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STRATEGIC MODEL FOR THE ARMY NATIONAL GUARD NETWORK TRANSFORMATION

LTC (P) Robert E. Banks, (TxARNG), and
Maj Clayton Duncan, USAF

Defense acquisition policy directs all participants in the acquisition system to recognize the reality of fiscal constraints and to view cost as an independent variable. By direction, "Milestone Decision Authorities (MDAs) are to identify the total costs of ownership and, at a minimum, the major drivers of total ownership costs." This article describes an Information Technology (IT) Modernization Strategic Driver Model, applies it to the modernization efforts of Army National Guard (ARNG) Joint Force Headquarters (JFHQ) Wide Area Network (WAN), and analyzes the model's impact on accomplishing defense acquisition system policy objectives. The article establishes and supports that a properly developed strategic model permits decision makers to align acquisition program and technical planning to strategic drivers.

"The significant problems we face cannot be solved at the same level of thinking we were at when we created them."

– Albert Einstein

Acquisition and modernization of information technology systems is an uneasy balance for mission support personnel. Those responsible are challenged by the quickened pace of change and dwindling resources for implementation and maintenance. These same rapid technological advancements almost overtook the Reserve Component Automation System (RCAS) program before it was fully implemented and now have stretched the RCAS-deployed IT systems beyond

the operational design capabilities (Brady, 1998). This reinforces the need for military networks to undergo a period of revolutionary or even disruptive rather than evolutionary change, that is, a *Transformation*. Strategic planning for the modernization of the JFHQ WAN would be a vital aspect of the ARNG military network transformation.

The American soldier is empowered in war by new technology, just as information technology has empowered consumers (Vandergiff, 2002). The G6 applications of Information Management (IM) and IT concepts are leading the military's transformation of its networks to increased responsiveness in mission support. These officials are responsible for integrating policy, process, and technology through the initiation, validation, and enforcement of business process re-engineering. However, many well-intended officials do not apply the engineering principles associated with rapidly changing technology. Often, their validations focus on one or two core factors, such as *New Technology* or *Governance*, without also considering the second-order effects of other core factors, such as *Legacy Systems* or *Funding*. The same holds true for third-order effects that involve *Support* or *Services* of the variety of models. This article describes an IT Modernization Strategic Driver Model, as shown in Figure 1, and applies it to the modernization efforts of ARNG JFHQ. This model shows that IT operational core factors' actions can align with the strategic objectives. Decision makers often don't visualize the effects of their network-change decisions from a strategic model viewpoint, nor are they fully aware of the best methodology to achieve strategic IT objectives. This limited perspective

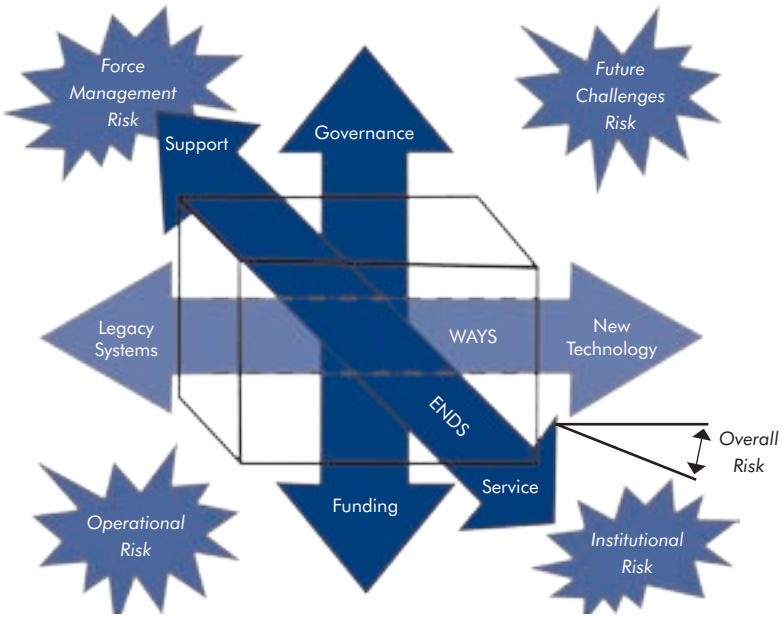

FIGURE 1. INFORMATION TECHNOLOGY MODERNIZATION MODEL

* The ideas represented in this figure are the authors' concept of a strategic model that permits ARNG decision makers to better align actions to achieve strategic Information Technology (IT) objectives.

results in new stovepipe, stand-alone IT platforms and networks, rather than the more robust enterprise network solutions that are truly capable of providing new communication essential *Services*.

To ensure a comprehensive knowledge of more constructive ways to achieve WAN modernizations, we begin with a discussion of the main IT modernization drivers, transformation axioms, and strategy influences. Next, we examine a strategic decision model and offer an Information Technology Modernization Model to balance limited resources among conflicting interests within a strategic IT decision-making framework. We then describe recent practices that highlight the need for a better application of the engineering laws to align decisions and actions with strategic IT objectives. Finally, we suggest how personnel at the operational level, who deal with these core factors of network modernization, can exploit technology changes to achieve their strategic IT objectives.

Decision makers often don't visualize the effects of their network-change decisions from a strategic model viewpoint

CORE FACTORS

MISSION

The Army National Guard, along with the Active Army and the Army Reserve, are partners in fulfilling the nation's military needs. Due to the Global War on Terrorism (GWOT) and other requirements, the 54 JFHQ WANs of the Guard (one per state/territory) need upgrades and more robust networks to support the essential services to satisfy the command and control, administrative, health, and welfare needs of soldiers both here and abroad. On a broader scale, to effectively engage in the GWOT these ARNG state-level WANs need improved connectivity with other DoD commands and federal government agencies.

SERVICE AND SUPPORT

Clayton M. Christensen, author of *The Innovator's Dilemma*, examined the reasons why many good organizations (companies) fail to remain atop of their industries when confronted with a disruptive market and technological change (Christensen, 1997). Christensen discovered these organizations achieved their leadership when both company officials and their customers became heavily focused on the same objectives. However, Christensen also found businesses tended to optimize and localize current capabilities to obtain short-term gains, rather than take on the challenges of new systems that would yield a more widespread benefit influencing future operations and profitability (Fastabend & Simpson, 2004).

Within most organizations, the role of information technologies and networks has changed and grown; therefore, technology and WAN investments should undergo a similar change. In the past, IT organizations ran effectively as local support functions. However, most new IT applications now span the entire organizational enterprise, and they are an integral part of its operations and support functions. These applications also connect via linked networks to external joint partners and customers (Lohmeyer, Pogreb & Robinson, 2006). Today, IT managers are key team players in the development and delivery of new technology network-based products and services. In an effort to gain competitive edge, IT initiatives are now generally sparked and led by organizational business leaders, and not the IT staff. In an effort to enhance mission success, comply with net-centric key performance parameters, and better leverage senior leader programs, IT refresh, upgrades, and modernization initiatives are driving organizational leader performance demands.

These leaders are trusted to accomplish these strategic goals with limited or redirect allocation and resources. Modernization initiatives and execution designed for customer satisfaction enhance the importance of IT support within the organization and affect their strategic IT goals. In addition to adding capabilities, the associated training cost over several years can exceed the cost of a new IT system. As a result, an organization's proposed IT training budget may be in direct competition with desired technological upgrades. The IT technicians who maintain these systems have perishable skills. If not refreshed via training, these vital human capital assets lose value. Proper force management requires balancing desired institutional services with the training required to sustain a skilled support staff.

NEW TECHNOLOGY AND LEGACY SYSTEMS

Technology is racing ahead, and today's equipment will be considered obsolete in less than 10 years. For example, consider the brief life span of the 1994 Pentium chip and associated desktop computers (Kurzweil, 2003). It took only a few years for the original Pentium systems to be totally outdated, that is, replaced by a series of Pentium I, II, and III upgrades. Such rapid technology changes did not occur 53 years ago when the B-52A first flew in 1954. Today, these same B-52s are one of the few exceptions to obsolescence. These old weapons platforms continue to perform, mostly due to well-planned and -engineered evolutionary upgrades. They delivered 40 percent of all air-dropped explosives during Desert Storm (Air Force Link, October 2005).

Today, the match between process and product continues to shift dramatically. The best organizations use standard application packages for routine tasks; however, they minimize customization of these products. In addition, to ease integration between departments, they keep their network infrastructures as uniform as possible. In these ways, organizations shift spending away from maintaining IT systems and network capabilities. Instead, they move towards developing new applications—these are the ultimate drivers of network-based IT Services and can be used as a measure of an organization's value.

In technology, there are definitions of how things operate, such as Ohm's Law for voltage across a component, and Kirchhoff's Laws for current in a circuit. Additionally, so called "laws" ingrained in mainstream culture aren't really laws at all. Instead, they are folksy rules of thumb. For example, Murphy's Law (first uttered in 1949) said that, "If there are two or more ways to do something and one of those ways can result in a catastrophe, then someone will do it."

One question raised by these rules-of-thumb is the "legitimacy" status. Do these laws merely describe reality or do they create it? Some of these so called rule-of-thumb "laws" have stood out by driving today's technology changes (Ross, n.d.). Present network implementations have not paid sufficient attention to the engineering laws and their combined beneficial or detrimental influences on network modernizations. The most significant of changes applicable to IT and network modernizations are changes in capability, bandwidth, and value as alluded to by these three laws (strategic drivers):

1. Moore's—The number of transistors on a chip doubles annually.
2. Nielsen's—Internet connection speed will grow by 50 percent per year.
3. Metcalfe's—A network's value grows proportionately to the number of its users squared.

MOORE'S LAW

Often referred to as the mother of all "engineering laws/rules of thumb," Moore's Law was suggested in a 1965 Intel Corporation paper (Moore, 1965). Today, this law is

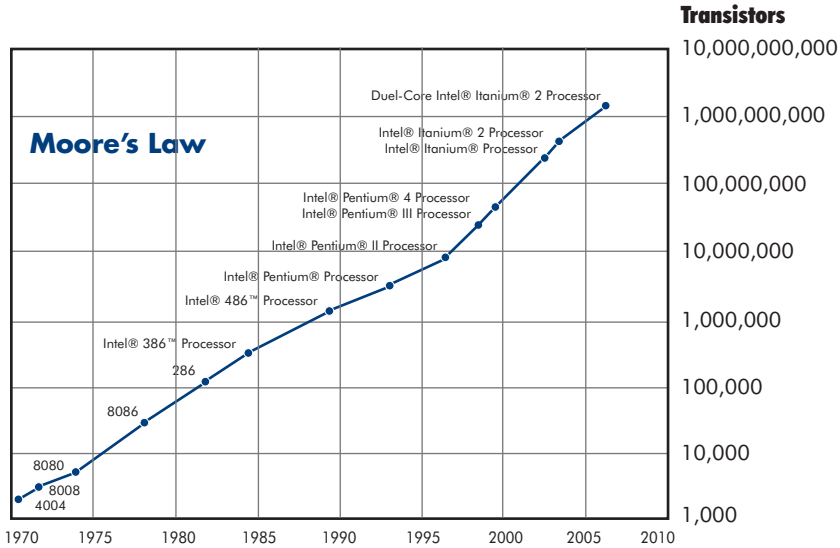

FIGURE 2. INTEL PROCESSOR PERFORMANCE

* Moore's Law Made Real by Intel® Innovation. Retrieved Nov. 15, 2007, from http://www.intel.com/technology/mooreslaw/index.htm

integrated into the "road map" of many industries, and is used as a measurement bar to assess corporate achievement. It was Carver Mead of California Institute of Technology, not Moore, who dubbed this rule a "law" many years after Moore's initial paper.

Clearly, Moore's Law drives technology's pace. This implies that DoD acquisition programs and technical strategies must be structured to leverage Moore's Law as a driver (Department of Defense, DoDD 5000-1, May 12, 2003). Processing power, measured in millions of instructions per second (MIPS), has steadily risen because of increased transistor counts. Figure 2 characterizes this chip-doubling in performance terms, which has impacted IT servers, routers, and switches. Applying this law is equivalent to a requirement for an approximately 60 percent average annual growth in an organization's IT equipment capability. The second- and third-order effects certainly influence an organization's acquisition strategies and procurement plans.

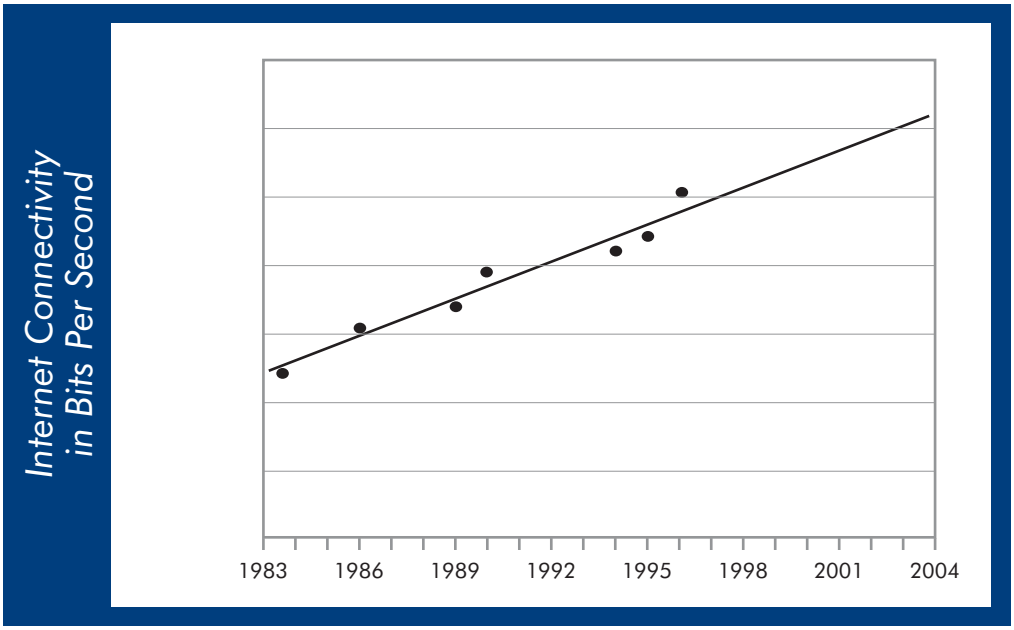

FIGURE 3. NETWORK CONNECTIVITY SPEED

* Nielsen, Jakob. (1998, April 5). Nielsen's law of Internet bandwidth. *Jakob Nielsen's Alertbox*. Retrieved March 17, 2006, from http://www.useit.com/alertbox/980405.html

NIELSEN'S LAW

Nielsen's Law deals with bandwidth growth within the Internet. In 1998, Jakob Nielsen, an Internet usability expert, predicted that a high-end user's Internet connection speed will grow by 50 percent per year (Nielsen, April 5, 1998). This law impacts the *Services* roll-out pace. Figure 3 shows 2001 full T-1 (1,544,000 bps) bandwidth upgrades for GWOT support were surpassed in the following year. Bandwidth available to the user will remain a gating factor in the Internet speed and quality experience, so what's the organization's acquisition plan for bandwidth growth?

METCALFE'S LAW

Metcalfe's Law asserts that a network value grows proportionally to the number of users squared. In the 1980s, Robert Metcalfe, founder of Ethernet and 3Com Corporation explained, "Having the one telephone in the world would be of zero value, but this value increases for each new telephone it can call." Applying this law means the value of single JFHQ WAN increases with Internet Protocol (IP) convergence of its current voice, video, and data capabilities with those of other linked IP networks. In 1993, Forbes ASAP maintained Metcalfe's Law would amplify Moore's and, in so doing, remake the world. Do our Acquisition Strategies facilitate technologies' convergence for increased service value?

Instead of adopting a prioritized modular approach for constructing high-value, large-scale networks, decision makers have sometimes opted instead to build isolated new technology WAN solutions, either as showplaces or test beds for the latest IT equipment capabilities. This approach undermines and delays an organization's transition to a larger-scale, more capable enterprise network that benefits many, rather than a few. Similarly, in the long term, attempts to retain existing *Legacy Systems* prove to be equally counterproductive. As stated in Metcalfe's Law, a network that is twice as large, will be four times as valuable, because there are four times as many things that can be done due to a larger number of interconnections. Therefore, larger enterprise-solution networks will always be of greater value than smaller networks, even if these smaller versions have desirable, special-purpose features or benefits (Nielsen, July 25, 1999). The conclusion is that it is far better to invest in enterprise-level network solutions, such as the Global Information Grid (GIG), which will ultimately provide high-speed, all-Command access to the Guard's JFHQ WAN. For the ARNG, this means it should continue to modernize all 54 of its state-level WANs to the new GIG standards and eliminate its *Legacy Systems* in order to become a fully compliant member of the DoD's secure, worldwide GIG network solution.

GOVERNANCE AND FUNDING

Governance ensures decisions are aligned with the overall strategy of an IT enterprise network. It provides guidance and establishes standards and principles for prioritizing and managing investments. However, *Governance* is not a safe haven that averts risk. Rather, risks are identified, assessed, tracked, reported, controlled, transferred, assumed, or mitigated. When decision-maker actions are properly aligned to IT strategic network objectives and the appropriate drivers, they can continue to leverage cost, schedule, and performance metrics for mission success.

IT network investments have the potential to improve lives and organizations. However, if not planned and implemented well, these projects can also become risky, costly, and counter- productive. Portfolio Management (PfM) is a strategy for managing IT capital investment and control (Portfolio Management [PfM] Overview, n.d.). The main benefit of judicious PfM is a more accurate alignment of an organization's network and technology needs to its business goals and missions.

Information technology ease of information access reduces uncertainty; but, IT can also develop redundant processes that require additional efforts for interoperability.

Therefore, IT decision makers must balance these efforts and should concentrate on a limited number of key impact areas and equipment selections that benefit the greater user population. Spending on equipment should also be influenced by adherence to the technology standards of the targeted parent network, such as the Army's LandWarNet and the DoD's GIG. "The importance of standards" balances, to some degree, the risks associated with *Legacy Systems* and the estimated needs of future applications.

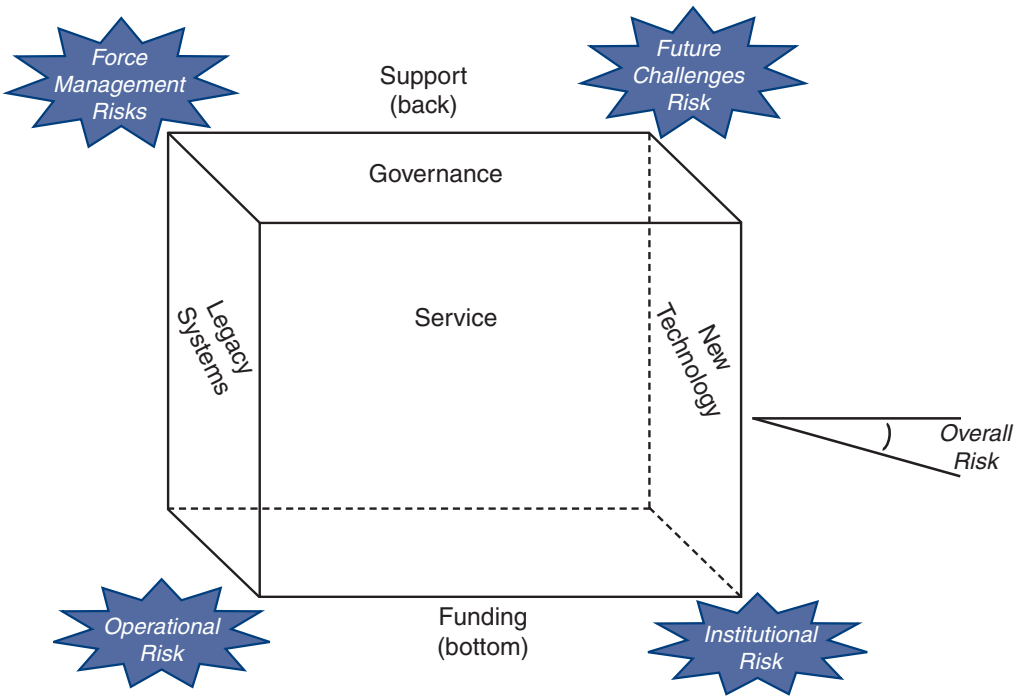

FIGURE 4. CORE FACTORS RISK

* The ideas represented in Figure 4 are based on publicly available sources of risk to link them with IT core factors in the development of the authors' strategic model.

RISK

Managing risk is central to the new way of thinking within DoD. In a complex enterprise network, it's essential to assess the risks associated with *IT services and support*, such as those shown in Figure 4. For example, consider the factors involved with institutional risk of *new technology*, which often counter the factors affecting force management risk, that is, the ability to recruit, train, equip, and retain quality personnel. Then, there's the risk in future challenges, that is, the ability to invest in new services and operational concepts. These should be balanced with the funding and governance of operational risk factors, as well as *funding of legacy systems* to shape the near-term objectives (Department of Defense, *Military Transformation—A Strategic Approach*, 2003).

The goal of risk management in science and technology is to seek workable solutions by exploiting technology advantages, while continuing to incorporate innovation into military organizations (Sinnreich, July 14, 2002). Technology alone does not dispel uncertainty or eliminate frictions that occur from actions within our current organizational structures. War and transformational change are inseparable, and success in both is about identifying and mitigating the major risks in a cost-affordable manner.

TRANSFORMATION

War transforms an Army. America is at war, while simultaneously revamping policies and processes to change and reshape the Department of Defense workplace. Most large organizations—like Dell's Just-in-Time Operations—embrace continuous adaptations to remain ahead or overtake their competitors. Being at war accelerates change from the academic debates and speculations into an immediate need for realistic approaches to develop and deliver new capabilities, which are needed now.

The Army has an extraordinary record of anticipating and leading change. The 1960s brought about the advancement of the airmobile concept; the 1970s emphasized doctrine development and training revolution; and the 1990s introduced digital technology warfare (Fastabend & Simpson, February 2004). These remarkable innovations all require the willingness to use resources differently to maximize the use of new capabilities.

Transformation of all types focuses on effects-based thinking. The strategic objective of this thinking is to obtain a desired outcome through the collective application of the ideas obtained at the tactical, operational, and strategic levels. This approach, when applied to the challenge of JFHQ WAN upgrades, should change the structure and the actions ARNG decision makers incorporate and stress in the planning and execution of their network upgrade operations.

AXIOMS

Mr. David J. Ozolek, the Executive Director of the Joint Futures Lab for U.S. Joint Forces Command, J9, recognizes that there are many definitions for transformation. This official knows the Army's Transformation Strategy has three major components: the Process, Capabilities, and Culture. Ozolek's view is slightly different from the ideas above, but it supplements this discussion. It suggests the following (Ozolek, June 24, 2005):

- Do things in a fundamentally different (and better) way
- Enable by technology
- Accomplish upgrades with minimum change

The lessons learned in 4 years of the GWOT remain the catalysts for comprehensive change within the JFHQ WAN community. The ARNG should use PfM to further examine its network baselines and assess concepts that employ new organizational constructs, capabilities, and policies to achieve long-term, enterprise-

level improvements. It should then determine whether these findings are sufficiently transformational to justify major investments. Finally, ARNG decision makers should adjust JFHQ WAN *governance and funding* to well-engineered, validated IT initiatives that ultimately benefit the total ARNG enterprise network.

BENEFITS

While there are many potentially useful technology upgrade options, decision makers sometimes do not fully understand the core factors associated with IT system modernizations or how and where to make the best use of new technology. Upgrade solutions should drive the processes. Under no circumstance should resident processes be allowed to constrain possible solutions. Fast, cheap, and reliable equipment is crucial on the battlefield; likewise, the pace of innovation must also increase to align itself with today's rapidly changing technologies. The best new solutions result from a continuous, evolutionary cycle of collaboration, feedback, and experimentation as outlined within PfM. As each participant gains a feeling of responsibility, innovation accelerates in a fundamentally different (and better) way to achieve organization objectives (Department of Defense, 2004 *Army Transformation Roadmap*).

Intel's model of transformational change requires the co-evolution of tactics, technology, and organization (Macgregor, 2003). Co-evolution is the best way to exploit available and emerging technology. The Army should adopt a similar approach to improve its technological transition and insertion approach and not wait for the next new-generation technology platforms. This infusion of intellectual property and the pace of technological advance will combine to slow the implementation process. Information Age military components' forces should do their best to avoid creating platform-constrained systems and do more to become network-centric. In addition, a much larger enterprise network is required to handle new technology and Web-based applications. The Army, as well as the ARNG, is now undergoing the most wide-ranging transformation since World War II, especially in IT.

Transformation is also necessary to ensure U.S. forces continue to operate from a position of overwhelming military advantage in support of strategic objectives. The PfM provides this continuous cycle of innovation, experimentation, and change that leads to a more responsive force, equipment superiority, and supports diverse mission requirements.

INFORMATION TECHNOLOGY MODERNIZATION MODEL

Information management strategic decision makers benefit from models and illustrations of how IT core factors and risks relate to each other. The Lykke's Stool Model (Figure 5) is commonly used in developing strategy. Strategists tend to ask three key questions: Ends, Ways, and Means. The model depicted in Figure 1 represents them as dual-arrow axes. The struggle of conflicting ideas is depicted here as "imbalance." The model's WAYS or MEANS axis tilts towards one of the listed risks. Given the rapid pace of change in today's technology, more should be done to get IT decision makers to pay greater attention to operational shifts in *services* that are necessary to achieve IT strategy objectives. This model also shows that IT operational core factors need to align with actions focused on the achievement of IT strategic objectives.

ENDS

A strategist's first key question seeks to find out "what" needs to be accomplished. Information Management's strength is derived from a balance of *service and support*. New Technology can enable *services* to do things better. However, these new *services* must be harmonized with the other core factors, like PfM, Program Objective Memorandum (POM) *funding*, maintenance of *legacy systems*, and regulatory *governance*.

Leadership balances *service* goals, such as knowledge management, within limits, to complement the force management and institutional risks. Workforce skills must continue to develop and keep pace with technology change. However, the risks associated with training expenses must not be allowed to exceed related technology upgrade costs and life-cycle benefits.

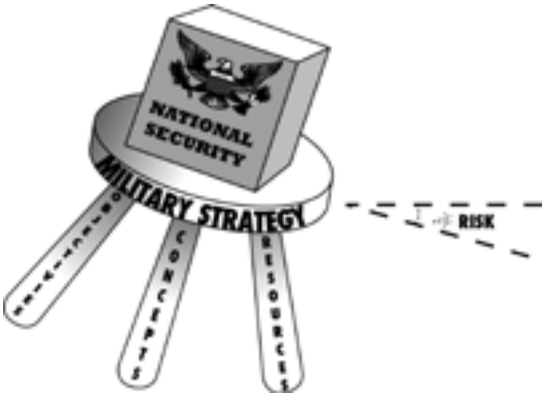

FIGURE 5. LYKKE'S STOOL STRATEGY MODEL

* The ideas represented in Figure 5 are based on publicly available sources of risk to link them with IT core factors in the development of the authors' strategic model.

WAYS

A strategist's second key question concerns how to identify the best courses of action to implement and resource strategic IT objectives. Organizations use analysis and environmental knowledge to determine how to achieve these concepts. IM effectiveness results from *services* enabled by *new technology*, and it can also be achieved when the technology facilitates transition of *legacy systems*, as referenced in Metcalfe's Law. IT investments, concentrated on a few high-priority *service* areas, are the best means to achieve JFHQ-modernized WAN strategic objectives.

Moore's and Metcalfe's laws continue to apply in the development of complex enterprise networks, so it's essential to manage these risks from multiple sources. *New technology* addresses the risk of future challenges, but it can be costly to implement and difficult to replace *legacy systems*. *Legacy systems* have the operational risk of rising costs, vendor's decreasing support, and limited new *Services*. Management should evaluate the best way to deal with *new technology*

and *legacy systems* by considering second- and third-order effects, such as funding availability and return on investment. This approach maintains equilibrium of the risks from the future challenges by leveraging these with existing operational risks.

MEANS

A strategist's third key question asks what specific resources are necessary to apply the best approach to accomplish the objectives. *Governance* and *funding* resources can either support or constrain IT strategic objectives. The benefits are attained from accurately aligning an organization's IT needs to its service needs, thereby successfully carrying out its mission. The goal is to balance the overall risks with a position located at a slightly forward tilt of new *services* to hedge the rapid pace of technology change.

Subordinates use processes and procedures to balance funded resources with relevant *governance*. In the past several years, the economic benefit of IT automation has changed rapidly. Recently, AR-25-1 was modified from a 5-year to 3-year refresh cycle. This updated regulation acknowledges IT's fast pace to obsolescence with its associated loss of vendor support, information assurance shortfalls, and deficiencies due to change, which need more timely, cost-effective alternative product and technology solutions (Department of the Army, *Army Knowledge Management and Information Technology*, July 15, 2005).

CONCLUSIONS

The GWOT is a rapidly changing asynchronous conflict that involves many varied missions and overlapping commands. Rapid successful modernization of ARNG 54 JFHQ WANs enables the Guard to effectively and efficiently participate in and contribute to the GWOT. In addition, completion adds a vital component to the military's transformation. However, these WAN upgrades need to include modern Communications-based services to handle the constantly growing demands for more rapid Command and Control functions; better administrative, health, and welfare support; as well as improved DoD and federal interagency coordination.

The second- and third-order effects of other ARNG decisions yielded marginal results, often not focused on the ARNG's main strategic IT objective, that is, GuardNET backbone and JFHQ WAN connectivity to the GIG. The decentralization of WAN equipment selections via an IM Committee contributed to this situation. Many well-intended IT procurement initiatives did not adequately consider the rapid rate of change in technology or the engineering laws discussed in this article. Committee-based WAN equipment refreshment remains primarily driven by available *Funding*. As a result, only a few JFHQ WANs selected *new technology* upgrades. The latter now maintain a status quo WAN configuration and continue use of earlier technology. The following examples highlighted some of the complexities associated with the WAN upgrade procurement:

ARNG ROUTER FY 2004 STATUS

In 2004, Figure 6 shows 80% of the ARNG Routers were End of Sale (EOS), where vendors provided only software support and available replacement parts but no new hardware products, upgrades, or services. Additionally, 13% of these routers were End of Life (EOL) with no product support, not even for Information Assurance Vulnerability Alert (IAVA) patches.

Since their actions were not visualized within a strategic methodology, several equipment refresh efforts have not matched pace with Moore's Law. RCAS Phase III procured this equipment over 8 years ago. Then, processor performance was 1,000 MIPS (Pentium II). Today, they're beyond 10,000 MIPS (Xeon). The refresh of the ARNG Switches was slightly better to yield a 60% EOS for these key network components. Both examples show that these core factors, i.e. *Funding*, were not properly aligned with the Guard's IT strategic objectives.

ARNG FY 2005 ROUTER SELECTION

Also in 2004, the ARNG Network consisted of more than 3,000 routers of 70 different types/models. The 2004 procurement IT catalog for the ARNG listed 16 different routers and 30 switch models. This represented a refresh strategy that offered lower capacity choices to reduce unit cost for greater procurement quantities. This yielded a funding-based approach, rather than one focused on new capacity and improved network services.

When you compare the list of available routers (Figure 7) to identified service needs, and then apply the associated engineering laws, the choice selection becomes limited. First, consider router performance in a mixed-traffic environment. Metcalfe's Law indicates the network growth value will increase with service expansions from data, voice, and video users. Then, when Nielsen's Law is overlaid against potential router performance, it reveals a situation that quickly discourages the use of lower-

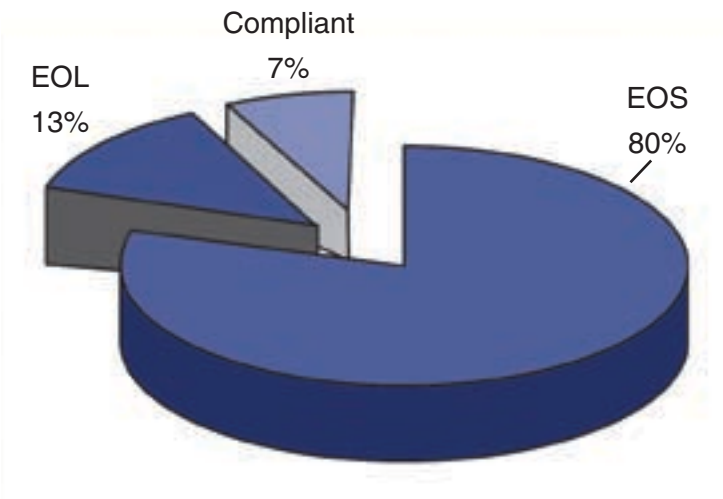

FIGURE 6. ARNG ROUTER FY 2004 STATUS

capacity routers. Finally, services for firewall and Intrusion Detection System (IDS) protection require additional bandwidth performance and router capacity. Therefore, router selection is limited to a few choices, and there are still router procurement quantity and deployment decisions to be made by the ARNG.

Applying the network's Pareto Analysis also shifts the focus of ARNG hardware refresh to the network half that affects 81% of the user community service needs. Portfolio Management, when teamed with Moore's Law, indicates the reuse of existing equipment will satisfy the service needs for the remaining 19%. More performance is certainly desired, but the limits imposed by Moore's and Nielsen's Laws restrict cost-efficient refresh to 81% of the customer base. This fact should shift equipment selection away from a capability-based deployment towards a more beneficial effects-based solution.

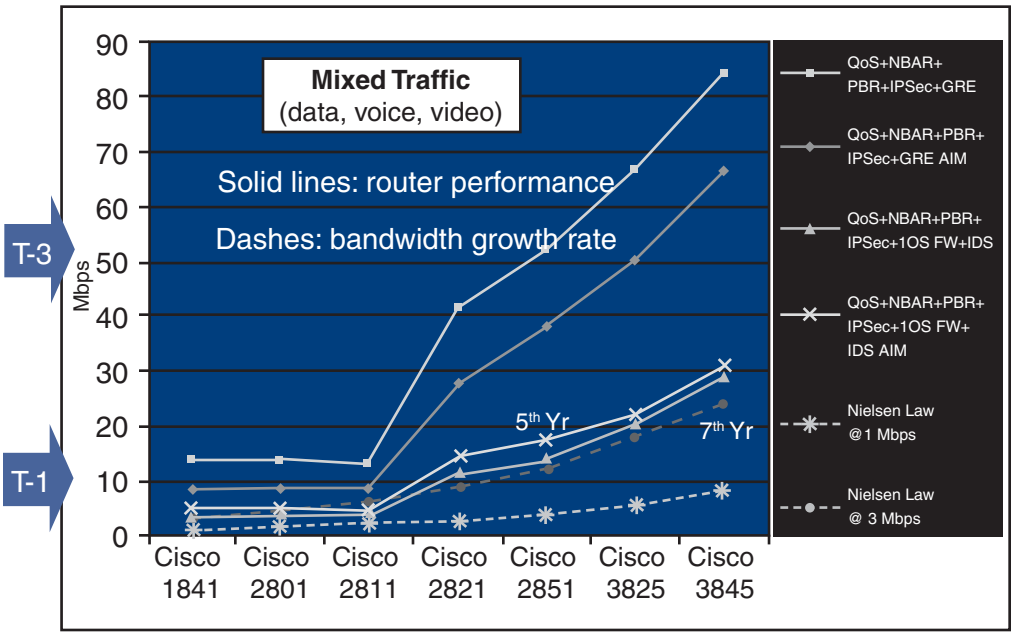

FIGURE 7. ARNG ROUTER FY 2005 SELECTION

Transformation focus should be an effects-based solution. The Army has a record of leading such initiatives. These normally require a willingness to use existing resources differently. Leaders who model Information Technology core factors and visualize their second- and third-order effects can exploit technology rules-of-thumb or "laws" to create effect-based solutions that coincide with an efficient military transformation.

RECOMMENDATIONS

The Portfolio Management process provides a centralized guidance and oversight that enables stakeholder participation, collaborative decision making, and decentralized execution of the WAN modernization for the ARNG 54 JFHQ. The IT organization should use PfM for implementing an effects-based approach that aligns business needs. The key is in the execution.

A strong portfolio management program should:

- Maximize IT investment value while minimizing risk.
- Improve communication and alignment between IT and the strategic plan.
- Encourage "team" leaders versus department or mission area.
- Support an enterprise approach to IT investments and management.

The Information Technology Modernization Model represents limited resources among core factors within a strategic structure to visualize an alignment of IT strategic objectives. Future efforts need to link these IT core factors and apply the "drivers" or engineering laws of technology pace of change. These laws also indicate that attempts to retain existing *legacy systems* or isolated *new technology* solutions will fail IT long-term objectives. Finally, decision makers at the operational level, who deal with these core factors, can exploit technology changes to achieve the strategic IT objectives of their organizations.

LTC (P) Robert E. Banks, (TXARNG), received a BS in industrial engineering from Texas A&M University and a U.S. Army Reserve Officer Training Corps (ROTC) commission in the Aviation Branch. He holds an MS in engineering science from the University of Texas at Dallas; an MS in national security from the University of New Haven; and a master's in strategic studies from the U.S. Army War College. He is DAWIA Level II certified in program management, and Level III certified in systems planning, research, development, and engineering; information technology; and science and technology manager.

(E-mail address: robert.e.banks@us.army.mil)

Maj Clayton Duncan, (USAF), earned a BA in mechanical engineering from New York University. He earned his commission from the Air Force Officers Training School and also attended Squadron Officers School. He has a combined 28 years of military and civilian experience, serving on both active duty and in the Air Force Reserve. His corporate experience includes manufacturing process engineering, communication facilities management, financial contract management, and rapid software development. Currently, he is a professor of engineering management assigned to the Engineering and Technology Department, Defense Acquisition University.

(E-mail address: clayton.duncan@dau.mil)

AUTHOR **BIOGRAPHY**

REFERENCES

Air Combat command, Public Affairs Office. (2007, October). *B-52 Stratofortress*. Retrieved January 2, 2008, from http://www.af.mil/factsheets/factsheet.asp?fsID=83

Brady, G. R. (1998, April 15). *The Reserve Component Automation System (RCAS)—A case study in the evolution of an information management system* (Research Report, p. 32). Carlisle Barracks, PA: U.S. Army War College.

Christensen, C. M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail* (p. 29). Boston: Harvard Business School Press.

Department of the Army. (2005, October). *Army CIO/G-6 500-Day Plan.* Washington, DC: U.S. Department of the Army.

Department of Defense. (2003, May 12). The defense acquisition system (DoDD 5000.1).

Department of Defense. (2003). *Military transformation—A strategic approach* (p. 16). Washington, DC: U.S. Department of the Army.

Department of Defense. (2004). 2004 *Army transformation roadmap* (pp. 1–4). Washington, DC: U.S. Department of the Army.

Department of the Army. (2005, July 15). *Army knowledge management and information technology* (AR 25-1, p. 34). Washington, DC: U.S. Department of the Army.

Echevarria II, Antykui J. (2004). Center of gravity recommendation for joint doctrine. *Joint Force Quarterly*, *35*, 10–17.

Enterprise Solutions Competency Center (n.d.). *Portfolio management overview.* Retrieved April 10, 2006, from http://www.army.mil/aeioo/pfm/pfm_overview.htm

Fastabend, G. D., & Robert, H. S. (2004, February). The imperative for a culture of innovation in the U.S. Army: Adapt or die. *Army Magazine*, 54, 14–22.

Foster, G. D. (1990, Winter). A conceptual foundation for a theory of strategy. *The Washington Quarterly*, 43–59.

Fowler, C.W. (2002, April 9). *Center of gravity—Still relevant after all these years* (Research Report). Carlisle Barracks, PA: U.S. Army War College.

Hanson, V. D. (2003, Spring). Military techonology and American Culture. *The New Atlantis*. Retrieved January 19, 2006, from http://www.oft.osd.millibrary/library_files/article_78_The%20New%20Atlantis.doc

Intel. (n.d.). Moore's Law made real by Intel® innovation. Retrieved November 15, 2007, from http;//www.intel.com/technology/mooreslaw/index.htm

IT Infrastructure Library (ITIL). (n.d.). *IT Service Management.* Retrieved April 1, 2006, from http://www.itil.co.uk/about.htm

Kurzweil, R. (2003, September 23). *Exponential growth an illusion?* Response to Ilkka Tuomi's essays. Retrieved March 17, 2006, from http://www.kurzweilai.net/meme/frame.html?main=/articles/art0593.html?printable%2Fbiblio.htm

Lohmeyer, D., Pogreb, S., & Robinson, S. Who's accountable for IT? *Mckinsey Quarterly.* Retrieved February 5, 2006, from http://www.mckinseyquarterly.com/article_abstract.aspx?ar=1251&L2=13&L3=13

Macgregor, D. A. (2003). *Transformation under fire*. Westport, CT: Praeger Publishers.

Moore, G. (1965, April 19). Cramming more components onto integrated circuits. *Electronics, 38*(8), 114–117

Moore's Law–Made real by Intel® innovation. Retrieved November 15, 2007, from http://www.intel.com/technology/mooreslaw/index.htm

Nielsen, J. (1998, April 5). Nielsen's law of Internet bandwidth. *Jakob Nielsen's Alertbox*. Retrieved March 17, 2006, from http://www.useit.com/alertbox/980405.html

Nielsen J. (1999, July 25). Metcalfe's law in reverse. *Jakob Nielsen's Alertbox*. Retrieved March 17, 2006, from http://www.useit.com/alertbox/990725.html

Ozolek, D. J. (2005, June 24). *Joint concept development and experimentation overview*. Lecture presented at Crystal City, VA. Carlisle Barracks, PA: U.S. Army War College.

Ross, P. (n.d.). 5 commandments: The rules engineers live by weren't always set in stone. *IEEE Spectrum Careers*. Retrieved March 17, 2006, from http://www.spectrum.ieee.org/careers/careerstemplate.jsp?ArticleId=n120403

Sinnreich, R. H. (2002, July 14). A caution tale about soldiers and technology. *Lawton Constitution*, p. 2.

The Army National Guard. (n.d.). *Our state mission.* Retrieved March 17, 2006, from http://www.arng.army.mil/aidingamerica.aspx

Vanergiff, D. F. (2002). *The path to victory* (p. 263). Novato, CA: Presidio Press.

Yarger, H. R. (n.d.). Towards a theory of strategy: Art Lykke and the Army War College strategy model. Retrieved April 1, 2006, from http://dde.carlisle.army.mil/authors/stratpap.pdf