

University of California
**Information Technology: Foundation of the New Business
Architecture**

NBA Technology Planning Group
July 2001

In January, 2000, the Senior Vice President – Business and Finance commissioned a planning group to consider the impact of anticipated changes affecting the University over the next decade. The charge to the group stated in part:

Between the years 2000 and 2010, significant enrollment growth will be accompanied by growth in innovative industrial partnerships, philanthropy, sponsored research, complexity of government regulations, and increased scrutiny by our constituents. These factors will markedly increase business transactions on the campuses and the Office of the President. It is also likely that during the coming decade, we will not see a proportionate investment in the administrative infrastructure to adequately handle this increase in transactions and workload.

Approximately 60,000 additional students are expected to enroll in the University of California over the next decade. This unprecedented growth represents almost a 50% increase and will be accompanied by 4,000 new faculty and a new campus (Merced). The planning group's report, *UC2010*¹, recommends that the University plan a transition to "a New Business Architecture" (NBA) that will enable the University to:

- Manage growth
- Control costs
- Improve the work environment
- Implement best business practices."

In order to accomplish this, the report proposes significant changes in the way UC administrative processes are structured. A six part strategy is identified that "will allow the University to achieve these objectives:

- Develop campus **business portals** that will integrate components of the NBA;
- Apply new approaches to how the University recruits, retains, and develops the very best **people**;

¹ "UC 2010: A New Business Architecture for the University of California", July 2000

- Streamline UC's cumbersome **policies and processes**;
- Leverage new **technology** to contain costs and improve services to UC's constituents;
- Integrate campus **financial systems** and provide enhanced financial reporting through implementation of emerging technology standards; and
- Embed **performance management** systems in UC business processes and focus on the most important **financial controls**."

Implementation of components of this strategy will require a greatly enhanced technology foundation and, in some cases, restructuring of the way University business processes work. For particular components, for example e-commerce, new partnerships in addition to investments in technology may be necessary.

Consistent with one of the basic tenets of the NBA – that the University must restructure its business processes to deal with the influx of new students over the next decade – implementation of the necessary underlying technology foundation and acquisition of new technology to support particular components of the NBA must themselves be accomplished through different processes than have generally been used in the past. Achieving the NBA goals will require that technology projects undertaken on its behalf fit with an overall technology architecture and be well coordinated across the University in order to:

- realize economies of scale;
- minimize duplication of effort;
- result in solutions that facilitate sharing of application systems, data and processes among and across various combinations of campuses and UCOP;
- permit seamless access by individuals, when authorized, to various common services across the University.

In order to begin identifying the elements of this new technology architecture, begin the coordination of NBA-related technology projects in a collaborative manner, and begin to identify the complex process for deployment of new NBA technology components, an NBA Technology Planning Group² (NBA-TPG) was formed. As its first product, this document identifies the major initial components of a technology architecture that will form the foundation for all NBA technology-enabled projects. It further recommends which projects should be undertaken in a collaborative multi-campus manner in order to create the system-wide IT foundation required to meet the broad goals of the NBA as outlined above.

² See Appendix A for the working group membership.

This report does not touch on the institutional or policy issues that may also need to be addressed if the NBA is to be successfully deployed. It does not deal directly with recruitment or retention issues or performance management. However, the technology infrastructure recommendations may help inform and support initiatives in all of these other important areas.

This initial identification of IT architectural components should not be seen as an exhaustive list but rather as the first set of clearly identified foundational projects. The NBA-TPG recommendations include implementing them as soon as possible and in a manner that will contribute most effectively towards the goals of the NBA.

New Technology Architecture

The overarching vision of a technology architecture supporting the NBA is of a full range of highly efficient business applications supported by a set of common infrastructure services and standards for easy information flow among the applications. The goal is to support streamlined operation, management, and reporting while distributing responsibilities, minimizing duplication of effort, and increasing job satisfaction.

All business applications require authentication of users that constitutes assurance that an individual using a resource is who they say they are or have the affiliation or role they say they have. A common authentication methodology supported by highly reliable digital credentials will simplify management of access to these applications and minimize the overhead users face in gaining access and reduce the number of different means of authentication supported throughout the University today. In addition, various applications may require different levels of authentication. For example, in certain cases retrieval of restricted information may require that a user be in a University role that makes them eligible for such access – specific user identity is not required. Therefore, directories associated with UC digital credentials are necessary in order to provide reliable information about each persons affiliations, roles, and responsibilities.

To support the needs of the NBA, UC digital credentials must be sufficiently trustworthy so they can be used to validate transactions with external partners such as government agencies, vendors and contractors, and other research and education institutions. In order for this to function appropriately, we need an “attribute server” that will provide a standard method for internal **and** external applications to request additional information about UC credential holders while

assuring that private and confidential information about individuals is not released inappropriately.

Digital signatures are necessary to prove the validity of certain types of digital transactions between organizations, for example, electronic purchase orders. This can streamline business processes while retaining appropriate workflow, approvals, and auditability. The purpose of any signature is to bind a personally identifying mark to a particular set of information. The UC digital credential technology referred to above also can be used to create reliable digital signatures. Digital signatures applied to internal University transactions can eliminate the need for paper and ink documents.

University financial management requires accurate and timely reporting of complex data from many sources. New technology to enable ready exchange of information reliably among a variety of applications can streamline both routine reporting and *ad hoc* data analysis. Purchasing systems can feed information into general ledger systems, inventory systems, and accounts payable systems. General ledger systems on different campuses can feed information directly into consolidated corporate reporting systems as well as into departmental management support systems.

The NBA report identifies the need to provide more flexible reporting tools and reporting capabilities. Data warehouses, the first generation of which exist at many campuses, are key to achieving this objective. Operational system data must be transformed and normalized in data warehouses to support the use of intuitive, easy to use reporting tools that can provide powerful analyses and other *ad hoc* reporting. Where data warehouses exist, they need to be updated or rebuilt to support modern reporting tools and related technologies. At those campuses where data warehouses do not exist, they need to be implemented.

The use of "portal" technology to integrate user access to many different business support systems will simplify job performance and improve the training of staff, making their jobs easier, and improving controls. Portals will make use of UC digital credentials to identify users and make use of standardized information exchange to enable the portals to present information to the user in a consistent manner. The user will be able to tailor their "portal" to streamline their job responsibilities such as accounting, purchasing, calendaring, e-mail, and so forth. Content management systems that are components of portal architecture will ensure both availability and appropriate management of information.

Once the basic infrastructure services described above are established, additional services and technologies may be developed that build on the basic services to

provide additional functionality. An on-line digital notary service would attach a University recognized data and time stamp to digital documents to verify their existence and state as of the date of notarization. Digital document archives would use the notary service and digital signatures of the archive managers to streamline the process of preserving accurate digital records and making them available. Automated workflow could make use of roles information to direct the processing of University business, making more efficient use of personnel and ensuring that transactions are handled in the proper order and in a timely manner. Data encryption standards and technology could help ensure the privacy and security of data exchange both within the University and with external partners. Expanded access to documentation, policies, and operational information integrated with portals and/or business applications could enhance staff performance as well as improve the training and learning process. These additional services are described further in Appendix B.

Essential Components of NBA Technology Infrastructure

Exhibit 1, attached, illustrates essential components of a technology architecture to achieve the goals of the NBA. While the NBA-TPG feels strongly that each of these components is required, over time this architecture will be refined and updated and additional components will be added. Given that UC is embarking on an NBA initiative more forward looking than any that is in existence in higher education today, it is not realistic to make completely definitive statements about all the technology components or the size of the investments needed to achieve them. Instead, it is our current goal to build upon what we do know and what initiatives are already underway both within UC and the IT industry.

A ubiquitous, robust, and high capacity data communications network is the fundamental enabling component of a distributed information technology architecture. While the University has invested a great deal over the last 15 to 20 years in campus network as well as wide area network infrastructure, continued enhancement of network capacity and robustness is required, for example to support new bandwidth intensive technologies that will support just-in-time e-learning or e-training for the NBA.

In addition to the existence of a reliable communications network, a number of common infrastructure services are necessary in order to support the wide variety of NBA applications and services. These include common authentication services, data interchange standards, content management capabilities, data warehouses, e-training capabilities, and integrated access to NBA systems.

Infrastructure services may be inter-dependent as well. For example authentication and directories each may be implemented in a number of ways but require each other in order to be effective.

The major initial information technology architecture components recommended by the NBA-TPG are described in the following section. Some additional components that should be addressed in the near future are identified briefly in Appendix B.

1. Authentication and Directories

A common strong digital authentication methodology in conjunction with centrally managed, campus-wide directories provide an important foundation for the deployment of various NBA projects. Digital credentials can provide a reliable reference to a known individual. Directories provide the important information about that individual such as common name, affiliation and status with the University, University roles, and possibly job related responsibilities. Making such information accessible to a variety of services or applications is critical to implementation of business portals.

Over time, well designed and reliable digital credentials can replace many of the system-specific authorization methods in use today thereby improving security and easing the burden on users who now must remember many different passwords. In addition, applications that may require additional information about the user, for example campus address or affiliation, can retrieve accurate, up-to-date information automatically from the associated directory.

Authentication and directories are essential components of systems for providing "single sign on" services through business portals. Attributes retrieved from directories, for example, can serve as the basis of portal customization and eligibility for services. Eventually, roles based authorization might supplant the need for User-specific authorization for many purposes thereby streamlining management of access controls. Roles-based access management will result in more uniform administration of various systems of authorization, based on information the University stores on individuals, reducing the effort systems administrators and others spend to manage access to data and services.

Digital credentials based on Public Key Infrastructure (PKI) are already being made available to members of the UC community. These credentials also can form the basis for trustworthy digital signatures and, eventually, data protection through encryption. University business processes can make use of digital

signatures to ensure auditability of critical transactions, both within the University and with external partners.

In order to assure the availability of common authentication services and uniformly accessible campus directories, the following should be undertaken:

- Adaptation of existing business applications to make use of UC Common Authentication digital credentials in support of “single sign on” portal access.
- Implementation of campus-wide directories, containing data associated with each member of the University community and linked with their digital credential. Such directories already have been initiated at some campuses. Where not implemented, campuses must proceed to implement directories. These will support the simple use of digital credentials but must be expanded and enhanced to include roles and responsibility information as well.
- Development of on-line systems to support broad-based eligibility and access management systems, based on University affiliation. Such systems must utilize existing databases and new or existing rule-sets in support of roles-based authorization and access control to a variety of resources available through web browsers and portals.
- Implementation of Attribute Servers. Access to external resources and vendors through the use of UC digital credentials will require controlled release of attribute information about credential holders. This can be achieved with Attribute Servers that manage access to University directory information, can apply University business rules to determine what information may be released, and can log such releases. E-commerce contracts and contracts for the use of external resources should require that vendors recognize and make appropriate use of UC digital credentials, including checking for authorized roles and responsibilities via a local UC Attribute Server.

Campus business and technology staffs need to agree upon a minimum set of common attributes that must be included in each campus-wide directory. Standard definitions for the syntax and semantics of these attributes must be developed. Campuses that have developed campus directories already are sharing their work with other campuses in order to reduce costs of common directory development across the University and to reduce the time necessary for deployment on all campuses. However, software and servers of sufficient capacity must be deployed on every campus in order to support this vital service.

2. New Technology and Standards for Data Exchange

Improving access to financial data and reducing workload associated with exchange of financial data will require common methods of defining and exchanging such data across University systems. This strategy will streamline financial reporting as well as enable the most effective use of portals.

The new business architecture report recognizes that costly implementation of new financial systems is not the best means of assuring easy access to data for reporting and decision making. As the commercial sector has discovered, the use of new technologies to link together disparate systems is a more cost effective and quicker means of achieving data integration for reporting and analysis. Towards that end, the NBA-TPG recommends that Extensible Markup Language (XML) standards be adopted to integrate financial system data across the University. Industry developed schema should be used where available but extensions and new schema may need to be developed as well.

In order to implement XML data exchange across University systems, the following should be undertaken:

- Identification or development of standard XML schema or Document Type Definitions (DTDs) for UC financial data and business transactions;
- Development of a pilot implementation to provide easy, managed access to financial and transaction data from around the University;
- Development of a plan for providing ready access to all University business data in a manner that provides for consistent presentation for reporting and analysis.

3. Business Portals and Content Management

Central to the NBA recommendations is implementation of portals at each campus:

To simplify our current environment and improve productivity, the portal will provide seamless integration across all University assets and resources. It will allow staff to quickly find the information needed to do their jobs. All necessary tools will be provided to perform business processes and transactions. And most important, self-directed orientation and training will be available to allow for just-in-time learning and knowledge creation.³

³ UC2010, page 9

Business portals can serve as the underlying platform for integrating and tailoring the tools that are needed in order to improve effectiveness and productivity in the work environment. Deployment of this technology itself will be dependent on supporting IT services and new on-line information flows as described above.

Important to the adoption of portal strategies at each campus is consideration of the decentralized nature of UC operations and the need to integrate portal functions, services (including academic and business), and data from across the campus and University for the particular customized portal presentation to each University community member. Common channel definition is recommended as a means of enabling such integration.

UC policies need to be rewritten and simplified and training on policy and procedures needs to be incorporated into University portals. This will provide University community members with training information as well as ready reference whenever they need it.

In order to implement business portals in the most cost effective and expeditious manner, UC should undertake at least the following:

- Acquisition or development of robust, flexible and interoperable portal technology. The exact product selection, and development or acquisition strategy cannot be identified at this time. However, the recommended project in this area should consider the use of:
 - the Java in Administration Special Interest Group (JA-SIG) uPortal⁴;
 - the multi campus licensing of particular commercial portal technology; and
 - the development of UC-specific technology.
- Acquisition or licensing of common Content Management software for portals. Selection of such software must make the same considerations as those associated with portal acquisition above. Collaboration across the campuses should occur on the identification and selection of such software. Opportunities to obtain favorable, multi-campus purchases should be exploited.
- Acquisition or licensing of E-learning technology . Selection of such software must include the same considerations as above and provide for integration with Content Management software to be able to provide just-in-time context sensitive training.

⁴ See <http://mis105.mis.udel.edu/ja-sig/uportal/>

The Path Forward

Definition, acquisition and deployment of all of these initial IT components may take at least several years to accomplish. However, the foundations have already been laid for some of the most critical ones. The NBA-TPG recommends building on existing projects as expeditiously as possible while continuing planning efforts towards realization of the additional IT services and capabilities to transfer higher volumes of transaction and reporting data.

Appendix C provides a more detailed set of initial projects to be undertaken, an estimated timetable for their completion and general estimates of costs for these initiatives. Given the preliminary nature of the definition of these projects, these costs should be considered only as general guides at this point. These costs will be refined once better definition of the projects and, in some cases, available software surveys, are completed.

To assure that resulting NBA components are interoperable and that the University is being as frugal as possible in investing funds in NBA technologies, it is recommended that a Technology Support Fund be established to underwrite the cost of NBA technology projects where there is multi-campus collaboration, consideration of use at more than one campus, and direct benefit to the NBA.

In order to initiate work on these activities, it is recommended that a fund of \$1 million be established to cover the direct costs of incremental dedicated staff to further refine needs, identify and analyze products and other potential solutions.

Appendix A

NBA Technology Planning Group

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Appendix B

Additional Infrastructure Components

Areas for further future investigation as part of the standard UC NBA architecture include:

- Development of a Digital Signature standard for UC and technology to supports its broad use across the University;
- Definition of data encryption standards and their appropriate use as well as policies necessary to ensure business continuity when critical data is encrypted;
- Development of a standard policy language for rule-sets in support of roles based authorization and access control;
- Deployment of an on-line “digital notary service” for University documents;
- Definition of standards and policies for deployment of an on-line digital archive for electronic documents;
- Availability of Policies and processes on-line and linked to applications as appropriate.
- Identification of automated workflow servers and tools

Appendix C

Proposed NBA Technology Projects and Timetables

Timeline to Establish Directory at Each Campus

	Months 1-3	Months 4-6	Months 7-9	Months 10-12	Months 13-15	Months 16-18	Months 19-21	Months 22-24
Focus/Planning								
<ul style="list-style-type: none"> ■ hire technical lead 								
<ul style="list-style-type: none"> ■ form participating committee with representatives from each campus 								
<ul style="list-style-type: none"> ■ establish solution principles 								
Design Solution Details								
<ul style="list-style-type: none"> ■ define comon elements 								
Build and Test								
<ul style="list-style-type: none"> ■ each campus to implement instance of Directory with at least common elements 								
Deploy								
Enhance								

Timeline for UC Common Authorization Methodology

	Months 1-3	Months 4-6	Months 7-9	Months 10-12	Months 13-15	Months 16-18	Months 19-21	Months 22-24
Focus/Planning								
■ hire lead technical analyst	■							
■ outline needs, principles, and standards		■						
Design Solution Details								
■ identify and evaluate alternative technologies		■	■					
Build and Test								
■ install in pilot at one site				■	■	■	■	
Deploy								
■ deploy for one or more applications								■

Timeline for UC Financial Data Exchange Pilot

	Months 1-3	Months 4-6	Months 7-9	Months 10-12	Months 13-15	Months 16-18	Months 19-21	Months 22-24
1. Focus/Planning								
■ hire lead staff	■							
■ identify pilot campus		■						
■ identify application area to be piloted		■						
2. Design Solution Details								
■ identify schemas/DTDs		■						
3. Build and Test								
■ build XML exchange for application area			■	■				
4. Deploy								
■ production use of XML for exchange of data with first application at pilot site					■			
5. Subsequent Campuses								
■ repeat steps 1 through 4						■	■	■

Timeline for UC Portal

	Months 1-3	Months 4-6	Months 7-9	Months 10-12	Months 13-15	Months 16-18	Months 19-21	Months 22-24
Focus/Planning								
<ul style="list-style-type: none"> ■ hire technical lead ■ establish technical requirements, consider alternative solutions, ■ define UC-wide protocols and standards for presenting data and for integrating applications/data across campuses, between campuses, and between campuses and UCOP ■ draft RFP if necessary 								
Design Solution Details								
<ul style="list-style-type: none"> ■ consider and select means of integrating with legacy and "open" systems 								
Build and Test								
<ul style="list-style-type: none"> ■ install with delivery of content 								
Deploy								
Enhance to integrate one application								

Preliminary Cost Estimates to Establish Directory at Each Campus

Project	Year 1	Year 2	Total
Establish Directory at Each Campus			
<ul style="list-style-type: none"> ■ 1/2 UCOP FTE ■ System and service support costs -- \$250K/campus per year ¹ 	\$50,000	\$50,000	\$100,000
	\$2,500,000	\$2,500,000	\$5,000,000
Total ²	\$2,550,000	\$2,550,000	\$5,100,000

¹ UCSC estimate ~\$400K for their directory project; UCSB estimate ~\$500K (includes 3FTE)

² preliminary estimates -- costs to be refined by 10/10/01

Preliminary Cost Estimates to Establish Common Authorization Methodology

Project	Year 1	Year 2	Total
UC Common Authorization Methodology			
<ul style="list-style-type: none"> ■ 1/2 UCOP FTE ■ software costs -- \$450K per campus one time plus maintenance ¹ ■ Campus FTEs -- 1 per campus (\$100K/FTE) ² 	\$50,000	\$50,000	\$100,000
	\$4,500,000	900000	\$5,400,000
	\$1,000,000	\$1,000,000	\$2,000,000
Total ³	\$5,550,000	\$1,950,000	\$7,500,000

¹ UCI estimates cost of Netegrity Siteminder tool at ~\$350K per campus plus installation and on-going support

² UCSB estimates +1 FTE for on-going support

³ preliminary estimates -- costs to be refined by 10/10/01

Preliminary Cost Estimates to Establish Financial Data Exchange Pilot

Project	Year 1	Year 2	Total
UC Financial Data Exchange Pilot			
<ul style="list-style-type: none"> ■ 1/2 UCOP FTE ■ Campus FTE ¹ ■ software costs 	\$50,000	\$50,000	\$100,000
	\$25,000	\$25,000	\$50,000
	na	na	
Total ²	\$75,000	\$75,000	\$150,000

¹ estimate 1/4 FTE

² preliminary estimates -- costs to be refined by 10/10/01

Preliminary Cost Estimates for Initial Portal Implementation

Project	Year 1	Year 2	Total
UC Portal			
<ul style="list-style-type: none"> ■ 1/2 UCOP FTE ■ Campus FTEs -- \$500K per campus per year ¹ ■ \$200K per campus cost to acquire portal ² ■ \$30K per campus yearly maintenance cost ³ 	\$50,000	\$50,000	\$100,000
	\$5,000,000	\$5,000,000	\$10,000,000
	\$2,000,000		\$2,000,000
	\$300,000	\$300,000	\$600,000
Total ⁴	\$7,350,000	\$5,350,000	\$12,700,000

¹ UCSD had 5 FTE developing content for their business portal; UCSB estimates minimum 2 FTE

² UCSD had \$200K start-up costs including licensing

³ assume 15% yearly maintenance fee on purchase of software

⁴ preliminary estimates -- costs to be refined by 10/10/01