeywell Information Systems (previously General Electric) and initially, Bell Laboratories.

user to create the (the vendor's) process from within his own (- user) process, thereby simplifying the creation of the service process and permitting Multics to provide the service process with the identity of the requesting user in a secure fashion.

The installation manager is provided with a number of tools to enable him to provide the necessary basic services. In particular, the Multics access control system provides a mechanism (- rings) to permit the installation manager to partition the user's process into multiple levels of protection, thereby permitting the installation manager to provide his own services at a more secure level than the user's own programs but without affecting the manufacturer-certified portions of the system. One of the important interfaces so provided can be the call to the installation accounting system to permit vendors to submit claims against user's accounts.

6. Extension to a distributed system.

It is difficult for a single computer system to satisfy the diverse needs of all users, especially with respect to the need for very specialized hardware. It is also likely to be beneficial to encourage competition between installation managers, though not to the extent of negating the value of close interaction between services. Even when there are a number of autonomous computer installations, the constraints applied to a single installation to improve the user's interface to the system (i.e. the solutions to the problems in section three above) should still apply. In particular, the user's interface to a service should not reflect the details of the specific system on which it may happen to be running. In the case of the network, the need to know where the computations for a service are actually being performed should be minimized, though in practice the degree to which this can be done is limited. For example, the communication costs must be charged to some account, the degree to which service may be closely connected may be limited and the actual data representations may differ. These problems are general research topics in themselves and will not be explored fully in the thesis.

Fundamental to the maintenance of a uniform interface is the extension of the centralized financial service to the distributed system. The installation managers must coordinate the clearing of financial records. Furthermore, they may be required to

extend credit on behalf of their users for the use of a service at a remote installation. Specific protocols must be established to coordinate these financial transactions.

The ARPA Network [1] provides the communication facilities (and associated protocols for their use) needed to permit the Multics implementation of a computer utility to be extended to a distributed system. A simple extension is to a number of similar installations. Since, however, the installation would communicate through well defined protocols, the other installations may, in fact, be any system that observes these protocols. Thus, by defining a suitable set of protocols for communicating between installations, the implementation can be extended to a distributed system of heterogeneous computer installations (as long as they conform to the model given in section two).

(1) The ARPA network (ARPANET) is sponsored by the Advanced Research Projects Agency of the Department of Defense. It provides a message switching communications system to encourage cooperation among computer researchers sponsored by the agency.