



# LAYER 8

**A White Paper on Managing Information Technology Investments  
to Advance NC State's Mission**

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## LAYER 8\*

### *A White Paper on Managing Information Technology Investments To Advance NC State's Mission*

*\*There are seven layers in the networking architecture that define how systems communicate. This architecture is the foundation on which all information technology (IT) is built. Insiders frequently refer to the human factor in IT as the eighth layer. The title is the message; our greatest challenge is not the technology.*

## Prologue

### *The changing role of IT in higher education*

Andrew Grove, employee number one and former Chair of Intel, applied the term “inflection point” to describe “a time in the life of a business when its fundamentals are about to change.”<sup>1</sup> We stand at such an inflection point.

An interesting perceptual shift has begun on our campus. Administrators, faculty, staff, students, and other stakeholders are all coming to the same conclusion: the way we manage our information technology (IT) investments must change. But how it should change and why are far from obvious; these are complex questions the answers to which will challenge our established thinking and behaviors.

This white paper is designed to frame the context for the changes taking place and to generate dialogue on our campus—and beyond. Our university's goals, values, and plans of action form the basis of this conceptual framework. From this framework, we need to articulate a vision to help shape IT investment thinking and actions that further common university purposes. The authors see this as a starting point rather than a finished product. This is an invitation, not just a challenge, to discuss how our university excels in a technology-rich world.

IT is a tool that can either aid or hinder our progress. If the university can sense the emerging realignment and understand the direction in which IT is moving, we can leverage it to significant advantage—not just in IT but in our core mission, in the things we value most. This white paper is about doing the things we do—teaching, research, extension and engagement—much better.



# Context

## *Changing IT investment strategies in higher education*

Our nation's continued global competitiveness is widely believed to depend upon the U.S. maintaining its leadership in the development and management of new information technologies.<sup>2</sup> Rapidly changing technologies have pervaded every sector of American society, infusing nearly everyone's work and personal life. Although the specific timeframe and level of need are in some dispute, government agencies and business leaders are in general agreement that, over the long-term, more highly educated IT workers are needed to maintain and increase the economic productivity of the United States.<sup>3</sup> Investment in ***IT has become an integral element of higher education.*** It represents a multibillion dollar facet of the budgets of institutions of higher learning and is increasingly administered by Chief Information Officers and their equivalents.

*Insanity: doing the same thing over and over and expecting different results.*

*(Albert Einstein)<sup>4</sup>*

The evolution in higher education instruction, research, and administrative IT investment has been accompanied by a myriad of analyses, commentaries, and speculative prognostications. In spite of this, ***productive investment has faltered because of a failure to recognize and address a fundamental change in culture and a lack of communication about it.*** This state of affairs is not unique to our institution or to higher education.

## IT Investment Strategies

### *Today: Investing in technology*

Our IT investments are currently focused on the procurement and implementation of systems and their requisite hardware and software. IT is too often acquired because of the capacities and performance characteristics of the *technology*—without full priority consideration of the actual needs and goals of the university and its stakeholders. This may have been a reasonable strategy when technology was the limiting factor in achieving mission outcomes. But the incredible technological advances of the last several years have produced an explosion of new capabilities and opportunities, completely reversing the decision landscape. Today the greater limitation is in formulating and coordinating the desired outcomes that are to be supported by technology.

What higher education has been slow to address is central to information technology's evolution: IT has become integral to the whole university enterprise, and therefore the selection and application of information technology profoundly influences the university's critical objectives. Our next step challenges us to think beyond technology, to look at how we might change our processes, our structures and our investment strategies to improve institutional outcomes.



NC State's research and education mission is increasingly advanced by the use of information technologies. The university's LITRE plan—Learning in a Technology-Rich Environment—has recently articulated a ten-year vision of university teaching and learning, stating its goal to “accelerate NCSU's movement to a learning-oriented culture, using technology to enable and facilitate students' success.”<sup>4</sup> Many, including the SACS external reviewers of the LITRE plan, have begun to ask where the funds required to manifest that envisioned environment will come from in our strapped economy.

*Tomorrow: Investing in NC State's mission*

The underlying motivation in developing a radical alternative to our current IT investment management strategy is the conviction that ***we can and must make use of existing funds in a far more judicious and effective manner than we are doing now.*** To be successful, higher education's investments in IT need to be guided by the institution's mission and the recognition that IT investments must be linked to university-defined goals.

To move toward that greater efficacy, we identify at this stage two overarching goals:

- 1) To dramatically improve the value gained on IT investments by linking them to university-defined goals and outcomes.
- 2) To construct the frameworks by which we can answer the critical questions, Are we competitive in the 21<sup>st</sup> century educational, research and workforce preparation environment? and, How do we know?

Moving toward these goals will require the input of all our university stakeholders. The challenges and opportunities we face are discussed in the sections below.

## Inflection Point

*The current business model*

NC State, like most institutions of higher education around the country, has been continuously incorporating new technologies into the full scope of its academic and administrative strata. But now, IT development has reached a new stage. IT's evolutionary path has made it integral to the academic functions and administrative operations of the university.<sup>5</sup> In part, it is the maturing of both new technologies and of management processes that is pressing a re-evaluation of the frameworks used in IT management and accountability strategies.

*The trouble with the future is that it usually comes before we're ready for it.*  
(Arnold Glasow)<sup>6</sup>

Like most higher education institutions, ***NC State has failed to sufficiently consider and understand the implications of IT decisions for research, teaching and learning.*** Despite the enormity of the changes that have taken place over the last decade, the university is still operating in much the same way it did before the time of mass IT commoditization and ubiquitous access. In consequence, institutional credibility is undermined, and IT return on investment is diminished.



NC State is holding onto older investment strategies that are now counterproductive. These strategies diminish the potential IT can have in realizing NC State's mission and lock us into implementation modes that are corroding our competitive edge. This counter-productivity manifests in numerous practices—including *duplication* of materials and labor within colleges and administrative units; *fragmentation* of IT services with consequent inequities in security and capacity, and quality of service; as well as the *loss* of resources for opportunity investments, for example, in discipline-specific applications and faculty-student training.

#### *The future business model*

We need to develop a transformative university goals-driven operational model for IT investment. In other words, the university needs to develop a business model based on the university's mission. While the term "business model" in relation to higher education should be viewed skeptically if used to imply adoption of corporate values and organization, it is necessary to construct an *appropriate* university business model that insures the realization of our own values and organization.

To effectively manage IT as a tool that facilitates achieving our educational goals entails understanding the changes in our culture requiring a new business paradigm. The new paradigm recognizes that ***IT investments must be managed within a decision-making and performance assessment framework that enhances value creation***; that is, a framework that links IT investment strategies to the advancement of university-wide performance and outcomes.

The mission of NC State is to utilize "the active integration of teaching, research, extension, and engagement [at] North Carolina State University [to] create an innovative learning environment that stresses mastery of fundamentals, intellectual discipline, creativity, problem solving, and responsibility."<sup>6</sup> The only way this state's and this country's workforce will remain competitive in the context of global markets is to not only learn how to produce, evaluate and preserve intellectual property, but also to learn through using state-of-the-art IT solutions and tools. This cannot be done unless the IT environment higher education offers is "ahead of the curve" all the time. Our IT investments, therefore, are only successful to the extent that they further one essential goal: making NC State best able to meet its mission, goals, and objectives.



# Transformational Concepts

## *Time compression*

The *rate of change* is the key driver behind the transformations in our culture related to IT development. A metric familiar to IT professionals is Moore's Law, which states that computer power doubles every eighteen months at constant cost (figure 1). Significant increases in processing speed, capacity, and functionality occur within yearly increments.

The speed and constancy of change has resulted in innovative computational capability often far beyond what individual users know how to productively use. Moreover, the constant, fast-paced change and heightened IT capacities that are produced have overwhelmed institutional business acumen as well. We find ourselves mired in traditional modes of operation that hinder the use of IT to support the beneficial growth of the university.

In effect, our IT investment strategy is out of sync with the changing world. We are accustomed to making institutional and societal change slowly. What made economical sense when the speed of technological change was far slower is no longer economical. Yet, as will be discussed at greater length below, we continue to operate as if the older business imperatives such as owning and controlling all technological infrastructure are still appropriate, even while they rob us of critical monetary and human capital. Before looking further into the transformational concepts underlying the changes crucial to realizing our goals, let us take a brief look at the human experience of technological change within historical and contemporary time frames.

## *Historical legacies*

The great technological revolutions of human history have taken place over continually compressing timeframes. The changes wrought by the technologies of the Agricultural Revolution were measured in millennia, the Middle Ages in centuries, the Industrial Revolution in multiple decades. Currently, Internet changes are measured in months.

*The changes we will experience over the next ten years will be the equivalent of what we have experienced over the last twenty-five.*  
(Michael Nelson)<sup>6</sup>

Before the Industrial Revolution, technological change took place much more gradually, in rhythm with the seasons, over generations, and in the course of a lifetime. Beginning in the 20<sup>th</sup> century and into the present we experience monumental changes over short periods of time. We see the beginning, middle and end of technological innovation in the fraction of a lifetime. Given the speed of digital innovation and the current gap between potential and application, the changes we experience are likely to increase in both frequency and impact.

Those old enough to have witnessed the arrival of the computer are fundamentally grounded in Industrial Age attitudes toward technology and are often imbued with the



ethos of an older generation seasoned by the Depression of the 1930s. Yet, Information Age values, attitudes, and beliefs are diametrically opposed.

What are the attributes this white paper’s authors consider fundamental to successful Industrial Age vs. Information Age technology investment?

Transformational Concepts Shaping Technology Investments	
Industrial Age	Information Age
1. Long-Term Durability	vs. Disposability
2. Fixed Infrastructure	vs. Malleability and Adaptability
3. <i>Ownership and Control</i>	vs. <b><i>Partnerships and Linkages</i></b>

The attributes listed above intersect and in particular point to the last line in each category: *ownership and control in the Industrial era versus partnerships and linkages in the Information era*. In order to elaborate more fully on the outcomes of both modes of thinking, the sections below explore each of these oppositions separately.

## Transformational Concept #1

### Long-Term Durability vs. Disposability

Technology investment during the Industrial Revolution depended on the development and purchase of durable equipment. Mechanical systems were designed to last as long as possible, and repairs were an important dimension of extending their life. Improvements and innovation in Industrial Age machines occurred slowly over an extended time span, and the economic viability of a machine was almost solely a function of its mechanical viability.

*If the system settles into harmony and equilibrium, it will eventually stagnate and die.*  
(Kevin Kelly)<sup>f</sup>

The opposite is true in the present. The speed of technological innovation makes a functioning computer-based device an uneconomical and impractical choice long before it stops working, when new capabilities and capacities enable improved workflows to be accomplished far faster and for less cost. The fast pace of enhancements makes routine replacement of existing hardware and software a necessity. To use a computer or communication system until it has worn out would mean wasting considerable time



and effort on operations that could be freed for much more creative and productive purposes.

The cost and the physical attributes of disposable technology also reverse the nature of industrial machines. Technological development continually moves toward smaller and more dense devices.<sup>7</sup> Information Age infrastructure currently relies on machines the size of coins. Hardware is increasingly more compact and functionally rich, as exemplified in the evolution of the cell phone. There are significant rewards to be realized from taking advantage of rapidly evolving advances in speed, ease, and scope of operation. Basic communication, production and organizational tasks are constantly being simplified and accelerated.

An example of these developments can be seen in the contrast between state-of-the-art devices from the 1950s and from the present. In 1956, an IBM disk file storing 4.4 megabytes of data leased for \$240,000 per year (in 2004 dollars), "occupied the space of two large refrigerators and weighed a ton," and even then it wasn't fast enough to play an MP3 song.<sup>8</sup> An Apple iPod storing 40,000 megabytes of data can be purchased today for \$399, weighs 5.6 ounces and fits in the palm of your hand. These vastly different characteristics allow the iPod to be marketed as a personal device with a relatively brief life expectancy.

Rapidly evolving technology development means that the value of IT acquisitions must be realized within a relatively short timeframe as well. In 2001, the North Carolina Supercomputing Center purchased a state-of-the-art supercomputer worthy of national recognition. By three years later when the center closed, the supercomputer had become a marginal performer. In 2003, three years before the lease was to terminate, it had depreciated 98% in value; the original \$10 million total value was reduced to \$200,000. Three years and \$4 million in payments then remained on the original six-year lease.

The consequence of this change from long-term durability to disposability in the technology we use is reflected in an investment reality that has not been fully internalized by most university administrations: ***equipment depreciates rapidly, and must be updated and/or replaced on a regular and relatively frequent basis.*** Yet, most academic and administrative units across campus do not accurately include those costs in their budget forecasts. We operate in an immature fashion in our IT investment planning, in our governance, and in our processes relative to IT's cyclical evolution (figure 2)—and this we must change.



## Transformational Concept #2

### Fixed Infrastructure vs. Malleability and Adaptability

The fixed infrastructure fundamental to the Industrial Age enterprise was predicated on the nature of machines of the time. They were mechanical systems designed for a specific function, and they could not be used for another kind of output.

In contrast, one of the imperatives of the Information Age is to recognize and take advantage of the malleability and adaptability of information itself and of the engines that manipulate it—computer-based systems. Following on the discussion of disposability above, one way to mitigate the *cost* of built-in obsolescence is to continually explore and experiment with alternative or expanded uses of technology. That technology purchased for one function can be adapted to another is a mark of the value creation fundamental to successful IT investment and management.

*It is not that the business environment is changing. Change is the business environment.*  
(Charles Fishman)<sup>8</sup>

One of the principal building blocks of IT investment and management strategy is capitalizing on the number of ways the same technology can be re-arranged and reconfigured. A case that illustrates the value of this adaptability is the virtual computing lab initiative being developed at NC State.<sup>9</sup>

The Virtual Computing Lab (VCL) project arises out of the potential for the High Performance Computing (HPC) initiative to benefit a much larger group than initially targeted. Advances in high-speed processing and Internet connectivity at decreasing cost have made basic software production tools (word-processing, presentation production, spreadsheets, etc.) and broadband network access on desktop and portable devices affordable to the vast majority of students. Traditional on- and off-campus computing labs are increasingly redundant and inconvenient for students seeking access to learning tools, routine software, information databases, and communication networks (figure 3).

Applications and computational power beyond the reach of student-owned devices can now be placed on high-density, centralized blade architectures and accessed at a distance. The majority of space allocation funds—presently allotted to personnel and hardware in traditional computing lab settings—can be re-channeled into other IT investments that produce greater value in meeting learning outcomes. The total cost of ownership would be lowered and students better served. Vital group learning activities and student social interactions that currently take place in computing lab spaces are important aspects of undergraduate education and are much needed. Alternative group spaces that better meet these needs are already being developed through LITRE grants and other avenues.

The Virtual Computing Lab project is being piloted this semester (Fall 2004). It has evolved through planning and implementation across division boundaries, and it adapts for student learning the success of the High Performance Computing Initiative driven by the needs of advanced university research.



## Transformational Concept #3

### Ownership and Control vs. Partnerships and Linkages

The issues raised above—long-term durability vs. disposability, and fixed-infrastructure vs. malleability/adaptability—coalesce in the primary opposition of ownership and control vs. partnerships and linkages. Clearly, ownership and control were essential to technology investment strategies when the maintenance of costly machines and the need for mechanical systems dedicated to one fixed function were critical aspects of a successful business model.

*The network economy is founded on technology, but can only be built on relationships. It starts with chips and ends with trust.*

(Kevin Kelly)<sup>h</sup>

With the transformation from a static to a dynamic operational workflow, a transformed business model is mandatory. Ownership and control are no longer the foundation for a competitive and successful IT investment and management strategy. In fact the opposite is true; in the university setting, individualized ownership and control over common shared activities result in fragmentation of quality, limited funds being spent on too much overhead and duplication, a reduction in the speed needed to promote and take advantage of innovation, and an overall distraction from what really needs to be accomplished to advance the university's mission.

There is an additional cost, perhaps the most negative in its impact. The mindset that expects each unit to own and control all technological systems precludes the exploration of partnerships and linkages—partnerships and linkages that may be far more productive and serve the mission of the university far more effectively.

NC State is already a beneficiary of one such collaboration, as are its partners, UNC-Chapel Hill and Duke. The Triangle Library Research Network (TLRN) has been a tremendous success, leveraging the shared resources for the three universities and building library collections in times of economic downturn. NC State's ranking in the ARL (Association of Research Libraries) has dramatically improved (from the bottom ranking of 101<sup>st</sup> to 32<sup>nd</sup>), demonstrating the returns to be gained from allocating resources more judiciously and investing in areas that make a difference. TLRN includes shared catalogs and coordinated collections that demonstrate impressive results in reducing duplication and enhancing specialization. A 1992 study shows that 6.7% of library items are held by all three universities, 17.5% by two universities, and 75.8% of items are held by only one of the three Triangle universities. A rapid delivery service provides library patrons on each campus with easy access to the sum of the three collections.

***The move from ownership and control to partnerships and linkages is fundamental to the paradigm shift needed in the way higher education manages its IT investments.*** It is not, however, a simple issue of centralization vs. decentralization; effective partnerships and linkages will simultaneously free up funds to support specialized individual initiatives. This is a complex shift of vital importance that requires input from all interested stakeholders. The next section introduces the salient factors involved in such a move and lays the ground for further discussion.



# Rethinking our IT agenda

When Lou Gerstner came to the moribund IBM in 1993, he encountered what he referred to as fiefdoms: internal divisions that fragmented the operations of the entire global organization and consequently the value to customers and shareholders. His intent was to radically transform the way IBM was run (and thus increase its productivity and global competitiveness), and he pursued it through years of resistance, upheaval, and ultimately the success of the company's recovery.<sup>10</sup>

*Nobody here owns anything.*  
*(Lou Gerstner to his employees, as new CEO, IBM)<sup>i</sup>*

While not moribund, NC State and the UNC system as a whole have reached the stage when a radical re-thinking of our IT investment and management practices needs to occur to ensure that the university can retain its vitality and competitiveness in the 21<sup>st</sup> century. To do that, we must become more innovative. The university cannot afford to waste its resources in duplication and fragmentation, but neither can it allow centralization that is not agile and responsive enough—centralization that may lead to ossification of the infrastructure and its ability to adapt to an ever-changing IT landscape and the needs of university stakeholders.

A shift in business paradigm is required to provide the foundation for an IT strategy dictated by the achievement of university research and LITRE-defined goals: to create an environment in which research and teaching and learning are facilitated by the most productive technological infrastructure possible. We need to move our IT agenda from one that asks, “How do we implement an IT function?” to, “How do we invest to fulfill the university mission?” In the sections below, we explore the seven driving forces underlying transformational change: collaboration, efficiency, risk, communication, training, re-allocation, and process.

## Collaboration

The changes outlined above make *ownership and control* an outdated and inappropriate guiding principle for IT investments and management. Fiefdoms arise, as evidenced at IBM, and the loss of quality and productivity can be staggering. We must manage our IT investments more wisely, more collaboratively, more productively—and that means in a less fragmented fashion. The failure to re-think traditional ways of managing technology drains resources in every area of human activity in higher education.

What needs to change? The primary transformation needs to center on *collaboration*, a collaboration built on *partnerships and linkages*. We begin by challenging traditional boundaries.

### *Redefining competition*

NC State sees itself in competition with Chapel Hill, which in turn sees itself in competition with Duke, and on and on. Yet, if economic forecasters are right, our prime competition is not in fact with each other; it's *global*—it's with China, India, Malaysia,



and other countries and regions that are re-training their workforces to enter into the IT economy.<sup>11</sup> We have many effective inter-institutional collaborations, and yet we have complete duplication and lack any operational integration of IT systems and services at NC State and Chapel Hill. We are captive to the common “me too” rationale for IT investment: if others have it, we need to have it too. We delude ourselves that this is a necessary and profitable IT investment strategy.

We need to define what we are really good at and what is really valuable to us, rather than simply assuming that what Chapel Hill or Duke has we must have also. To be competitive, an organization protects and brands core competencies in what it selects as its area of distinction. Duke promotes itself on this basis—but there are other areas where Duke’s need is simply to provide their students with rich experiences and opportunities to learn. If we brand excellence, we may be giving that to our students by having them take non-core courses or utilize scale-efficient services at a partnering institution.

Technology is a real factor in this challenge to the status quo. IT has matured to the stage where its core value is in enabling capabilities and services, reflecting the emergence of what one analyst calls, “the next scientific revolution: the science of networks.”<sup>12</sup> We need to construct a new collaborative model by which we aggregate partnerships that bring us value and competitive advantage on a global level.

#### *Beginning with the power of three*

We could begin with a model based on a power of three, the three Triangle universities in a collaborative effort to centralize specific IT operations that benefit from *efficiencies of scale* (figure 4). How might this be applied in the future?

As discussed above, the Triangle Research Library Network is a successful example of effective collaboration. Another potential example can be seen in the management of large-scale applications like the Oracle Collaborative Suite, recently purchased via a consortium within NC State that included the student Educational Technology Fee fund. The suite will provide calendaring and other organizational tools to students that are aimed at streamlining the management of their degree paths. Inherent in the suite is the capacity to extend these functions significantly beyond NC State’s campus. A possible scenario could find UNC-Chapel Hill running Oracle for the Triangle campuses and perhaps beyond, instead of NC State, Chapel Hill, and other institutions each operating their own Oracle Suite for the same benefits. The Oracle technology is sufficiently robust to handle this, and the technical development skills found in the Triangle’s research universities could be leveraged to benefit rural areas and other less technology-centric areas as well.

The UNC system-wide Teaching, Learning & Technology Collaborative (TLTC) is actively investigating collaborating on Learning Management Systems (LMS) at all sixteen campuses—not simply in terms of hardware and software, but in sharing content as well. At NC State, the next-generation LMS is being prepared for campus implementation through the shared efforts of Learning Technology Services, Registration and Records, the libraries, and the Information Technology Division.



### *Adding value*

Other universal common functions could—and as this paper argues, should—be considered for management in a similar fashion. Email and data storage services are but two examples of applications and infrastructural services that can be run centrally for a campus, or for an extended community of common interest. Beyond the economic and performance benefits this centralization would bring, the university would also reduce its costs in productivity that incur when independent server operators on campus break rules set by national telecom providers. The price of such rule breaking in the past has included the blockage of email exchange by Internet service providers such as AOL, a move affecting the entire campus.

Substantial gains can also be realized by making distinctions between value-added and non-value-added security and standards. There are situations in which different security levels are appropriate, as for example the security firewalls that safeguard student records. Such security protocols add value to the academic enterprise but should not be applied uniformly across university units. In those situations in which security differentiation does not add value—such as basic security measures against viruses and other intruders that apply to the broadest population of computer uses—security and standards should be centralized and standardized.

The virtual computing lab initiative discussed above is an excellent example of collaboration across administrative and academic units. NC State's College of Engineering (ITECS) and Information Technology Division (ITD) have combined expertise—with Engineering doing much of the application development work and ITD providing the core technology infrastructure—for a desired outcome that neither unit could have achieved on its own. Additionally, the virtual computing lab could ultimately be operated by NC State for multiple campus communities.

Other IT services should be considered in the same light. Within the NC State community is a wide range of constituents whose activities need to be supported by a new vision of IT decision-making, including Facilities, Purchasing, and Legal departments. Robust and dynamic partnerships would elevate the learning and research environment for all concerned, and our competitive edge would be raised, not eroded.

## **Efficiency**

Efficiency is often confused with consolidation and/or centralization. While consolidation and centralization may result in reduced costs, they are not worth much if they are done at the expense of institutional goals and mission.

*Wholesale IT renewal programs have typically been considered a prerequisite to effecting process change, but they have actually become a roadblock and often a distraction.*

*(Booz Allen Hamilton, Inc.)<sup>k</sup>*

### *Impact on mission*

Efficiency must be defined pluralistically in higher education. For example *we cannot determine areas of academic IT functions that would be best served by being centralized without simultaneously determining which functions must remain*



***decentralized.*** A determination of impact on university mission and objectives is integral to this process.

Efficiency in relation to academic IT management and accountability must be measured both in terms of cost *and* responsiveness to academic goals. Cost-cutting alone can be destructive to crucial mission outcomes. Choosing to make a tradeoff to lower costs and sacrifice a goal may at times be the best way to manage resources; it is, however, a potentially destructive action if lowering costs is prescribed without the awareness of what goals will be harmed and to what degree.

#### *Institutional effectiveness*

The core business goals of NC State are to maximize excellence in research, outreach, and in teaching and learning. LITRE's vision statement outlines teaching and learning goals within a technology-rich environment. Particularly in relation to questions of efficiency and diversity, any IT management and accountability strategy must be measured against its impact on realizing university objectives.

Diversity is fundamental to the exploratory and discovery process at the foundation of a research university. It encompasses diverse learners, teaching methods, learning outcomes, disciplines, research agendas and methodologies, and modes of scholarship.

The need for diversity, fundamental to higher education, extends to certain intra- and inter-disciplinary uses of technology as well. Much of the IT used to enhance specific research and learning outcomes is particular and customized. The fulfillment of our goals as an institution of higher learning requires the exploration of boundaries. Given university priorities and underlying economics, we cannot afford to *not* diversify where it serves our educational outcomes; as a treatise on IT complexity states, "***well-managed differentiation can offer valuable competitive advantages.***"<sup>13</sup>

Efficiency in relation to academic IT management and accountability must be measured both in terms of cost *and* responsiveness to academic goals. Cost-cutting alone can be destructive to crucial mission outcomes.

#### *Accountability drives efficiency*

Accountability for IT investments is not identical to efficiency unless the diverse goals of the university are included in the accounting framework. Economic efficiency is the often-stated goal of IT re-engineering for corporations or state government; though it is tempting to use this as a standard for measuring the value of academic IT investments, the university's mission, goals, and motives are very different. We cannot simply try to decrease costs; we must focus on desired outcomes and then find the most economical ways to achieve them.

Academic IT investment involves making choices that are not right or wrong but instead *appropriate or inappropriate* for the defined outcomes. For example, supporting multiple computer operating platforms (Windows, Unix, MacOS) is appropriate to meet the diverse research, teaching and learning goals of students and faculty in a research university, whereas it may be inappropriate for an institution or corporate entity whose goals are not hindered by being constrained to a single platform.



The baseline for determining the appropriate strategy is *value differentiation*: **where there is minimal value added, consolidation is appropriate** (for example, with email servers); **where there is significant value added, diversification is appropriate** (for example, with supporting multiple operating systems). Faculty, departments, and colleges get the freedom of selection but must bear the burden of justifying the need. Similarly any centralized offering must be accompanied by a verified design and policy document; those proposing centralized services must also bear the burden of justifying that need.

The price of flexibility is accountability as is the price of centralization. **Without accountability, flexibility is expense without justification and centralization is savings at the risk of becoming less competitive.**

## Risk

Nationally, two-thirds of major IT initiatives fail. In 2002, the success rate was 34%. Eight years before, it was 16%.<sup>14</sup> Yet grim as these figures may be, rapid changes force us to routinely explore new possibilities.

*Nothing ventured, nothing gained.*

*(Chaucer)<sup>15</sup>*

### Confronting the risk factor

Several recent large-scale IT implementations exemplify the hazards of continuing projects without appropriate risk containment strategies. Canada's national computerized firearm registry was slated to cost \$2 million in 1998; its cost is now expected to exceed \$1 billion.<sup>15</sup> Nearer to home, NC WISE—a public school computer system—will miss its target date of fall 2004 and has grown in costs from the initial budget of \$54 million to \$113 million.<sup>16</sup> A report estimates that it will take two more years to be completed, will likely cost as much as \$150 million overall, and teachers find it difficult to use.<sup>17</sup>

Risk is unavoidable; any worthwhile IT endeavor will have it. Moreover, simply avoiding risky new IT initiatives would be an irrational business decision. **Universities are not immune from the forces of change in the rest of the world.** There is more risk and more is *at risk* because of structural and organizational complexity. Technology itself is more complex, and the activities of the university are complex unto themselves. Yet, oversimplification or simply transferring complexity from one unit to another is not a solution.<sup>18</sup> Risk comes with complexity, but the risk can be managed in ways that allow innovation to benefit university goals.

### Managing the risk factor

There are several steps to be taken to manage risk. Carefully devised and executed pilot programs must come first. Metrics need to be designed to assess the impact of technology in the immediate and in the wider context. Such pilots contribute to an important aspect of good IT management: the ability to *assess and contain* risks. To adequately contain the risks of an IT initiative, line management must stay aware of each step taken. It is imperative to be ready to change course, and even terminate, as fast as possible in some circumstances. **An integral part of any risk-based strategy is an exit strategy.** Recognizing and admitting when the direction is wrong and stopping



before too great an investment is made is critical. Throwing good money after bad is a losing proposition, yet this is precisely the response often given to IT initiatives gone awry. ***Failing initiatives are the result of poorly aligned fundamentals and poor accountability, conditions for which merely adding more funding is a remarkably ineffective remedy.***

By implementing safeguards, it is possible to take calculated and appropriate risks in IT investment strategies. We make IT investments with certain assumptions. To have accountability in IT management, we

must determine if those investments have proven valuable in the long run. Value must be defined and measured, in part, in relation to risk. Calculated risk is made on the basis of research, prior experience, and as a rational gamble on *a reasonable scale*. When risks are relatively low and are calculated as above, even IT investments that do not result in expected outcomes contain potential value *in learning what went wrong*. They can be viewed legitimately as learning opportunities; learning what assumptions about student learning, implementation of a tool set, or assessment were incorrect more than justifies the investment. Learning is a necessary process in managing future risk.

*There are risks and costs to a program of action. But they are far less than the long-range risks and costs of comfortable inaction.*  
(John F. Kennedy)<sup>m</sup>

## Communication

Communication across horizontal and vertical lines, within and among the university's academic and business sides, and within and among disciplines, is vitally important. The options that exist for taking advantage of opportunities or for solving problems using IT need to be broadly communicated, and too often they are not.

*Transparency is essential*

An important aspect of managing risk in a new business model is the need to move toward greater transparency.

Communication is key to transparency in decision making and a cultural value which is critical to the success of a new investment strategy. Economic transparency leads to well-defined budgets and decision-making frameworks. Accountability becomes more transparent as well: investments in assets and resources, people and technology are tied to decision-making processes and effective financial management. Leaders and managers alike need also to understand well-managed risk, to gain the ability to identify early in the investment process whether it will prove beneficial. Such understanding can contribute to investments made with sufficient departure points before too much is invested.

*One of the first meetings I asked for was a briefing on the status of this [mainframe] business... At that time, the standard format of any important IBM meeting was a presentation using overhead projectors....I stepped to the table and switched off the projector. After a long moment of awkward silence, I simply said "Let's just talk about your business."*  
(Lou Gerstner)<sup>n</sup>

Those people who have been at NC State long enough to have experienced TQM (Total Quality Management), later renamed TQI (Total Quality Improvement), have directly encountered what failures in lines of communication can produce. Whether or not the plan itself contained fatal flaws, the lack of resolute conviction from top



administrators—and the failure to communicate a compelling message to university stakeholders to obtain buy-in from the bottom up—doomed the project from the beginning.

### *Fostering engagement*

The university currently has two circumstances that are favorable to considering a radical change in the ways IT investments are accounted for and managed. The first is that the institution has articulated goals based on what is valuable in teaching and learning defined by LITRE in a process that included large representative segments of university constituents in open and well-publicized campus forums. The second is that as IT investment strategies have matured, so have the users in relation to IT. We now have many people on campus who are capable of evaluating the *context of technology use* and of making a constructive value judgment *because* their use of technology has matured into an integral part of their everyday functions.

The communication needs on campus include creating vertical and horizontal channels; exploring and refining ideas; establishing and advancing cultural identity; building partnerships and forging linkages; and influencing behaviors, actions and outcomes. Increased communication of this kind will help create a culture of mutualism especially necessary when ***no one person can encompass all the answers or even the right questions to be asked.***

### *Inclusive leadership*

Leadership must become more diversified and comprehensive. A CIO cannot understand every strategic direction or solve every IT problem, and the CIO profession is coming to the same conclusion. As *Public CIO* states in its article, “Leadership in the Balance,” CIOs are facing a declining role in the public sector because of an imbalance in their organizational behaviors. “Most CIOs spend their time managing when leadership should consume 80 percent of their efforts. . . Management is based on authority. . . Leadership, on the other hand, is based on influence.”<sup>19</sup> The IT decision-making process must mature; it must become less isolated from enterprise concerns and more integrated into a university-wide investment strategy.

Understanding the faculty perspective is equally important in shaping IT investment in order to ensure that technology nurtures, rather than cripples, teaching and learning. The report published by the GAO (Government Accountability Office), *Information Technology Investment Management: A Framework for Assessing and Improving Process Maturity*, states, “If managed wisely, investments in information technology (IT) can enrich people’s lives and improve organizational performance. However, along with the potential to improve lives and organizations, IT projects can become risky, costly, unproductive mistakes.”<sup>20</sup> Faculty members’ voices must be included in the conversation; what their concerns are and the experiences that led to them need to be part of the understanding we seek in changing our investment patterns.



## Reallocation

IT reallocation is based on a harsh economic reality: today's state budget crisis is a chronic condition. The underlying problems are structural, and any resolution will be long and difficult. Nevertheless, IT demand is increasing in terms of functionality and scale in every sector of the university. We are in a situation in which something has to give. The core concept of IT reallocation points to the necessity of asking what we can let go of and where we can re-channel resources to yield higher return value for the university as a whole.

*We can't innovate—We're too busy.  
(university professional IT staff member)<sup>o</sup>*

One of the fundamental attributes of successful IT management is the ability to channel more resources towards innovation by streamlining the routine. In other words, we must first work toward achieving efficiencies of scale for those operations that can be done better and at less cost centrally, in order to provide support for innovative teaching and research practices through differentiated IT among the disciplines.

A non-trivial percentage of the total annual university budget is allocated to IT spending, but current accounting practices make it difficult to tell precisely how much and for what. LITRE has identified \$30 million per year being spent on information technology. The value of current IT investment in its totality needs to be assessed, with particular attention paid to the realization of teaching and learning objectives delineated by LITRE. Currently, the university lacks a portfolio that provides a comprehensive overview of IT investments made across the university each year. As stated in the GAO investment framework, "An IT investment portfolio is not just a collection of projects but a conscious, proactive look at how the organization expends its limited resources on IT, what beneficial impacts these investments have on the organization, and a continuous search for investments that will better achieve the organization's ... missions, strategies, and goals."<sup>21</sup> Effective reallocation of resources can only take place when we have an inclusive accounting of IT expenditures. All colleges and administrative divisions must develop an IT investment portfolio.

***Technology evolves cyclically***, which means that ***embracing the new and streamlining the old are continuous and simultaneous demands***. Continuous change and adaptation are manageable processes, but they require reallocation of resources—both electronic and human. As discussed above, the Virtual Computing Lab has the potential to demonstrate the benefits that appropriate reallocation generates. If successful, students will have greater access to the things they need to further their learning—far more conveniently and effectively than was possible before—and scarce economic and human resources can be redirected to far more productive uses.

## Training

What is our greatest barrier to the adoption of new technology? Greenberg (2004) included in his discussion on university business models a segment on the failure of higher education institutions to incorporate new technologies in their pedagogical practices. He laid much of the blame for that perceived failure at the feet of tenured



faculty who, because of being tenured, were complacent or resistant to learning and exploring new educational applications.<sup>22</sup>

### *Positioned for success*

The perception of a lack of IT incorporation in teaching and learning does not hold up at NC State, nor in surrounding institutions. Moreover, where there is a slowness on the part of faculty to utilize IT enhancements in courses, it must be acknowledged that radically new and creative methods to transform pedagogy are neither obvious nor simple to come by. Rather than demonizing an entire and very diverse population, a more productive approach than Greenberg's is to explore ways that support the selection and utilization of effective choices.

*The competitive difference in the 21<sup>st</sup> century will be people... It will not be process. It will not be technology. It will be people...The stakes are high.*

*(David Walker)<sup>p</sup>*

Human capital in the form of technical competency and proficiency as well as intellectual capacity is readily available at a research university such as NC State, more so than in most of the public sector. NC State's IT staff are agile and adaptable. They understand and appreciate the inevitability of change and are prepared to both contribute to and accommodate change. Such flexibility in turn supports innovation and diversity. Our Faculty Center for Teaching and Learning (FCTL) is expanding under new leadership; its role and that of Learning Technology Services (LTS) in the development of creative pedagogical practices are essential to a comprehensive evaluation of IT efficacy. In addition, efforts being made by colleges and departments, as well as individual faculty expertise are an integral part of IT planning and execution. Faculty participation routinely adds to the depth and breadth of thinking and innovation in the selection, deployment, and use of technology.

### *Preparing people for success*

What is missing and needs to be developed is two-fold: (1) a means of more effectively tapping and utilizing the available talent and, (2) a means of engaging all university personnel in the articulation of the conceptual framework we are presenting—a framework in which the perspective of the collective balances that of the individual. In addition, the technology offered to the faculty must be not only appropriate but also dependable.

If IT investment is understood only in terms of hardware and software infrastructure, we will not see the realization of LITRE-defined goals for learning to take place in a technology-rich environment. Process design and adequate training are also needed for investment success. According to Axson (2003) "Too many investments have simply automated inefficient processes or have delivered incredible functionality that no one fully understands how to leverage."<sup>23</sup> Resources need to be made available for the significant differentiation among disciplines. Recent research supports the need for *discipline-specific and distinct training of faculty and support personnel* in order to realize the rich potential of IT-enhanced pedagogies.<sup>24</sup>



NC State's Learning Technology Services (LTS) has already recognized the need for discipline-specific instruction and is refining their instructional approach accordingly. In 2004, LTS's Faculty Development Services began to deliver customized training that encompassed requests by departments for faculty hands-on training, for students in courses in which particular skills were needed, and seminars to acquaint academic departments with available services. Supporting and expanding these kinds of approaches to faculty training is essential to the success of the LITRE plan and to the enhanced research productivity of the university.

### *Managing resources for success*

Every academic department across the university requires an IT management role to make IT investments curriculum and discipline specific. Each department must define its own values and goals in order to formulate an IT investment strategy that will further those aims. **By asking what is distinct about its IT needs and what is not, every department can determine how it can correlate its IT investments with the university goals-based IT strategy we are prescribing.**

We need also to recognize ways that add value to IT solutions. As an example, presenting IT software to develop resources to be used by blind students at each college ensures that faculty and staff have greater opportunities to learn how accessibility-related applications can help them in their curricula. The pedagogical training and development of faculty and staff in the appropriate use of IT are critically important elements in which colleges and departments need to invest. However, the funding needed for adequate training is not likely to come from new sources. In an area as crucial as this, we can see how important it is to find ways to free up resources dedicated to duplicated IT functions—for example, maintaining systems for what have become commoditized services, such as the number of separate email servers found throughout the colleges at NC State—and reallocate them to higher value functions, such as local support for necessary multiple platforms, LTS and FCTL training, and other opportunities to advance learning outcomes.

Consequently, we must ensure that our training encompasses the needs of people who are displaced with shifts in IT applications. We have large numbers of technical personnel maintaining operations that can run better centrally. Those already trained in skills that can aid learning outcomes will serve such goals much more directly through their greater availability to faculty and students. Others can benefit from re-training. In either case, we move towards meeting greater needs by letting go of outdated operational procedures, methods, and practices.

## **Process**

Our first step is to educate the campus as to the context in which a new IT investment and management strategy can be understood, in order to generate the meaningful discussions that are needed.

*The success of any program depends as much on how a change is made as on the nature of the change.*

*(McKinsey Quarterly)<sup>9</sup>*



### *Creating awareness*

Recent research demonstrates the greater wisdom groups versus individuals bring to strategic decision making. The intelligence of the university community as a whole is needed to determine our direction.<sup>25</sup> This requires not only that technical staff be aware of the administrative business dimensions of IT investing, but that administrators be aware of the technical dimensions involved. Both groups must operate consistently with the mission-driven values of the university.<sup>26</sup> Increasingly corporate CEO's are responding to this problem by adding technology to the agendas of existing top-executive committees.<sup>27</sup>

We need to recognize the similarities and differences with other forms of business as we define what models and practices best serve our mission as a university. We need to codify and articulate the new business model so that ultimately a decision made in one part of the university is synergistic with a decision made in another. A template on that order would provide the appropriate questions and the route to answering them: How does this investment tie to our business goals? If I invest over here in this way, will it benefit or contribute to university-defined outcomes? How do we increase value creation with our IT investments, and how do we measure?

The lack of adequate IT management practices afflicts not only institutions of higher education; government agencies and corporations also have to adjust their business strategies as technology matures. The Government Accountability Office's IT investment framework identifies five stages of maturity in IT management (figure 7). Stage one, creating investment awareness, reflects IT spending without disciplined investment processes. It effectively characterizes the stage NC State has reached, along with a great many other institutions. Building and investment foundation, developing an investment portfolio, improving investment processes and leveraging IT for strategic outcomes are all stages that lie ahead of us—and are critically important to any attempt to invest in IT wisely and effectively.

### *Creating mature processes*

Fortunately, we are already well equipped at NC State to further the process of making needed changes. The GAO report presents in extensive detail a "how to" template for developing mature IT investment management processes (figure 6), and NC State's University Information Technology Committee (UIT) is positioned to move us ahead with strategic initiatives that further the goals of our collectively-constructed vision. As the GAO investment framework states, the process of reorienting IT investments supports, rather than overrides, the knowledge and expertise that articulates that vision: "ITIM [Information Technology Investment Management] does not evaluate strategic plans and decisions made by the organization's executives. Rather, the purpose of ITIM is to describe and improve the IT investment management processes so that the strategic plans and decisions that are made can and will be effectively supported by highly effective IT investments."<sup>28</sup>

Glimpses of the application of a new IT investment and management strategy can be seen in actions already undertaken at NC State. The campus has begun by engaging in a series of collective discussions about how IT has operated in the past and what needs to



be applied to best align its IT culture, strategies, and practices with an institutional agenda. The Information Technology Division (ITD) emphasizes to all staff that they are here to support the mission and programs of the university, and it has made progress in changing the culture from vertical to horizontal, and individual to judicious collective decision making when it comes to IT investment.

ITD and the Resource Management Information Systems division (RMIS) have already implemented several joint projects with other divisions to reduce overlap and redundancy, as can be seen in the recent merging of Telecommunications and Data Networking, and in the response to the State Auditor's questions about multiple help desk phone numbers, by creating a single Help Desk contact point for the entire campus. ITD has begun initiatives in High Performance Computing with intra-institutional and inter-institutional programs, and in enterprise storage. These initiatives represent a technological jump from old to new, with cross-capacity and function. All of these efforts have arisen from transformational changes in thinking about IT investment and management.

The goals and needs of the university come from its stakeholders. We are at a juncture; our paramount need is a critical mass in thinking of how and why the underlying paradigm has to shift. The shift to a new business model must go beyond individual colleges, departments, and units. **We need a full-spectrum change, in which everyone re-thinks the basis on which IT decisions are made.**

## Conclusion

The elements discussed in this white paper—disposability, malleability and adaptability, and especially partnerships and linkages—constitute the foundation for a radical paradigm shift in our business model. A new business model must be defined by the goals and mission of the university as well as by the changing world our graduates will enter. Those elements and the multiple aspects involved in that shift—collaboration, efficiency, risk, communication, training, reallocation, and process—provide a context within which IT investment decisions are debated. Why, for example, in one situation an IT application would warrant consolidation and in another diversity needs to be clearly based on a rational, reasonable, and measurable process of determination.

We have an overlooked opportunity to advance NC State's reputation and function by leading the way to a radically re-envisioned IT investment and management strategy. This document intentionally refrains from making detailed recommendations, not from a lack of possibilities, but in the belief that meaningful change must arise from the dialogue we are advocating across the university. Nonetheless, we can draw some general, overarching conclusions to guide further discussion.



## **1. NC State must strategically reassess its IT structures and business practices to advance linkage between IT investment and university goals.**

Change is inevitable, the rate of change is growing, and the status quo cannot be sustained. The *change can be preemptive and internally driven in alignment with university-defined outcomes—or it will be made for us by external agendas that conflict with institutional values and methodology*. The institution of NC State, along with the rest of the University of North Carolina, is currently seen by state government leadership as excessively random and arbitrary in its decision-making process regarding IT spending.<sup>29</sup> There is an imperative to put more logic and rationality into the process and to insert a set of guidelines by which the process becomes *transparent* to university and public stakeholders. Trust in institutional decision-making arises from demonstrating how spending decisions are tied into university goals.

## **2. NC State must improve and expand internal communications channels.**

Improving communications channels would aid strategic performance in two important ways:

(1) It would strengthen the linkage between technology decisions and the academic agenda. Academic administrators and faculty have too often excused themselves from detailed technology discussions and forums and thereby have failed to inform subsequent decision-making. Similarly technology staff have chosen not to participate in discussions of pedagogy and learning or have been excluded. One only has to look at the University Information Technology (UIT) Committee to see the negative impact of this disconnect between technology thinking and academic priorities. The deans as a whole have failed to insure appropriate academic administrative or faculty representation despite requests to do so. Though the majority of the issues discussed at the UIT meetings focus on technical matters, they almost always have profound academic implications. Email, for example, is a technical matter but infuses virtually every academic activity. Academic experience and focus expand the ability of technical staff to factor in issues they otherwise could not anticipate.

(2) It would enable the university to better leverage resident knowledge, expertise and creativity. *Our greatest IT asset at NC State is the exceptionally high level of intellectual capital*. We are not mobilizing our resources effectively. The greatest deficiency in our IT investment strategy is the relatively weak interaction between our intellectual capital base and the IT decision-making process. Moving beyond the current state of IT will require involvement and direction from our core constituency—those most intimate with the challenges and opportunities in teaching, learning, research, and service.

## **3(a) NC State must develop and articulate a coherent strategic vision for IT investment and management.**



The current campus IT culture is one that developed during the frontier gold rush days of IT. The often fragmented and narrowly focused efforts that fueled an explosion of IT innovation over the last two decades have also served to increase organizational and operational complexity. In the process IT direction and purpose has become balkanized. What is needed is a comprehensive strategic IT vision that informs and realigns workforce thinking and actions within a university-wide agenda.

**(b) NC State’s strategic IT investment and management vision must encompass diverse learning and research goals and embrace the technological diversity required to achieve them.** Today’s governance climate tends to value the things that can be easily measured at the expense of the things that are difficult to measure. Much of our educational and research activity falls into this latter category. The current tendency to measure the success of IT investments exclusively in terms of cost reduction is to be avoided; an appropriate strategic IT vision is not monolithic.

#### **4. NC State must be committed to prodigious human capital management, including enhanced training, and re-purposing of jobs.**

Change is at best intimidating and disruptive of workflows; at worst it can be frightening and destructive of workforce morale. This document advocates, and has built the case for, systemic changes to our IT structures and processes to respond appropriately to economic pressures and unmet campus needs. One dimension of meeting this challenge is to improve the alignment of resources and needs. Job changes and reassignments will be inevitable. And while not every job can be guaranteed, the skill and adaptability of our technical workforce makes a relatively smooth transition a reasonable possibility provided priority, empathetic, and skilled attention is given to the attendant human factors.

#### **5. NC State must improve institutional accountability for IT investment decisions and results.**

Despite improvements and noteworthy examples to the contrary, campus investment decisions are still often made within the limited context of individual units, thus providing local optimization at the expense of university-wide optimization. NC State must coordinate all individual unit IT decision-making into a coherent template supporting university-wide accountability for IT investment outcomes. This is *not* a requirement for across-the-board IT uniformity, but rather a requirement for a set of common mechanisms to identify investments and assess their performance, both locally and institutionally. The GAO report identifies post-implementation reviews as a key mechanism for assessing the outcome of an investment relative to its pre-implementation plans and expectations. **IT investment performance must become a factor in budget and resource allocations for colleges and units across the campus.**



### *Next Steps*

Change will require a *call to action* from the top. It must be a call from the Academic and Administrative Coordinating Group (AACG) that activates engagement across the institution. Faculty and staff are going to be asked to step out of their comfort zones and confront the twin challenges of greater individual autonomy and greater individual responsibility. They are going to be asked to be more holistic in their thinking and strategic in their actions. Engagement will be mandatory, purpose paramount, and “Why?” will become a recursive question demanding of an evolving answer. The authors look to broadly disseminate the concepts presented and to move people into thinking in and about a new paradigm.

*Make every cell the holder of the genetic code.  
Everyone must be a keeper of the vision –  
responsible for delivering on your purpose.  
(Keith Yamashita & Sandra Spataros)<sup>5</sup>.*

NC State has the potential to radically improve its performance in serving the research, teaching, learning, and service goals defined through LITRE and other avenues. Realizing this potential, however, will require letting go of considerable historical baggage. We need to adopt and develop new processes that lead to a mature IT investment strategy. Good investment practices must be reinforced through compact planning and performance assessments. ***The decisive challenge we face is whether or not we can muster the will to change and the resolve to make it transformative.***

*Graphic design and illustrations by Melinda Fine.*

### ENDNOTES

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<sup>1</sup> <http://www.wildblueyonder.biz/p179.html>. Accessed Aug. 20, 2004

<sup>2</sup> P. Freeman and W. Aspray, *The supply of information technology workers in the United States*, Computing Research Association: Washington, DC, 1999.

<sup>3</sup> Computing Research Association, <http://www.cra.org/govaffairs/index.php>; “Brain Drain in Tech’s Future?” <http://www.cra.org/govaffairs/blog/archives/000126.html> ; “Slides from CRA Computing Leadership Summit Online!” <http://www.cra.org/govaffairs/blog/archives/000040.html>; J. Sargent, *Adequacy of the US Science and Engineering Workforce*,



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[http://www.cra.org/govaffairs/sargent\\_adequacy\\_of\\_S-EW.ppt](http://www.cra.org/govaffairs/sargent_adequacy_of_S-EW.ppt). Sargent is Sr. Policy Advisor at Technology Administration (<http://www.technology.gov/>), US Department of Commerce (<http://www.commerce.gov/>); Information Technology Association of America, <http://www.itaa.org/>.

<sup>4</sup> [LITRE goals, http://litre.ncsu.edu/dfiles/goals.html](http://litre.ncsu.edu/dfiles/goals.html). Accessed Aug. 18, 2004.

<sup>5</sup> See Appendix A for excerpts from the Government Accountability Office report, "Information Technology Investment Management: A Framework For Assessing and Improving Process Maturity," GAO/AIMD-10.1.23, May 2000, version 1. Updated GAO-04-394G, March 2004, version 1.1 <http://www.gao.gov/new.items/d04394g.pdf>. Accessed Sept. 13, 2004.

<sup>6</sup> The abbreviated version of NC State's mission statement reads as follows: "The mission of North Carolina State University is to serve its students and the people of North Carolina as a doctoral/research-extensive, land-grant university. Through the active integration of teaching, research, extension, and engagement, North Carolina State University creates an innovative learning environment that stresses mastery of fundamentals, intellectual discipline, creativity, problem solving, and responsibility. Enhancing its historic strengths in agriculture, science, and engineering with a commitment to excellence in a comprehensive range of academic disciplines, North Carolina State University provides leadership for intellectual, cultural, social, economic, and technological development within the state, the nation, and the world." This document can be found at

<http://www2.acs.ncsu.edu/UPA/strategicplan/mission.htm>

<sup>7</sup> It is to be hoped that smaller devices make the environmental toll of disposability a less troubling issue as a result. The authors of this white paper believe that higher education needs also to be responsive to the reality of disposable technology. Attention needs to go toward developing biodegradable, eco-friendly materials; and curricula in design, engineering, and textiles, to name a few, are needed. There are issues of ethics involved that should also be explored in academic settings. The university must be responsive and proactive in a culture where rapid technological change is here to stay.

<sup>8</sup> G. Rostky, "Design Classic: Disk drives take eventful spin," *EE Times Online*, July 8, 1998, <http://www.eetimes.com/news/98/1016news/disk.html>. Accessed Aug. 24, 2004.

<sup>9</sup> See Appendix B for a more detailed discussion of the Virtual Computing Lab Initiative.

<sup>10</sup> L. Gerstner, *Who Says Elephants Can't Dance? Inside IBM's Historic Turnaround*, HarperBusiness, 2002.

<sup>11</sup> "India hails China as hi-tech ally," *BBC News World Edition*, June 26, 2003, <http://news.bbc.co.uk/2/hi/business/3022204.stm>; "CFO: US increasingly outsources tech R&D to India and China," *The Economist: ebusinessforum.com*, Oct. 1, 2003, [http://www.ebusinessforum.com/index.asp?layout=rich\\_story&channelid=2&categoryid=13&doc\\_id=6744](http://www.ebusinessforum.com/index.asp?layout=rich_story&channelid=2&categoryid=13&doc_id=6744)



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- <sup>18</sup> "Getting IT Right," p. 5.
- <sup>19</sup> M. Struckman and C. Struckman, *Public CIO 3*, vol. 2, Fall 2004, pp. 27-31.
- <sup>20</sup> "Information Technology Investment Management," p.1.
- <sup>21</sup> "Information Technology Investment Management," p. 17.
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<sup>25</sup> JSurowiecki, “Smarter than the CEO,” *Wired Magazine*, June 2004, <http://www.wired.com/wired/archive/12.06/view.html?pg=2>. Accessed September 24, 2004.

<sup>26</sup> At the same time, we must be wary of the “design by committee” syndrome that may provide inappropriate (but compromise-based) solutions and no personal accountability for mistakes and disasters. Decisions must be informed, but a clear line of responsibility for those decisions must also be established.

<sup>27</sup> “Next-generation CIOs,” *McKinsey Quarterly*, Sept. 15, 2004 [http://www.mckinseyquarterly.com/article\\_print.aspx?L2=13&L3=0&ar=1451](http://www.mckinseyquarterly.com/article_print.aspx?L2=13&L3=0&ar=1451)

<sup>28</sup> “Information Technology Investment Management,” p. 19; see Appendix A for excerpts from most recent version of report.

<sup>29</sup> *Final Report: Study of Information Technology Expenditures in State*, as directed by House Bill 397, Section 21.1 of the 2003 Session of the North Carolina General Assembly, Office of State Budget and Management, April 2004, [http://www.osbm.state.nc.us/files/pdf\\_files/2004\\_IT\\_Report.pdf](http://www.osbm.state.nc.us/files/pdf_files/2004_IT_Report.pdf). Accessed Aug. 24, 2004.

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<sup>e</sup> M. Nelson, speech at one-day conference on Grid computing sponsored by MCNC and SAS Institute.

<sup>f</sup> K. Kelly, *New Rules for the New Economy*, Viking Press, 1998, p. 110.

<sup>g</sup> C. Fishman, “Change: Few can do it. Few can sustain it. Few can survive it.” *Fast Company*, Apr./May 1997, p. 64, <http://www.fastcompany.com/online/08/change.html>.

<sup>h</sup> K. Kelly, p. 157.



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<sup>i</sup> L. Gerstner, recalled by Barbara Ellis of talks by Gerstner when he first arrived as the new CEO; Ellis served at the time in IBM's Customer Relationship Management, 1991-1994.

<sup>j</sup> J. Surowiecki, "Smarter than the CEO," *Wired Magazine*, June 2004, <http://www.wired.com/wired/archive/12.06/view.html?pg=2>. Accessed September 24, 2004.

<sup>k</sup> G. Irwin and G. Rao, "Getting IT Right: An Approach to Managing Complexity," Booz Allen Hamilton, *CIO.com*, July 15, 2004, <http://www2.cio.com/consultant/report2687.html>.

<sup>l</sup> G. Chaucer, quoted in *Wise Old Sayings.com*, <http://www.wiseoldsayings.com/wosdirectoryn.htm>.

<sup>m</sup> J.F. Kennedy, quoted in *The Quotations Page*, John F. Kennedy, [http://www.quotationspage.com/quotes/John\\_F\\_Kennedy/](http://www.quotationspage.com/quotes/John_F_Kennedy/).

<sup>n</sup> L. Gerstner, *Who Says Elephants Can't Dance? Inside IBM's Historic Turnaround*, HarperBusiness, 2002, p. 43.

<sup>o</sup> Comment by university professional IT staff member at staff meeting, NC State University, 2004.

<sup>p</sup> D. Walker, quoted in conference materials for *Going Beyond Green: Strategic Transformation Through Human Capital Planning*, Nov. 2002, <http://www.customerservice.gov/assets/conf.pdf>.

<sup>q</sup> "Effective Change Management Pays," *McKinsey Quarterly*, June 2004, [http://www.mckinseyquarterly.com/newsletters/chartfocus/2004\\_06.htm](http://www.mckinseyquarterly.com/newsletters/chartfocus/2004_06.htm).

<sup>r</sup> W. Kelly, "Pogo" (comic strip), *The Quotations Page*, Walt Kelly, [http://www.quotationspage.com/quotes/Walt\\_Kelly/](http://www.quotationspage.com/quotes/Walt_Kelly/).

<sup>s</sup> K. Yamashita and S. Spataro, *Unstuck*, Portfolio, 2004, p. 123.



## Figures and Charts

**Figure 1:** Moore's Law Change

**Figure 2:** Cyclic Evolution of Technology

**Figure 3:** Bifurcation in the Next Generation IT

**Figure 4:** Educational Networks and Affiliations

**Figure 5:** Email Sent Through ITD Relays

**Figure 6:** GAO Framework for Assessing and Improving IT Process Maturity

**Figure 7:** University IT Committee

# MOORE'S LAW CHANGE

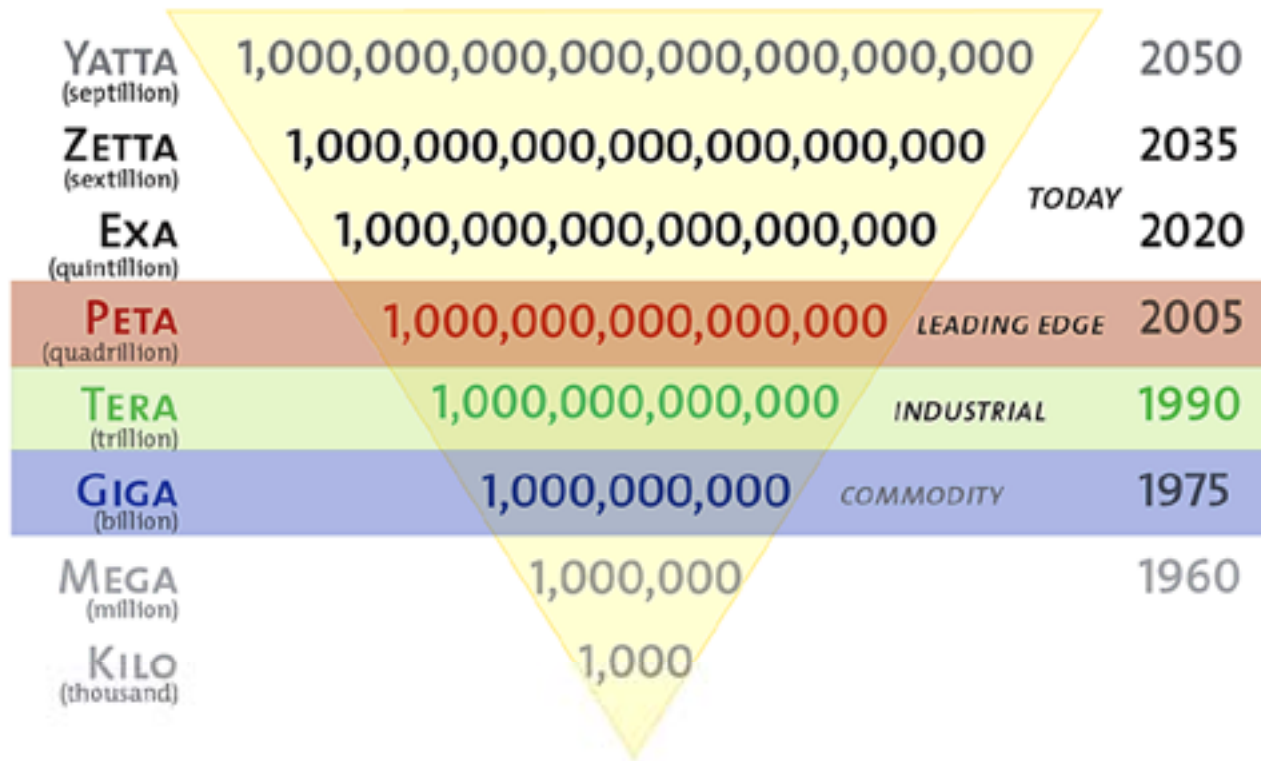
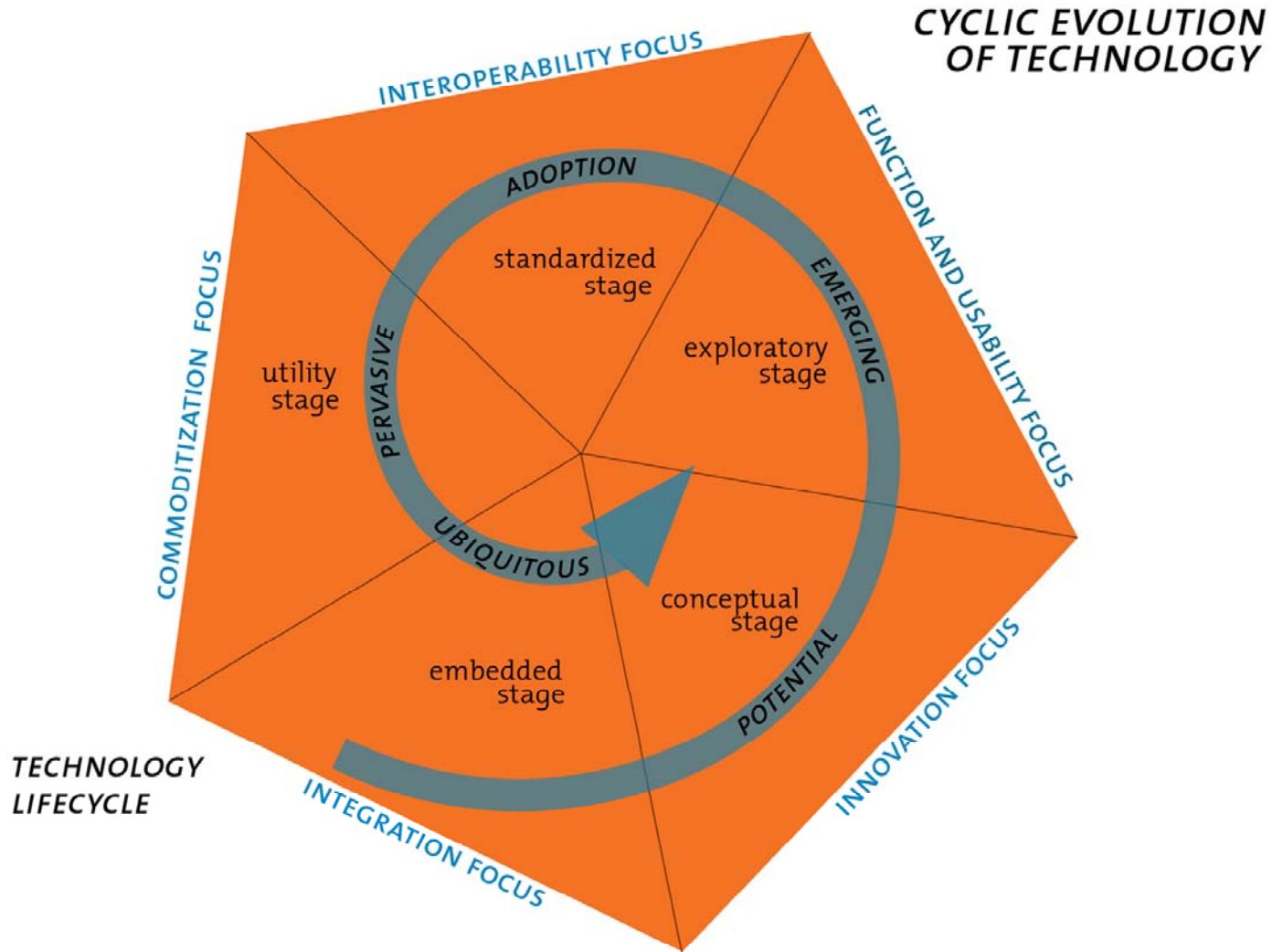


FIGURE 1

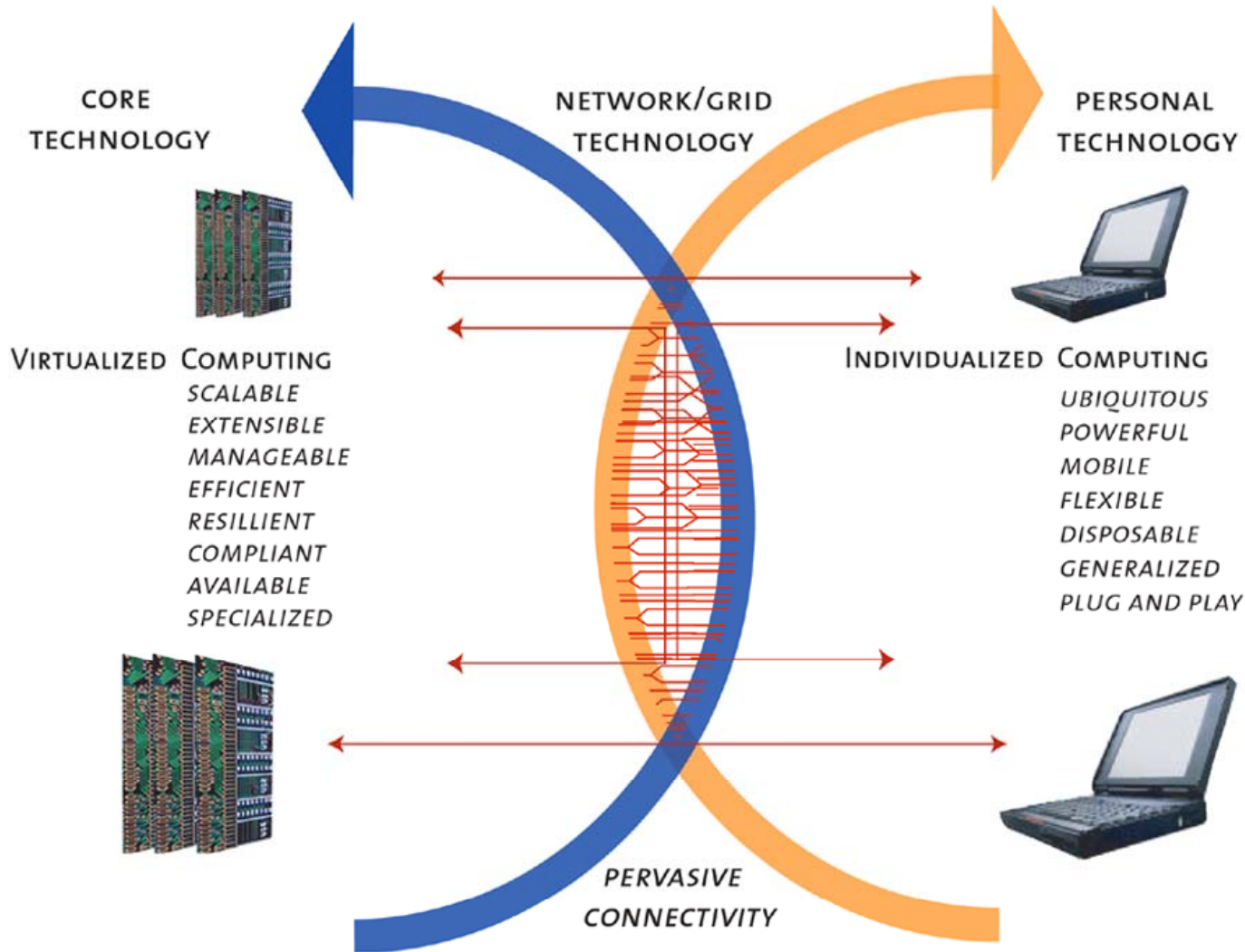
*Each successive horizontal band represents an increase in capacity and speed by x1000. If technology continues to double every 18 months over the next 45 years, devices in 2050 will be one billion times more capable than the ones today. The enormity of this increase makes it difficult to even imagine the implications.*



**FIGURE 2**

*Technologies evolve and mature. Each stage requires structural and process changes. The technology changes, the process repeats, and time contracts. Maturity of the last generation technology becomes the foundation of the next.*

# BIFURCATION IN THE NEXT GENERATION IT



**FIGURE 3**

*21<sup>st</sup> century technology is coalescing into two complementary clusters: consumer and infrastructure. Commensurately, IT is becoming an increasingly embedded part of our social and cultural fabric. Understanding and leveraging this realignment is essential to future success.*

# EDUCATIONAL NETWORKS AND AFFILIATIONS

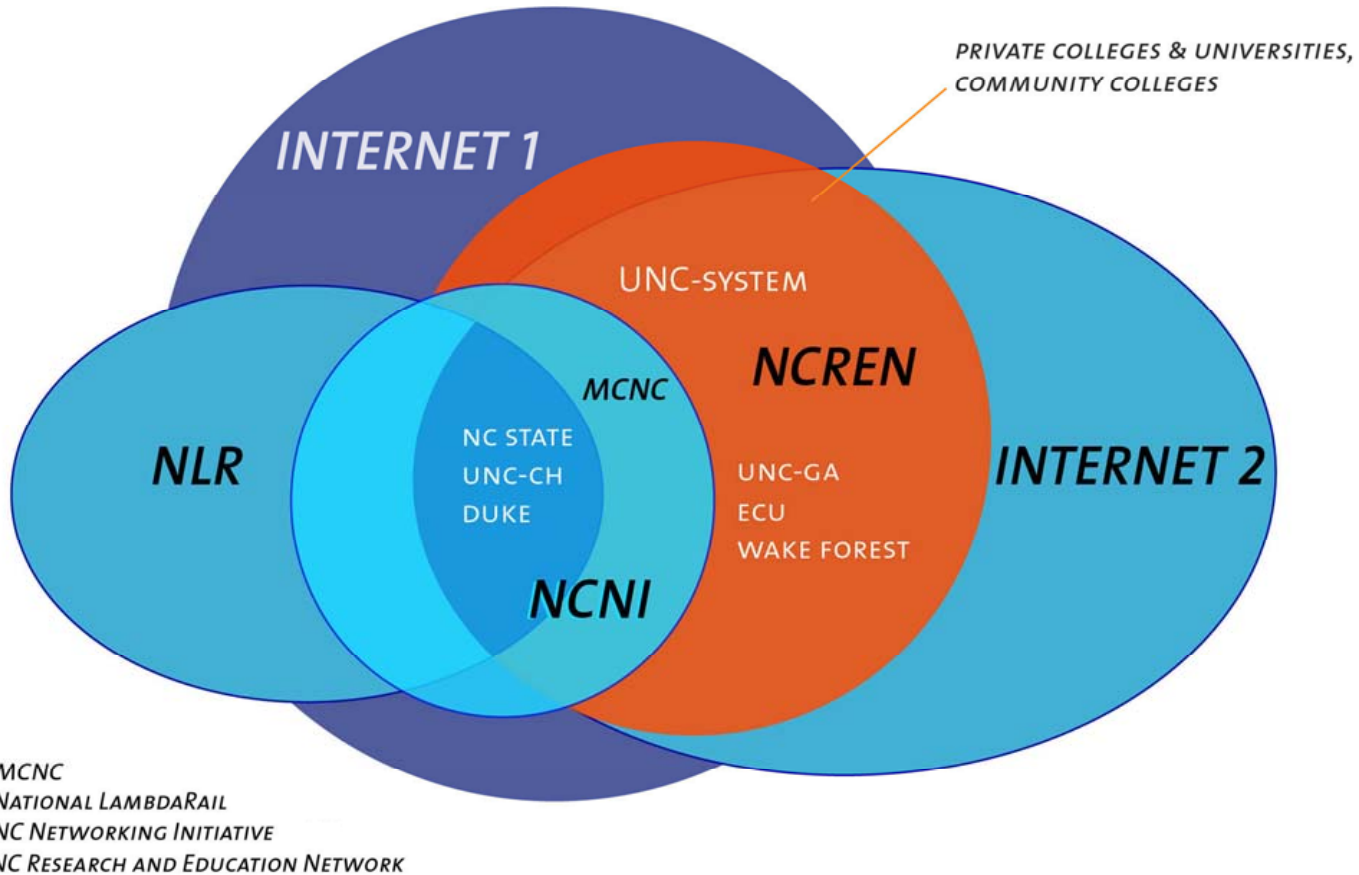


FIGURE 4

*Networking evolved in a highly distributed manner and remains so today because of continuing rapid technological advances and success of the peer-to-peer operational model. The diagram shows networks serving NC higher education and the overlapping institutional affiliations.*

# Email Sent Through ITD Relays

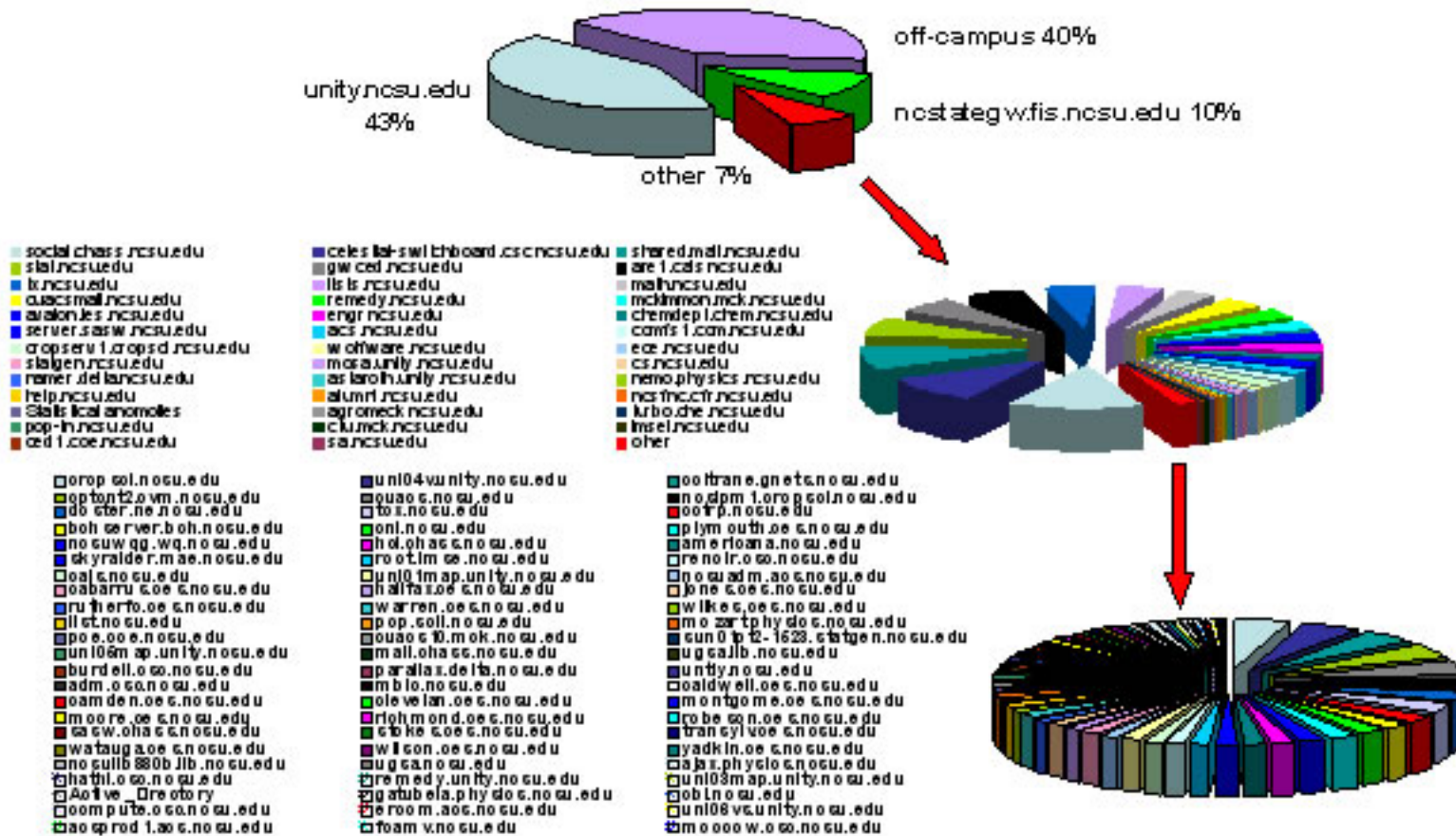


FIGURE 5

*As IT services mature and use becomes pervasive the services inevitably acquire regulatory, security, performance, and interoperability constraints. Legacy behaviors sometimes represent a failure to keep pace, but more often they represent a skills gap and/or an attempt to bypass legitimate governance.*

# GAO FRAMEWORK FOR ASSESSING AND IMPROVING IT PROCESS MATURITY

## ENTERPRISE AND STRATEGIC FOCUSED

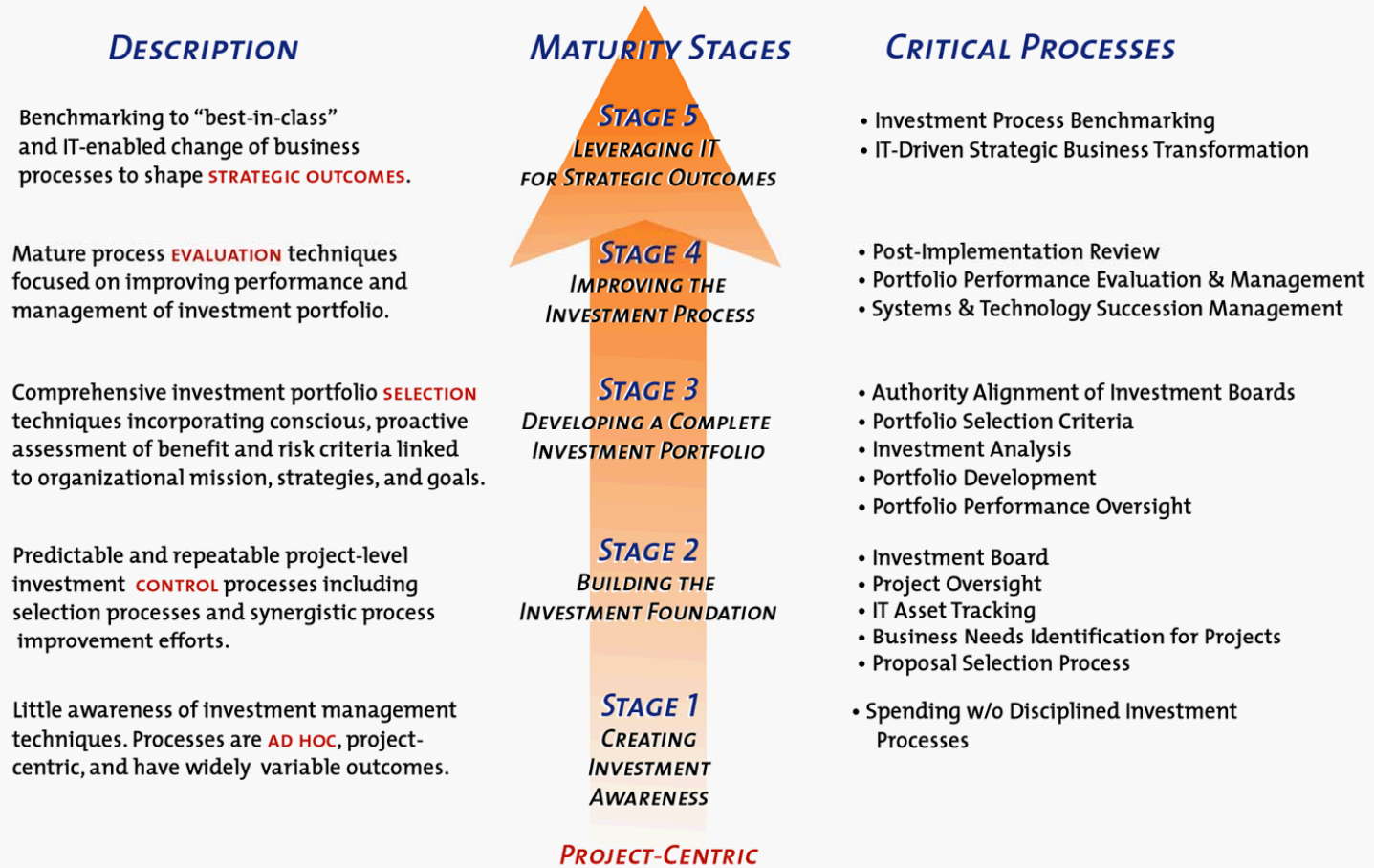


FIGURE 6

*The GAO framework provides a rigorous, high quality methodology for process development. The report identifies processes critical to ITIM maturity and provides guides for linking these processes to an agency’s or institution’s unique mission and goals.*

# UNIVERSITY IT COMMITTEE

*ADDRESSING ISSUES AT THE INTERSECTION OF TECHNOLOGY, PRACTICE AND MISSION*

CO CHAIRS: VICE PROVOST FOR IT

ASSOC. VICE CHANCELLOR FOR RMIS

## MEMBERSHIP:

### COLLEGE REPRESENTATION (ACADEMIC + TECHNICAL)

AGRICULTURE AND LIFE SCIENCES  
DESIGN  
EDUCATION  
ENGINEERING  
GRADUATE SCHOOL  
HUMANITIES & SOCIAL SCIENCES  
MANAGEMENT  
NATURAL RESOURCES  
PHYSICAL & MATHEMATICAL SCI.  
TEXTILES  
VETERINARY MEDICINE

### ORGANIZATIONAL/GROUP REPRESENTATION

NCSU LIBRARY  
FACULTY SENATE  
STAFF SENATE  
STUDENT GOVERNMENT  
DELTA  
INFORMATION TECHNOLOGY DIVISION  
RESOURCE MGT INFORMATION SERVICES  
UNDERGRADUATE AFFAIRS  
STUDENT AFFAIRS



*UIT facilitates the development and continuing evolution of campus IT strategy to improve service delivery, effective use, and mission outcomes. Recommends to Provost and VC for Finance and Business, and when appropriate, to Chancellor for approval and implementation.*

**FIGURE 7**



## Appendix A

**Excerpts from “Information Technology Investment Management: A Framework for Assessing and Improving Process Maturity,” Version 1.1, March, 2004, United States General Accounting Office (GAO-04-394G).**

In May 2000, the United States General Accounting Office (now officially renamed the Government Accountability Office) published an exposure draft of a major study entitled, “Information Technology Investment Management: A Framework for Assessing and Improving Process Maturity” (GAO/AIMD-10.1.23).

An updated Version 1.1 of this study was released in March 2004 (GAO-04-394G).

The following pages present the official summary “Highlights” of the revised version, and excerpts which include discussions of the following aspects of IT Investment Management (ITIM):

- Stages of Maturity (pp. 11-15)
- Progressing through the Stages of Maturity (pp. 15-19)
- Uses of ITIM (pp. 23-28).

Free copies of the complete report are available from the GAO Web site:

[www.gao.gov/](http://www.gao.gov/): <http://www.gao.gov/new.items/d04394g.pdf>

or, for the accessible text <http://www.gao.gov/atext/d04478t.txt>



## Appendix B

Overview of NC State Virtual Computing Lab project, launched fall 2004. See also, <http://vcl.ncsu.edu>.