To: Larry Rapagnani

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Re: Migration to DCE/DFS
Date: Friday, December 13th 1996

This report outlines the risks, benefits, costs and other issues which govern a migration from AFS to DCE/DFS and the use of DCE as enterprise wide infrastructure.

There are statements in this report which are judgmental i.e. trying to predict the future developments. These judgments were formed based on interaction and presentations at DECORUM, vendor presentations, Transarc training courses and conversations with individuals at other institutions over a period of time. Most recently Joseph Franco and Rich Sudlow visited Pacific Northwest Labs (PNL) in Richland WA where staff have been implementing an AFS to DFS transition for the last year and a half. In addition PNL acts as AFS, DCE/DFS coordinators for Department of Energy sites. The authors have some experience in the installation of our current DCE/DFS test cell. It should be noted that our training, work and observations are entirely based on the Open Software Foundation (OSF) version 1.1 of DCE/DFS.

**DCE/DFS History**

In May of 1990 the Open Software Foundation selected the proposed Decorum Technology solution backed by DEC, Hewlett-Packard, IBM and Microsoft based on the technologies of Locus and Transarc and work done at three universities MIT, CMU and UCLA. At that time, many of us felt that migration to DCE/DFS would occur in 2 to 3 years. However, the marketplace has been much slower in accepting DCE/DFS. Many sites have been running DCE test cells for 3 to 4 years and are planning on rolling out production services soon.
Migration from AFS to DCE/DFS

Currently there are two reasons for migrating to DCE/DFS:

1. As a replacement for AFS

Significant advantages of DFS over AFS from end user perspective include:

Ability to export CD-ROM's as part of DCE/DFS namespace

Ability to export chunks of their local disks into DCE/DFS filepace

We do not see these advantages as significant enough to consider migration from AFS to DCE/DFS.

2. DCE as Distributed Computing Enterprise-wide Infrastructure

We believe that DCE provides an open system, standards based core infrastructure upon which services can be built, both now and well into the future. However DCE is not object-based and some consider it "old technology." The following lines from FAQ on DCE address this issue well:

"Does the conclusion that future distributed systems will be object-based mean that it is a mistake to build distributed systems today using DCE? The answer is no for several reasons. First, many organizations cannot afford to do nothing for several years. End users have pressing needs for robust, scalable systems today. For many organizations, waiting would mean attempting to catch up with competitors who will have a tremendous head start.

Second, as this brief discussion has shown, it is possible to employ object techniques when developing distributed applications using DCE. Carefully designed systems will be able to take advantage DCE features such as dynamic binding and polymorphism and converge with CORBA-compliant systems as they mature.

Third, if object environments are to be successful in supporting industrial-strength distributed systems, they will have to address the problems that DCE addresses. The skills and techniques
developed in working with DCE will be directly applicable to distributed systems environments of the future. This applies not only to software developers, but also to operations personnel, planners, even business managers. Further, the likelihood that DCE will be at least one technology for CORBA interoperability, implies that the eventually migration of applications which use DCE directly to an object environment should not present any insurmountable difficulties."

Thus to restate this, CORBA can use different underlying communication mechanisms, one of which is expected to be DCE. For example, HP ORB plus is Hewlett Packards's implementation of the CORBA specification which uses DCE for communications. This means that a migration path for DCE applications into object-oriented environment exists.

"Finally, your direct experience in developing and operating robust distributed systems will provide you with great insight into the important characteristics of distributed systems environments as they apply to your organization's applications. This knowledge is vital to the shaping of successful tools of the future. History has shown that vendors and standards bodies, left to their own devices, will often miss the mark."

In conclusion, apart from DCE, there are no other open standards based infrastructure available currently and there doesn't appear to be anything else on the horizon for several years.

We foresee that primary reason for deploying DCE/DFS is to create a distributed computing infrastructure. This would enable implementation of current and future services which are secure and platform independent in a coordinated and coherent manner.

Problems with DCE/DFS

Some of the major problems we have identified are:

1. DCE/DFS is significantly more complex for a system administrator to administer, operate and troubleshoot as compared to AFS. This complexity will require at least twice as many system administrators to effectively replace our AFS cell. As with AFS the effects of a
growing cell are minimal to the addition of system administrators duties, however the initial testing, knowledge and implementation of the cell are a significant investment.

2. We believe that a DCE/DFS environment based on software currently available (OSF 1.1) would be significantly less stable than our current AFS environment. We expect this situation to improve as future versions of DCE/DFS are released from vendors.

A transparent migration from AFS to DCE/DFS is of utmost importance, especially due to the relative stability of AFS. Many faculty, staff and students form their impressions of the OIT based on the quality of the core services we provide. Many of these services, on which our image depends, would be affected by a AFS -> DCE/DFS transition. This includes services such as email, web access, printing and file services. A smooth transition from AFS to DCE/DFS is of utmost importance since it greatly determines the image that the Notre Dame community have of the OIT. A hasty or poor migration could result in a poor image which would take years to repair.

3. The acceptance, integration and testing of DCE/DFS by the marketplace and vendors has taken much longer than expected. Currently the estimated number of DCE/DFS sites is less than 100. In addition the porting of new OSF versions by the vendors is slow. We have seen new OSF versions take anywhere from six months to two years for vendors to release software.

4. A DCE/DFS client requires a significantly more powerful machine than AFS. Thus a sizable number of machines will need to be upgraded in order to run DCE/DFS.

5. DCE/DFS does not support access control lists based on IP numbers as is frequently used in our current AFS environment.

6. DCE is based on static IP numbers, thus it deals poorly with dynamically allocation of IP numbers as would be found in a mobile computing environment. While this is not necessarily a big drawback now we believe it will become more significant in future years.

7. AFS allows multiple tokens and can thus authenticate a user to multiple cells simultaneously. In DCE you only have one ticket at a
time making it very inconvenient to go outside your cell without cross cell authentication.

8. Hierarchical cells are not available for DCE/DFS now or in the near future.

Benefits of DCE / DFS

1. The most significant advantage of DCE is the potential it offers in developing platform independent, secure, authenticated client-server applications. DCE provides the ability to fully encrypt client-server data streams. The principal reason PNL chose to deploy DCE/DFS was this key point, allowing them to provide services to their researchers spread across the country without compromising security. This is also increasingly important here where many clients may reside outside the campus network.

Because DCE is an open system, standard based infrastructure, Notre Dame can purchase applications for many services which are independent of hardware platforms and offered by many vendors. Thus services e.g. Gradient's Web Crusader, could be purchased and would allow the OIT to employ services faster and with less ongoing support.

Deployment of DCE/DFS should not be viewed merely as duplication of AFS authentication and file services but as the creation of a basic computing infrastructure.

2. Ability to export CD-ROM’s as part of the DFS environment.

3. Ability to export chunks of local disk space into DFS environment.

Recommendations and Plan:

The OIT should continue exploration of DCE/DFS and periodically review the status with the eventual goal of full deployment. DCE addresses all the major issues of distributed computing and is currently the only candidate for enterprise wide infrastructure. Even if there is a viable candidate to DCE in the future, the experience gained in distributed computing would prove beneficial.
1. Testing and Performance Analysis of servers (Early 1997)

Form a DCE/DFS infrastructure team formed with a minimum of three staff members who devote at least 75% of their time on testing, administration and operation of DCE/DFS servers. We propose that this initial infrastructure group might be comprised of ourselves. It should be noted that currently there is little if any time to further testing let alone contemplate the start of a production cell. Thus to start this team would require reassignment of the majority of our current job responsibilities to existing staff and/or hire new staff. This team should be viewed as a long term team which would "see it through from start to finish".

This team would:

Follow work being done at other organizations. One university which is a pioneer of DCE/DFS is Stanford University. We believe the DCE Team at Stanford University (http://www-leland.stanford.edu/group/DCE/) represents a good model which we might follow.

Increase the number of servers from the one we currently have to three. This is what we've seen for realistic testing at other sites and represents a real rather than an emulated environment in which to work. The test cell in the first 6 - 9 months would consist of approximately ten machines the three servers and approximately 7 Solaris client machines.

Initially this team would carry out performance analysis of DFS as compared to AFS in the Sun Solaris environment. This work is currently planned and will be presented at the "Distributed Filesystem Performance" session at Transarc's Decorum 97. This work would aid in capacity planning and provide results and information. This would be needed in the future as we talk with OIT customers pertaining to our new infrastructure.

An early goal would be to synchronize accounts of our current AFS cell with the DCE security registry. A major milestone would be to populate the DCE security registry for "production" operation by the summer of 1997. Authentication services would then be available to facilitate the testing of clients and future production services.

Core services such as time synchronization and DFS backups would be of a production quality in the summer/fall of 1997 in order to
reduce hesitancy of individuals to work in the DCE/DFS environment. While we believe that time synchronization to be a minor problem it has been reported to us that it is one of the more troublesome services to provide.

The AFS to DFS migration toolkit purchased earlier this year from Transarc would be used extensively in the migration of AFS data and to facilitate transparency throughout the migration process. Full testing and implementation of this product would be completed by the end of 1997.

Additional administrators would be added to the DCE/DFS infrastructure group in the fall of 1997. These additional administrators would likely be all the current AFS administrators as plans solidify for transition from AFS to DFS in the summer of 1998.

We believe that the DCE/DFS infrastructure should be designed in such a way as to minimize human intervention, thus monitoring and backups would be totally automated. PNL is interested in a joint project with Notre Dame for automated monitoring and currently has some experience in this area.

2. Full and complete client testing (Fall 1997)

Form a DCE/DFS client team with representation from all client platforms (Solaris, AIX 4.x, IRIX 6.x, WinNT, MacOS, HP MPE). It would include representatives from Colleges of Business, Engineering, Science, Library and internal OIT staff.

This team would:

Be trained by a collaborative team of both Transarc and OIT staff. This would provide a general knowledge of DCE/DFS in addition to how other applications might be used, thus providing employees with "the big picture". It is imperative that this training be successful and the "big picture" understood. We believe it wise to extend this training to all OIT employees and key customers mentioned previously. We believe it advantageous to identify key members of the client team in addition to those providing key services prior to this time in order to have them attend training at Decorum, or other Transarc training locations, prior to the fall of 1997.
Focus on extensive and complete DCE, DFS, and application testing. This would require a great deal of time, effort and coordination as all software which we currently support would need to be tested in the DFS environment.

Look at the issues involved with the distribution of client software for the various platforms. This might entail writing installation software, or the integration of commercial installation software into our environment.

The client team should include all original members of the infrastructure team in order that good communications are maintained between those working on the servers and those on the clients. The primary responsibility of the infrastructure team would however be to continue the stability and refinement of the server environment.

3. Investigation, Development and Deployment of Services based on DCE Infrastructure (Early 1997 - Summer 1997)

Most sites currently running DCE are business based: large banks, financial houses, insurance companies or telecommunication organizations. A large portion of them using applications such as Transarc's Encina or IBM's CICS in their transaction processing environments. The acceptance of DCE into the business environment will result in applications built on DCE evolving much sooner in these areas. Evidence of the acceptance of business applications based on DCE can be found in the Speedware, Oracle, and Netdynamics products currently available and being used. If a DCE/DFS is to be a success at Notre Dame it will be due to applications and products written or purchased that utilized the DCE infrastructure.

We recommend that the BPR or similiar team investigate the internal development or acquisition of applications based on DCE. One key area for investigation being the use of transaction processing applications such as Encina as a tool for implementing current and future services.

Application programming in DCE requires considerable training and expertise. Considerable time and training would be required should Notre Dame elect to write DCE applications from scratch. Decorum
would provide an ideal time for some key individuals to begin training on DCE programming skills. We should also note that Transarc provides contract programming services of which Notre Dame might take advantage of in order to address this problem.

4. Prepare for production (Early 1998)

We believe that the earliest integration of DCE/DFS into OIT services and providing support of DCE/DFS to user desktops could be achieved is the summer of 1998. However we feel it necessary to note that we would certainly not be surprised if general "production" services were delayed until summer of 1999.

A team would need to be formed in early 1998 in order to communicate the new infrastructure to the University population. In addition training and documentation requirements would need to be addressed at this time.

In summary we feel that committing to DCE as a distributed computing infrastructure has long term consequences which affects the entire University. DCE provides the necessary underlying infrastructure with which to merge our diverse academic and administrative computing environments. It is imperative that this decision not be done without forethought as the resources, time, training and effort committed to such a future endeavor will be substantial. However we believe the rewards to be great as it provides the infrastructure on which to support the next two decades of computing services at Notre Dame.