

**An
Information Technology
Architecture
for
Emory University**

**Document 1:
Emory Priorities and
Architectural Requirements**

*Approved by CIRT
1999-2000*

Committee on
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1. Summary

The impact of Information Technology (IT) on the life of the University continues to grow. On the one hand, IT has already enabled us to pursue our mission in new and better ways and presents opportunities for further improvement. But on the other hand, IT creates the potential to disrupt our lives when critical systems fail or when the technology isolates us from one another. Moreover, in a time of constrained budgets the increasing amount of money being invested in IT causes great concern. New systems are constantly introduced by Schools and Divisions of the University, more staff time is devoted to IT support, and tens of millions of dollars are spent every year.

In such circumstances, we must develop (and follow) a set of guidelines for acquiring new IT resources and deploying them in a consistent and cost-effective way across Emory. Whether or not we adopt University guidelines of the types proposed here, IT will continue to change and we will continue to invest money in it. Because of the costs, in terms of both time and money, we should attempt to get the most benefit to the University from them.

As we develop such a set of guidelines (called an "Information Technology Architecture", a phrase discussed below), we can build on work that has already been done in setting some standards, defining some policies, and introducing new systems. The time has now come to pull this ad hoc work into a framework, and make some Emory-wide decisions about how we will go forward.

Agreeing on our priorities, and approving an architecture consistent with reaching those priorities, do not in themselves constitute a decision to spend money. (Indeed, having a set of policies and standards should contribute towards controlling costs.) Instead, creating an architecture sets some technology directions that we can travel together and provides a framework within which we can make cost-benefit decisions about new expenditures of money and time.

Even then, sudden, unpredictable, but inevitable, changes in the environment will afford exploitable opportunities that we had not considered in forming our previously stated priorities. We need to be prepared to perceive those opportunities, and know how we can mobilize ourselves to exploit them. One goal of the architecture is to create an environment that can support our priorities today and respond quickly to take advantage of the opportunities of tomorrow. How fast we can afford to move towards our priorities and take advantage of opportunities is another matter, which the University leadership can decide as approval is sought for specific new projects.

Agreeing on a set of common policies and standards would result in a more flexible environment in which our systems work together, our information resources are easily accessible, we can respond more quickly as circumstances and needs change, new implementations take less time, the cost of support is limited, and everyone understands the technological direction in which we are heading. This last point is important as our environment becomes more complex, and as units of the University deploy their own systems to deal with their own particular set of needs.

Accordingly, the Provost has chartered a committee chaired by Dean Hunter to lead the process of developing such a set of guidelines. The committee's membership and charter, the process to be used, and progress so far, are all described in this document.

2. Introduction

A long-range vision of the Emory Information Technology environment

A comprehensive information technology architecture must support the education, research and service missions of the University efficiently and effectively. We envision ultimately an architecture that will allow all members of the University¹ community to easily access and use information regardless of location or time.

Because the widely varying technologies and infrastructures worldwide and the financial resources available to the University impose certain limits, an architecture that will knit together students, faculty and staff throughout the world seamlessly is a vision for the future. The architecture developed for the near term, however, should be consistent with that ultimate goal.

We envision an architecture that is simple to use and that facilitates exchanges of information across all segments of the University. The architecture should provide for the protection of private, confidential and proprietary information, but the necessary security protections should still allow easy access, free flow, and the regular updating or correction of data. The architecture we envision will include sufficient diversity and redundancies to avoid disruptions of service. The architecture will include systematic upgrading, replacement and repair of hardware and software and will provide the necessary means for the University to take advantage of external technologies.

Further, we envision an architecture that is designed to respond to the multiple and varying needs of members of the University community and that simplifies exchange of information and access to information across unit and usage boundaries.

Finally, we note that the IT architecture is not an end in itself but is simply a means to improve the ability of members of the University community to pursue our educational, research and service missions. Therefore, the architecture itself should be unobtrusive to the ordinary users.

Why does Emory need an Information Technology Architecture?

Information Technology has now become a pervasive, mission-critical and extremely expensive part of the life of all major research universities, Emory among them. Because of its importance and cost, we need to seek ways to ensure that our use of IT is efficient and effective. Because of the rapid rate of change in the technology, we also need to avoid making choices that will lock us into hardware and software that will soon be obsolete.

An IT Architecture developed specifically for Emory University would address these problems of rapid change and high cost. By IT Architecture, we mean a set of mission-driven policies, procedures and standards that guide our technology choices in the hardware and software we

¹ Here and in the remainder of this document we will mean by the "University" and its community the enrolled students and the employed faculty and staff of Emory University no matter where they reside, keeping in mind that education and research involving faculty and students of the Health Sciences also occur at Emory Hospital, Crawford Long Hospital, Emory Clinic, satellite clinics, the V.A. Medical Center, Grady Hospital and its buildings, and Emory West. The term "Emory" alone includes all its sites.

buy and that guide the way we use them. When properly implemented, an IT architecture ensures that our systems are compatible, that everyone can communicate and exchange information, that we do not waste money on re-inventing systems, that we do not waste time and effort on re-evaluating alternatives, that we take appropriate advantage of economies of scale in buying and using technology, and that we can change the IT environment as quickly as needed to meet changes in requirements. While standards for desktop hardware and software play a part in IT architecture, other issues (network protocols, security, application development tools, etc.) are equally important, and need to be built into a compatible framework that operates smoothly – i.e., into an “architecture.”

An example of how “IT architecture” affects our ability to achieve our mission may be helpful. Emory encourages interdisciplinary work between departments. This type of work requires faculty to be able to share documents with one another. They typically do this by sending the documents to each other as email attachments. For this approach to work, several architectural elements must be in place: a common network connecting the departmental networks, all using compatible protocols; compatible network security systems; compatible email systems; and standards for file formats. Not all of these are in place everywhere at Emory today, so the lack of “IT architecture” means that there are unnecessary barriers to interdisciplinary research.

A second example: technology currently exists by which faculty (and staff) can work simultaneously on a document even though they are in different locations—talking to each other while jointly editing a document, sketching ideas, calling up research information, and so on. When individual faculty want to work together, they must find the technology pieces (or get their School IT staff to do so), get them installed, and hope the necessary hardware and software can be added to the network without disrupting everyone else. Thus, we could end up with a variety of systems in place connecting particular individuals, probably at a higher-than-necessary cost. The “architectural” approach would be to identify this as a strategic need and have a (single) group of people look at solutions that work widely across Emory and that fit the desired IT architecture. The Architecture Committee—with extensive input from the widespread Emory community—would develop consensus on an approach, and establish a set of guidelines. Then people who want to work together could implement the technology knowing that it would work across the community – and knowing what the initial and support costs were likely to be. There will always be exceptions for people with special needs, but if we used IT guidelines for even 80% of cases we would significantly improve our technological environment.

The question of standardization is a difficult one in a research university, where IT needs differ widely, and (even more important) where much of the strength of the institution comes from the freedom of its individual faculty to work in innovative, divergent, unconstrained ways. A successful architectural process must be one that identifies what things should be built into a common infrastructure, and what things must be left to faculty choice. The faculty benefit when IT functions smoothly and transparently. “Distributed” is good – closer to the users, more attuned and responsive to their particular needs. But “balkanized” is bad – people isolated from each other, spending too much time and money on re-inventing wheels that won’t work outside their own unit. An effective architecture will balance these competing tendencies, and during later stages of this process, we will discuss ways to achieve that balance.

Process for developing Emory’s IT architecture

To address Emory’s need for an IT architecture, the Provost has chartered an IT Architecture Committee, chaired by Dean Howard Hunter, consisting of Steve Kraftchick (Theology), Don

Corcoran and John Mason (alternates, Network Communications Division), Chris Alexander and Belinda Maaskant (alternates, School of Public Health), Lance Basler and Joe Medley (alternates, Healthcare IS), Peter Day (ITD), Myra Frady (Oxford College), Martin Halbert (Library), Walt Hultgren (Yerkes), Barbara Maaskant (Chair of ITDAC) and Prof. Benn Konsynski (alternates, Business School), Carole Meyers (Emory College), Don Harris (ITD), Rosalie Sanderson (Law School), and Stephen Warren (Medicine).

The IT architecture Committee has been asked to lead a process to create an IT architecture for Emory, ensuring that the results are consistent with the priorities of the University as a whole. Through the IT architecture, we aim to create the environment envisioned earlier in this section, where IT decision-making facilitates integration, is tied to University objectives, and responds quickly to a changing environment. The Committee serves as a bridge between the needs of the university and the realities of the technology environment that supports those needs. The primary focus is on the University, including the Health Sciences Schools, but we will also ensure that our work is consistent with similar architectures in Emory Healthcare.

The committee is following a process provided by a consulting company named META Group. The process consists of six distinct phases:

- Phase 1 (Startup) is complete.
- Phase 2 (Requirements): This phase, which is now complete, articulates a vision for IT at Emory (Section 2 of this document), Emory's strategic priorities (Section 3), and the information required to achieve those priorities (Section 4). It then identifies the requirements of the Architecture (Section 5) and surveys the technology trends likely to affect us (Section 6). Finally, it identifies the next steps (Section 7), which are:
 - Phase 3: Define the conceptual architecture
 - Phase 4: Specify the policies, procedures and standards for each of the "domains" (applications, data, desktops, etc.)
 - Phase 5: Analyze the gap between our desired future architecture, and where we are now
 - Phase 6: Design and implement plans to close this gap, moving towards the desired state (which itself will evolve over time, making this a continuous process).

We expect the first iteration of the process through phase 4 to take most of the year 2000.

During this process we will circulate draft documents for discussion to elicit community reaction. We will revise the draft based on feedback until we reach consensus on its content. The current Document 1 is the first one of such documents. Its adoption concludes the second phase. Appendix 1 describes the plan that we are using to communicate with the community about this and subsequent documents.

3. Moving Emory Forward

In this section, we will outline the major forces to which Emory must respond as it seeks to move forward in fulfilling its mission. The results will be used to motivate Emory's strategies and priorities for moving forward. The discussion in this section and the resulting strategies and priorities is based on a series of documents produced in the past six years: *Choices and Responsibility (C&R)* (1994), *Teaching at Emory* (1997), *Internationalizing Emory* (1997), *A Vision for Emory* (1998), *Strategic Plan of the Woodruff Health Sciences Center* (1998), and the *Provost's Letter to the Faculty* (November 1999).

The Emory University Mission

Emory is a relative newcomer to the ranks of the major research universities, with a tradition of strong teaching and research on the one hand and resources that have grown remarkably over the last twenty years on the other. Emory is also distinguished from other higher education and research universities by the way in which it pursues teaching, research and public service.

To quote from the Emory Mission statement: "Emory University's mission lies in two essential, interwoven purposes: through teaching, to help men and women fully develop their intellectual, aesthetic and moral capacities; and, through the quest for new knowledge and public service, to improve human well-being. These purposes rest upon the premises that education is the most powerful social force of our time for enabling and ennobling the individual, and that the privilege of education entails an obligation to use knowledge for the common good.

"...While Emory is a comprehensive university, its academic scope is limited to those fields in which, by virtue of history, location, or other circumstance, the university can excel and has a special responsibility. Thus, Emory's academic programs focus principally on the arts and sciences, business, law, theology, and the health professions. This constellation of disciplines is unified by their dependency upon liberal learning; by cooperative interdisciplinary programs; and by the common goal of excellence in research, teaching, and service.

"...Understanding its mission to have life and meaning only as it is embodied in a community of scholars, Emory strives to bring together outstanding faculty and students in a nurturing and challenging environment.... Beyond the demand that teaching, learning, research, and service be measured by high standards of integrity and excellence, the university aims to imbue scholarship at Emory with certain special qualities, including:

- a commitment to human teaching and mentorship and collegial interaction among faculty, students and staff;
- permeable disciplinary boundaries that encourage integrative teaching, research, and scholarship;
- a commitment to use knowledge to improve human well-being; and
- a global perspective on the human condition.

"Emory University was founded by the Methodist Episcopal Church, and it continues a cherished affiliation with the United Methodist Church. While its programs are today entirely non-sectarian (except for the School of Theology), Emory has derived from this heritage the conviction that education is a strong moral force in society and the lives of its individual members. It is that conviction, above all others, that guides Emory University today."

Emory continually reviews its academic priorities in the light of change. These changes, driven primarily by Emory's desire to advance its development as a research university while improving the education of its students, will profoundly affect the need for and use of information technology at Emory.

External forces affecting Emory

Emory must respond to several external forces over which it has little direct control. They include competition, regulation, legislation, globalization, customers, suppliers, partners, the job market, the economy, and technology trends and developments. For Emory the primary external forces for change are (in no particular order): (i) increasing competition for the best faculty and students, (ii) rapid changes in information technology, (iii) changes in the needs and demographics of the potential student population, and (iv) changes in the financial climate.

Emory now competes with the nation's leading research universities. These institutions use IT to enhance their reputation and competitiveness for grants and to attract the best faculty and students. To compete, Emory must offer comparable IT and other resources and a comparable intellectual climate. As IT advances, faculty, staff, students, alumni, and parents expect institutions of higher education to use IT to enhance their teaching, research campus life, and overall operation. New types of universities are also changing expectations. Enabled by advances in networking and communications, these new competitors challenge the residential college model by connecting students and faculty electronically to form virtual classes and communities.

These advances in IT, along with the changing needs and demographics of the students, will in particular affect teaching. As *Teaching at Emory* notes: "Innovations in the digital environment may well result in radical changes in the production of knowledge, the processing of information, and the nature of pedagogy. Nonetheless, responsible choices will have to be made about how Emory makes use of technological innovations. The digital environment is not the only area in which changes will occur. Teaching will continue to change with the increased diversity of the student and faculty populations and the evolving demands of the various professions."

The student population is indeed changing. According to the National Center for Education Statistics, by 2001 nearly 42 percent of the nation's 15.7 million students in higher education will be over 24 years old. A new wave of college students is expected to arrive at the nation's universities between now and 2009. By 2010 the population of 18-19 year olds will be one third larger and will be more diverse. The new century students will have greater expectations about what the curriculum will do for them, but yet will have uneven or insufficient preparation. They are moving away from a single learning model; instead, they want to learn at their own pace, where and when they want. This digital generation will be experienced with sophisticated technology and robust media. They will want an interactive learning experience and will expect reliable delivery of services beyond the current capability of most institutions. These expectations will influence the way faculty teach and will require new and more sophisticated information.

The way the university responds to changes in IT will affect its reputation and its ability to attract students. Once there were only a few groups (such as *U. S. News and World Report* and AAUP) that ranked educational institutions. Now the World Wide Web makes possible dynamic rankings based on student opinions (see, for example, deja.com) and provides easy access to rankings and comparative data.

Finally, Emory will be affected by the financial climate. Emory's endowment provides a large component of Emory's income, but the prospect is for slower growth. At the same time, salaries are a large component of expenses, and they must continue to be maintained at a competitive level. Yet parents and students are increasingly unwilling or unable to pay large increases in tuition.

Internal forces affecting Emory

Internal forces include Emory's values, organizational structure, culture, management needs, operational needs, IT competencies, economics, and the existing IT infrastructure. The primary forces for change that will affect the IT environment come from the diverse sources of leadership within the university, from the autonomy of the units to make IT decisions, and from the growing sophistication and complexity of the information technology needed by scientists.

Emory's strategic priorities since 1994 have been to increase research program excellence, teaching excellence, intellectual community, interdisciplinary scholarship, and internationalization. In 1998 the Emory Council of Deans emphasized the advancement of Emory's development as a research university and improvement of Emory's education of its students. To further these goals, two priorities of the Provost are to strengthen intellectual connections among Emory scholars and find ways for ideas and intellectual energy to flow freely across boundaries within Emory and between Emory and other institutions, both domestically and internationally.

In pursuing its priorities, Emory has the advantage that it is still evolving. As noted by President Chace in his introductory address to the faculty (*C&R*, p.1), Emory still has "the power to change, to alter its destiny, and to define an identity all of its own." Yet there are a number of forces making change difficult. Cross-unit information flow is complicated by the balkanized nature of many of the information systems on campus. This situation is partly due to a tendency to focus on projects and initiatives specific to departments, schools, and divisions, sometimes to the inadvertent detriment of the overall Emory IT environment.

Moreover, potentially useful data is going unused. Some of it is hidden due to being stored in disparate systems in multiple university units with no way of conveniently finding or accessing it. In other cases, security measures and access controls that are specific to systems rather than individuals or groups complicate access. For example, Medical faculty face problems as they move back and forth between the University and Healthcare networks because "course-grained" security makes access to resources on the other network difficult. Lack of a university-wide access control service creates problems for units or projects that seek to make information available to selected audiences, because they must individually implement their own access controls.

The information flow is further complicated because IT tends to be distributed across the units. While this has proven to be an effective structure to support a unit's unique needs, it has increased the complexity of managing the common infrastructure components. Even when unit needs can be addressed locally, it is difficult to support those needs quickly because the common infrastructure is so complex and access to modern application resources is limited.

The Emory Challenge

In light of all this, Emory must decide how to respond to the internal and external forces as it seeks to attain its goals and aspirations.

A major challenge is how to maintain balance and focus in the face of competing needs and requirements. For example, Emory must balance aspects of its mission while controlling costs. As the Provost explains in a letter to the faculty dated November 1999, "Declining growth in the endowment and inflationary pressures on costs are slowing programmatic developments needed to achieve Emory's advancement goals and creating a need to find improvements that can result in savings that can be used to fund new initiatives."

The Provost's letter also states the goal to advance Emory's development as a research university. An enhanced research environment will require cooperation among the researchers at Emory, along with better support processes, and the ability to act faster. As a result, Emory will need to be more deliberate in its use of IT to support University-wide initiatives across unit boundaries for the common good to foster University-wide process improvements and to promote the free flow of information.

Emory must also meet the challenge to support a global perspective on its research and teaching activities and on its recruitment, funding, and relationship with the extended Emory family. The global network of computers has made time, place, and distance irrelevant. Students and faculty may need to access information at any time and from any place. The spectrum of relations with students can range from classroom-facilitated learning to long-distance communication between and among faculty and students. Emory is already educating more and more students whose careers and life choices lead them outside the continental United States. In addition, Emory is increasing its focus on corporate and government funding resources and on student recruitment in the most prosperous cities overseas, such as those in the Pacific Rim. Along with degree-seeking and non-degree students, the schools within the university also have a variety of exchange students and joint-degree students, as well as a sizable group of former visiting faculty living abroad. As a result, Emory is challenged to maintain ties with thousands of people living in over 100 other countries. In addition, Emory will need management information generated in a form and distributed in a manner that makes the information accessible with the greatest ease and internal consistency, to anyone, from anywhere, at anytime.

Emory will need to pursue these and other university-wide initiatives without diluting the strengths of decentralization. Thus, Emory will need to maintain a balance between unit and individual IT autonomy to best meet unit and individual needs, and centralized systems and services to meet university-wide goals. In addition, the university must balance the need for specialists in the face of the accelerating growth of knowledge, and the need for experts to come together as fields of knowledge merge and solutions to problems increasingly require interdisciplinary approaches.

The information technology infrastructure can create an information sharing environment and synergy spanning individuals and units and supporting interdisciplinary approaches. Using international and university community standards, it can even extend globally. To be effective, consistent, and flexible, however, this information environment must be guided and driven by enterprise-wide information technology architecture serving as the roadmap for future technology deployment. A well-aligned IT architecture will provide the roadmap for future IT infrastructure development and for making IT tradeoff decisions, resulting eventually in a more flexible and responsive IT environment.

4. Emory's Strategic Priorities

Rather than hinder change as sometimes occurs today, IT will need to help Emory respond to external and internal forces and move forward toward what it wants to become and achieve. Although IT must continue to support existing systems, more critically, IT must be able to support the changes that Emory seeks. With this in mind, this section links areas of action for IT with Emory's strategic priorities.² A later section derives architectural requirements that will support actions in those areas. Since architectural requirements may not be immediately apparent, the analysis uses the intermediate step of deriving the information requirements to support each area.

In a letter dated November 1999, from the Provost to the faculty, Provost Rebecca Chopp articulated Emory University's strategic priorities. The letter indicates that for the previous year and going forward the goal of the University and Provost is to advance Emory's development as a research university by advancing faculty scholarship in all forms of research and teaching. This would be done using the following strategic priorities:

- ◆ Foster Emory's intellectual vitality—that is, Emory's power as a place for the discovery, integration, and transmission of knowledge, and Emory's determination to have others recognize this power;
- ◆ Strengthen the influence of faculty in the development of academic programs; and
- ◆ Reorganize or invent management structures to meet academic needs.

The letter stresses the use of two principal tools to advance the priorities: the budget process, and technological policies and their application. Both of these play into the need for IT architecture. Indeed, Information Technology can boost university priorities and advance the mission of the university in seven areas corresponding to strategies that Emory is using and is expected to continue to use. Conversations with senior members of the university leadership have confirmed the validity of these strategies. Under each strategy is a list of example initiatives to make the meaning more concrete and provide a basis for deriving information requirements.³ The linkage between the strategies and the priorities is given following the list of strategies. The strategies relate to academic excellence, structure and support of the academic community, internationalization, standing and reputation, and fiscal resources.

1. **Research Program Excellence: Improve Emory's prominence as a research university by increasing the number of excellent, preeminent and distinctive research programs.**

Choices to do this could include:

- Increase support for electronic research administration.
- Increase support for technology transfer.
- Create career development and evaluation programs for researchers.
- Design and support cooperative arrangements with other universities.
- Increase the fund for financial support of new researchers to help them produce results that will enable them to get external funding later.
- Create graduate and interdisciplinary post-doctoral training programs.

² The priorities address Emory Healthcare only insofar as they relate to the University Health Sciences. Healthcare clinical priorities and architectural requirements will need to be addressed elsewhere. Both architectures will need to address issues of interoperability between the University and Healthcare.

³ Implementation of these initiatives or others not listed here could potentially involve any of the many providers of information resources and technology as appropriate.

- Improve administrative support for research and clinical trial efforts so that researchers can do more with their time and create grant requests more quickly.
- Protect and maintain existing scholarly resources.
- Increase faculty recruitment and retention.

2. *Teaching Excellence: Demonstrate commitment to high quality teaching by increasing the support and status of teaching at Emory.*

Choices to do this could include:

- Link teaching excellence to recognition, reward, and advancement.
- Provide more complete information about courses and programs.
- Increase faculty time available to spend with students and on preparation by increasing administrative support.
- Improve teaching spaces and facilities, make it possible to schedule them on short notice, and make it easier to tell when they are in use.
- Develop additional spaces to foster learning and intellectual community.
- Increase support for media use including digital media.
- Protect and maintain scholarly resources.
- Provide resources for teacher training, including teaching with digital technology.

3. *Intellectual Community: Enhance the climate in which students, faculty, and staff can work and develop as individuals and help set direction and priorities by increasing the sense of intellectual community.*

Choices to do this could include:

- Begin including interest and support of the intellectual life of the Emory community in evaluations for admission, hiring, and advancement.
- Encourage collaborative teaching.
- Keep people better informed of campus activities, programs, and opportunities
- Provide a university-wide orientation program.
- Increase the number of the settings and forums in which intellectual community can occur.
- Adopt a unified calendar. This would create shared events.

4. *Interdisciplinary Scholarship: Meet the changing demands of today's research environment by increasing the amount of interdisciplinary scholarship.*

Choices to do this could include:

- Appoint more faculty with interdisciplinary interests.
- Provide alternative paths to allow students to pursue interdisciplinary curricula.
- Support students and faculty participation in interdisciplinary programs by establishing a uniform academic calendar, creating a campus-wide course atlas, facilitating cross-registration and joint-degree programs, and offering more interdisciplinary courses, seminars, and conferences.
- Make support of joint appointments among departments easier.
- Recognize and support contributions of faculty to programs outside their schools or departments.

5. *Internationalization: Achieve preeminence as an international research university by increasing the commitment to international research, teaching, study and service.*

Choices to do this could include:

- Coordinate existing programs that already make significant contributions to international scholarship and service at Emory and disseminate information about international activities on campus.
- Augment existing courses with international elements and develop new interdisciplinary courses on global and international issues and courses that place the United States in a global context.
- Sponsor conferences, symposia and colloquia dealing with international and global subjects.
- Strengthen partnerships with the Carter Center, CDC, CARE and other Atlanta-based institutions that have international missions.
- Upon return from an international experience, provide structured opportunities to reflect on the experiences, share it with others on campus, and contribute to scholarship in the area.
- Provide grants to seed cross-school and university-wide projects.
- Provide the Emory community with cultural sensitivity training as needed.
- Strengthen existing structures and create new ones that will enhance interdisciplinary scholarship in international and comparative subjects and increase foreign language learning and use by students and faculty.
- Create a comprehensive support system to ease the assimilation of international students.

6. *Emory's Standing and Reputation: Facilitate the way the world understands Emory and Emory's capacity to increase its prominence.*

Choices to do this could include:

- Improve the opinion voiced by students on web rankings and to prospective students by streamlining the processes to interact with Emory and obtain services and information, starting with first contact and continuing through admission, the campus experience (including instruction), and life as alumni.
- Improve Emory's position in often-referenced rankings (such as *U.S. News and World Report* and AUUP) by increasing Emory's ability to provide accurate, timely data.
- Increase the selectivity of admission using worldwide targeted recruitment to increase the number and diversity of outstanding applicants to Emory's schools.
- Increase the national and international visibility, name recognition, and image of Emory by increasing news media coverage that emphasizes the high quality of learning and teaching, important scholarship and research, excellence of students and faculty, and the services the University provides its constituencies.
- Improve the quality and accessibility of Emory's web site.

7. *Fiscal Resources: Increase available resources for new initiatives through increased funding, cost control and efficiencies.*

Choices to do this could include:

- Increase participation by alumni in giving to the university by increasing the number of programs that establish ongoing relationships with alumni.
- Increase the amount of giving by increasing the number of programs that establish ongoing relationships with alumni and foundations.
- Increase indirect cost recovery through increased grant awards by collaborating with other research institutions, by targeting areas where funding agencies are concentrating their money and by pursuing corporate and government funding sources outside the United States
- Develop products that can produce income from technology transfer and patents.
- Improve and automate background processes that support teaching, research, and clinical trial efforts to provide efficiencies and increase teacher and investigator time available for new initiatives.

Strategies 1, 2, 4, 5 and 6 (Research Program Excellence, Teaching Excellence, Interdisciplinary Scholarship, Internationalization, and Standing and Reputation) directly foster Emory's intellectual vitality. The third strategy, Intellectual Community, links with the influence of faculty in the development of academic programs and implementation of management structures that meet academic needs. Fiscal Resources, the seventh and final strategy, relates to using the budget process as a tool.

The above does not necessarily cover all of that to which Emory aspires. The university also aspires to:

- **Enrich the Student Experience:** Changes in the student experience are targeted to occur in intellectual community, interdisciplinary opportunities, the quality of teaching, internationalization, and streamlining of university processes from first contact through life as alumni.
- **Acquire Additional Research Space:** Changes here are covered under Research Program Excellence above.
- **Provide Public Service:** Public Service and university outreach are covered under "Standing and Reputation" within the phrase "the services the University provides its constituencies."
- **Enhance Network Connectivity to Support Teaching and Research:** Changes in connectivity are covered under Teaching Excellence and Research Program Excellence above under the requirement for access to timely, scholarly information located anywhere in the world. In addition, network connectivity is an architectural requirement that will be addressed in a subsequent section (see Arch 14: on page17).
- **Increase Giving, Increase Revenue from Research, and Control Costs:** Changes in these areas and the information needed are covered under Increased Resources.
- **Improve Operational Support:** Improvements in this area, including efficiencies in administrative support, are mentioned under Teaching Excellence, Research Program Excellence, and Fiscal Resources.
- **Improve Access to Information:** This is an information requirement that is addressed later under each of the above strategies.

5. Information Requirements

This section lists the information requirements to support each of the strategic goals as an intermediate step to derive the architectural requirements. Each information requirement should specify what information is needed, who needs it, when it is needed (and how frequently), and from where access to the information is to be supported. If not otherwise specified, it should be understood that authorized members of the Emory community and its collaborators and partners may need access to the Emory network and the resources on it potentially from any place at any time. Since the world contains many remote places, true anytime, anyplace access may not be achievable in the current planning timeframe. However, the architecture needs to allow us to move toward anytime, anyplace access to the extent appropriate and feasible, even if the capability to do that is not immediately available.

The following is a general list of information requirements (in no particular order) to support the strategic goals of the previous section. These general requirements were derived by clustering detailed information requirements developed for each of the bullet points. A companion *Document 1-A: Derivation of the Information and Architecture Requirements* provides more detail about each one and shows how the derivation was done.

- Info 1: Increase the speed and ease of communications and access to information to support teaching and instruction and the administrative processes associated with them.
- Info 2: Preserve scholarly information and resources on campus.
- Info 3: Provide timely access to scholarly information and resources both on and off-campus.
- Info 4: Provide anytime, anyplace access to the Emory network and the resources on it by authorized members of the Emory community and its collaborators and partners.
- Info 5: Allow information to be shared with specific individuals or groups.
- Info 6: Provide faculty and administrators with the capability to collect and maintain information and documents, and to analyze and report information in support of faculty recruitment, development, evaluation, and retention.
- Info 7: Provide information to scholars on availability of and access to funding opportunities.
- Info 8: Provide information about scholarly and operational data and information available at Emory and off-campus with enough detail to assess likely suitability for an intended purpose, request or obtain access to it, understand its elements, and get help if needed. (Such data about data is called "Meta data.")⁴
- Info 9: Maintain timely operational information about projects, processes and transactions that allows monitoring and tracking their status.
- Info 10: Provide the capability to locate and access opportunities, personnel, and facilities within Emory.
- Info 11: Increase the speed and ease with which anyone can interact with Emory and access information about Emory's facilities, services, events, and accomplishments.
- Info 12: Increase the speed and ease of collecting and accessing information and data to assess the current state of Emory and progress toward goals.

⁴ There is now so much information available, and the volume grows so fast, that the concept of "metadata" has been developed – data that describes other data, such as where and how specific information is stored, how to access it, and then how to interpret it. For example, the results of an experiment may be stored on a particular server, in a particular file format, as a table whose rows and columns have specific meanings. All of this is "metadata" which is needed by someone wishing to use the experimental results.

6. Technical Architecture Requirements

The requirements for the technical IT architecture are intended to support and enable the Emory goals, strategies and strategic information requirements. A companion *Document 1-A: Derivation of the Information and Architecture Requirements* provides more detail about each one and shows how the derivation was done. In accordance with our top-down approach, the order of the requirements is approximately from the most general to the most specific. A sense of magnitude and time frame needs to be added to them to the extent possible.

Most generally, the architecture is meant to create an IT environment that can respond to Emory's needs, delivering required capability in the needed time frame. This leads to the first and most general requirement:

Arch 1: Facilitate change as quickly as needed in academic and administrative processes and the applications that enable and support them.

More specific capabilities derive from the goals and information requirements as detailed in Document 1-A:

Arch 2: Enable work flows to be quickly and easily implemented and integrated with already integrated systems.

Arch 3: Provide a standard facility to allow a system to be quickly and easily integrated with other already-integrated systems to allow exchange of information with them as quickly as the information becomes available.

Arch 4: Provide standard mechanisms that allow access to services to be extended quickly and easily as needed to allow access using new types of devices.

Arch 5: Provide the capability for custodians of data items, services and resources to easily authorize (and change) access to services and people inside and outside Emory, individually or by membership in a group.

Arch 6: Provide a capability to quickly document the existence of information, its attributes, meaning, use, and how to access it.

Arch 7: Provide strong security mechanisms to help protect systems, resources, information, data, and communications from disruption, corruption, and loss, as well as unauthorized access, use or disclosure.

Arch 8: Support storage, access and conversion of multiple types of data in multiple media and formats.

Types of data include numbers, text fields, textual documents, drawings, images, binary files, documents, audio, video, hypertext, etc.

Arch 9: Provide access from Emory's campus network to the commodity Internet and Internet2 using world standards for interoperation, communication and data access.

Although the more general requirement is for connectivity with networks readily accessible by the public worldwide, and for high-performance access to other research institutions, for the planning period those networks are the commodity Internet and Internet2, respectively.

- Arch 10: Enable rapid increases in the volume of information that will be processed by university-wide systems.
- Arch 11: Provide a facility for managing the storage and dissemination of increasing amounts of data at Emory that can handle rapid increases over the next 5 years.
- Arch 12: Support broad-based standards that will increase interoperability, communication and exchange of information.
- Arch 13: Provide the capability for services and resources to be accessible through the network by any authorized service, resource or person at anytime from anyplace.
- Arch 14: Provide a high-performance, fully transparent, flexible and reliable campus network that allows people, systems, and services to communicate and exchange information.
“High performance” implies high bandwidth, low delay, and small variation in delay. A “transparent” network does not require knowledge of its internals to use it. A “flexible” network can be quickly and easily configured or upgraded as needed. Communication includes one-to-one, one-to-many, and many-to-many. “Information” can include numbers, text fields, textual documents, drawings, images, binary files, documents, audio, video, hypertext, etc.

The tables in Appendix 2 show how the architecture requirements link to the goals through the information requirements.

7. Technology Trends

Information technology trends and IT market trends will fundamentally affect the way we implement systems to meet the above architectural requirements. We need to begin now to discuss the trends we will need to track. As a basis for our discussion of technology strategy, we must agree on key technological trends and on the ways they will affect Emory.

1. Hardware will get faster, cheaper, denser and more diverse.

- Computer technology will continue advance without a corresponding increase in price.
- Computer processors will become faster, and memory and disk storage will get denser approximately doubling every 18 months.
- Backbone network bandwidth technology will quadruple every 18 months.
- Consumer devices (cell phones, pagers, PDAs, etc.) with embedded computer technology will be widely used and less expensive
- The diversity of desktop and server operating systems will likely remain.
 - UNIX,⁵ Windows NT/2000, and mainframes will have long-term enterprise server roles. Sun, IBM and HP will be the market leaders in Enterprise UNIX servers.
 - VMS will continue to be important in Healthcare.
 - Microsoft will provide multiple operating systems targeted at enterprise servers, departmental servers, desktops, and handhelds.
 - Microsoft Windows operating systems and Intel hardware will be the dominant desktop systems. Macintosh will continue to be important in the education, publishing, and audio-visual markets. UNIX desktops will be important in certain fields and sectors.

Implications for Emory

- Customers will expect Emory to introduce new technologies and increase the performance and capability of its servers, networks, remote access, classroom-lab-dorm facilities
- We must decide how to send Emory data and information to consumer devices, such as class schedules sent to students' PDAs; "Today at Emory" news sent to pager and phone displays; online phone book available on hand-held devices; etc.
- Emory will have to continue to support multiple operating systems in an environment where desktop computers, servers, and consumer devices are ubiquitous.
- Technological capabilities may increase faster than funding is available to implement them.
- VMS systems will continue to be present in the university's data center.

2. Demand for capacity will continue to increase.

- Application requirements and user demand will continue to consume more IT resources (such as disk space, processing speed, and network bandwidth) due to:
 - increasing use of interactive, multimedia, and distributed database applications
 - increasing amounts of data made available, increasing sizes of data items (pictures, audio, video), and storage of data about data
 - increasing volume of E-mail and data transfers between applications

⁵ The use of the term "UNIX" here is intended to cover various flavors including Linux.

- increasing number of users with increasing amounts of usage
- Users will become more dependent on application, server, and network response and capability to complete their work (ex. "e-Commerce" exchanges for paying bills or transferring funds, making alumni donations, EmoryCard purchases, etc.)

Implications for Emory

- Emory's IT resources will become increasingly mission-critical and must continually be upgraded and expanded.
- Emory will have increased costs to manage the growth.

3. Demand for access to "anything" from "anywhere" will continue to grow.

- Applications, information, and data will become increasingly available over the web.
- Wireless technologies will be increasingly used and less expensive. Wireless networks will still be slower than wired networks.
- Cable modems, DSL, and similar technologies for home access to high-speed networking will be increasingly cheaper and more available, becoming offered to more than 50% of households by 2002. However, analog modems will continue to predominate through 2002.
- Convergence of voice, video, and data technologies over the same network will blur their traditional separation.

Implications for Emory

- Competitiveness in attracting students, faculty, and staff will increasingly depend on the level and quality of access Emory can provide to them.
- Faculty and staff at many levels will be challenged to become facile in the use of web-enabled technologies.
- Telecommuting and learning regardless of location will increase.
- Emory will be challenged to converge its telecommunications, video, and data networks to support demand for use of converged products.
- Emory must have sufficient server capacity and network capability to handle the storage, search, and delivery of all types of data.

4. Security will be a primary concern with increased dependence on network applications.

- Destructive hacking, viruses, denial of service attacks and similar problems will continue to grow.
- Authentication and authorization for use of network applications will be necessary. Userids and passwords will still be used. Biometric identification will become more commonplace. The available security technologies will change rapidly over the next three years.
- Data encryption will be more widely used in transmission and storage.

Implications for Emory

- Emory must be prepared to incorporate new identification technologies.
- Faculty, staff, and students must be educated in good security practices.
- Emory must ensure that its security infrastructure still allows cooperation and collaboration with other research and education institutions.

- Emory will be faced with continuing issues over intellectual property and copyright violations due to increased amounts of teaching materials and research findings available over the network.

5. IT expertise will continue to be scarce and its cost will continue to rise.

- System management and administrative costs will constitute an increasingly larger portion of the expense of systems over their lifetime than the purchase price of the hardware and software.
 - Using extra hardware to reduce system administration will be more cost-effective than attempts to minimize hardware through increased tuning.
 - There will be opportunities to reduce management costs through centralization.
 - IT staff will need to learn new skills at an ever increasing rate.
 - Increased specialization and distributed support will create the need for new specialties to provide a whole system view.

Implications for Emory

- Emory will need to find creative ways to attract technologically competent people, keep them, and use their time efficiently.
- Emory will need to calculate the cost of IT projects, services and resources using a total cost approach that takes into account all expenses over their lifetime.
- Emory will need to find a balance between the savings of centralization and the customized support of decentralization.
- Emory will need to compute the real financial costs of support, both central and distributed.

8. Next Steps

Phase 2

The purpose of phase two is to achieve a common vision among those representing Emory as an institution and those representing Information Technology at Emory. We have seen that the vision as articulated in the current Document 1 covers key Emory strategic initiatives, the information and IT requirements to support the initiatives, applicable technology and market trends and their implications for Emory's architecture. Pervasive throughout Document 1 is the role of IT Architecture in creating an environment that enables Information Technology to be efficient, effective, and responsive to Emory's needs.

Steps in Phase 2

1. Generating Document 1 was the first step toward that vision.
2. The next step used Document 1 and the Communication Plan in Appendix 1 as the basis for a dialogue with all the stakeholders in the vision. This was an iterative process in which we obtained feedback and refined the document until it was accepted by the Council on Information Resources and Technology (CIRT) and by University leadership. That acceptance concluded Phase 2.

Phase 3

In Phase 3, we identify a logically consistent set of principles (e.g., design systems that are easy to link together as components) to guide the engineering and operation of the desired Emory IT environment. Then we organize that environment into a small number of high-level categories called "Architecture Domains" (e.g. Network, Applications, Desktop). The principles and domains together form the "Conceptual Architecture." The conceptual architecture provides an overall organization based on common principles. In this way it facilitates an environment in which the parts work together more harmoniously, changes can be made more reliably, new systems can be integrated into the environment more easily, and new projects can use the common infrastructure.

Steps to produce the Conceptual Architecture

3. We first assess "best practices," that is, those practices that have been found to give consistently good results, and then decide which are applicable to Emory.
4. We also assess Emory's current IT policies and principles to identify strengths and weaknesses (what supports the architecture requirements and what does not).
5. From the results of the previous two steps we derive architectural principles that link to the requirements identified in Phase 2.
6. We define architecture domains appropriate for Emory.
7. We then circulate for discussion a document summarizing our draft conclusions, and refine the document based on feedback from the community.

Adoption of the document mentioned in step 7 concludes Phase 3. Phase 4 can begin as soon as Phase 3, step 6 is done. In Phase 4 the Committee leads a process to specify the policies, procedures and (some) standards for each of the domains.

Appendix 1. Communications Plan

The IT Architecture Committee intends to keep the Emory community informed of the Committee's goals and progress and to provide the means whereby interested members of the community can communicate their opinions, concerns and questions to the Committee. The decision-making process will be as inclusive and open as is feasible.

Accordingly, the Committee has developed a plan for communication to and from individuals and members of various constituent groups at Emory. We invite your comments in whatever form you find most convenient. A phone call or email to members of the Committee (listed below), a written response, or email to the ITA listserv described below will all be welcome.

1. Circulation of documents

During each phase of our process, we will research and analyze the issues at hand, and produce a working document (of which this is the first). These will be distributed using the vehicles described below.

After a suitable period for comment, reaction and suggestions, the Committee will revise the discussion document as appropriate into a draft final document for that phase. The draft final document will then be circulated for approval by the appropriate bodies.

2. ITA Website and listserv

Discussion and final documents will be posted to the Web site (www.emory.edu/EITA) in html and pdf (Adobe Acrobat) formats. There is also a listserv (IT-ARCH@listserv.emory.edu) to which anyone may subscribe through the Web site. This listserv allows open participation in the process of creating an IT architecture for Emory, where anyone may raise relevant issues or topics.

The Web site also contains other information that may be of interest, such as other ITA documents, information on contacting the members of the ITA committee and links to other sites.

3. Presentations at Committee meetings

Members of the Committee will make presentations based on the discussion documents to appropriate University Committees and gather feedback:

Committee	ITA Contact
Council of Deans	Howard Hunter
University Senate	Don Harris
Administrative Council	Howard Hunter
Council on Information Resources and Technology	Don Harris
ITD Advisory Committee	Barbara Maaskant
Ways and Means Committee	Howard Hunter via Provost Chopp
President's Cabinet	Howard Hunter via Provost Chopp

4. Communication with constituency groups

Members of the Committee will communicate the discussion documents to a variety of constituencies and gather feedback:

Schools and Divisions	ITA Contact
Candler School of Theology	Steve Kraftchick
Central Administrative Divisions	Don Harris
Emory College	Carole Meyers
General Libraries	Martin Halbert
Goizueta Business School	Benn Konsynski/Barbara Maaskant
Graduate School	Howard Hunter via Dean Stein
Healthcare	Lance Basler/Joe Medley
Law School	Rosalie Sanderson
Medical School	Stephen Warren
Network Communications Division	Don Corcoran/John Mason
Oxford College	Myra Frady
School of Nursing	Chris Alexander/Belinda Maaskant
School of Public Health	Chris Alexander/Belinda Maaskant
Yerkes Primate Research Center	Walt Hultgren

Other constituency groups include the Local Support staff (who will be contacted using the ITD Local Support Conference and by Walt Hultgren using the Local-L listserv), and ITD (to whom Peter Day communicates).

5. Other communications media

The Committee will request that the Emory Report and the Wheel run stories about the Committee's progress at appropriate stages in the process.

Appendix 2. Tables linking strategies and requirements

Legend <input checked="" type="checkbox"/> Strong applicability <input type="checkbox"/> Moderate applicability		Information Requirements											
		1: Info. re Teaching	2: Preservation	3: Timely Access	4: Anytime Anyplace	5: Granular Access	6: Info about Faculty	7: Funding Opps.	8: Meta data	9: Status info	10: Resource Info.	11: Public Info.	12: Progress info.
Strategies	1: Research Excellence			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2: Teaching Excellence	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3: Intellectual Community	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
	4: Interdisciplinary Scholarship				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	5: Internationalization				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	6: Standing and Reputation	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
	7: Increased Resources					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Legend <input checked="" type="checkbox"/> Strong applicability <input type="checkbox"/> Moderate applicability		Information Requirements											
		1: Info. re Teaching	2: Preservation	3: Timely Access	4: Anytime Anyplace	5: Granular Access	6: Info about Faculty	7: Funding Opps.	8: Meta data	9: Status info	10: Resource Info.	11: Public Info.	12: Progress info.
Technical Architecture Requirements	1: Facilitate Change	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
	2: Workflow	<input checked="" type="checkbox"/>					<input type="checkbox"/>					<input checked="" type="checkbox"/>	
	3: Integration	<input checked="" type="checkbox"/>					<input type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>	
	4: New Devices	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>									
	5: Authorization	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input type="checkbox"/>				
	6: Meta data	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
	7: Protection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
	8: Data Types		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
	9: Internet & I2		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	
	10: Volume of Information	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	11: Data Facility	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
	12: Interoperability standards	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
	13: Accessibility	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>						<input checked="" type="checkbox"/>	
	14: Network	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									<input checked="" type="checkbox"/>