THE FUTURE FEDERAL INFORMATION INFRASTRUCTURE: The Responsibility of the Federal Information Resources Management Community

The world has entered the age of electronic information. Change dominates. Federal officials responsible for managing government information and information technology must prepare their institutions and systems to respond.

The U.S. Government remains the world's largest creator, collector, user, and disseminator of information. Scientific research and industrial productivity, the public health and safety, and the equitable collection and distribution of tax receipts are a few of the national priorities that depend on sound Federal information systems. In addition, the unique nature of information in a free society—Jefferson called it "the currency of democracy"—gives Federal policies special importance.

Typical of any new technology, information technology's application proceeds by fits and starts. Policy and sound practice lag the rapid deployment of new capabilities in information and communication systems, particularly in such areas as privacy, security, standards, and intellectual property. These gaps create a challenging environment for the Federal information resources manager.

Notwithstanding this unsettled environment, there is growing consensus as to both the importance and the general characteristics of an improved national information infrastructure. Once the infrastructure is fully developed, a person will be able to receive personalized, multi-media job and health care information and screening, pay bills, and apply for a birth certificate 24 hours a day, seven days a week, from home or at a public terminal.

Both the public and private sectors of the information economy are participating in the creation of this infrastructure. Federal officials have a special responsibility in that creation, given the roles and responsibilities the Federal Government plays in the information and information technology economy. The Federal Government produces information resources, uses them and makes policy for their use, acts as a catalyst for their development, and delivers services through them.

This article has three purposes. It describes the changing environment that Federal officials face. It discusses the evolving national information infrastructure and the Federal Government's roles and responsibilities in that development. It concludes with some brief suggestions for action that will help prepare the Federal information resources management community to take on these responsibilities.

THE ARRIVAL OF INFORMATION TECHNOLOGY: FORCES AFFECTING FEDERAL OFFICIALS

Institutions and the Smart Machine

Much is made of the pace of change today, and Federal officials inhabit an environment of particularly rapid change. Often they confront this problem concretely, as when taking delivery of newly acquired equipment that is already a generation out-of-date. But the change created by the proliferation of electronic information is broader and more profound than faster processing. The attack of the "smart machine" on existing organizations and expectations confronts the Federal official in at least five ways.

First, and most fundamentally, information technology *transforms* the way work is done. When used to its full potential, information technology goes beyond the automation of paper processes and allows the rethinking and redesign of those work processes to eliminate steps and make them more efficient. A simple example is the use of electronic ordering and supplier information to eliminate the need for warehouses of parts, instead creating "just-in-time" delivery from suppliers to users. Similarly, the consolidation of mainframe centers and the rise of distributed information and processing power—illustrated by current experiments in telecommuting—are just beginning to be felt in the way work and work groups are organized. This redesign affects the kinds and numbers of tasks to be performed and the skills employees need to perform those tasks.

Variety is a second aspect of the attack on existing institutions. Organizations may now choose from

multiple communications media. The year that the last operator-assisted party line was removed in Montana, GSA's FTS 2000 program initiated the nation's first transcontinental, production-grade, digital integrated voice-data service. This variety threatens traditional structures by creating islands of inter-peer networks that reach across traditional organizational boundaries. The ease of transmitting international electronic mail over the Internet[1] is allowing scientists in developing countries to spend more time communicating with their international peers than with members of their traditional national communities.

Beyond diversity, Federal agency *dependence* on information systems and on the quality of information in them have become absolute. For legal purposes, the Internal Revenue Service (IRS) does not record the receipt of taxpayers' returns until automated processing is complete at one of ten service centers and then on the mainframe computers at IRS' Martinsburg Computing Center. Because of a processing problem in Philadelphia, many taxpayers had to wait twice as long to receive their tax refunds in 1986 because their returns had not been processed and "recorded" by IRS' definition. More profoundly, many kinds of work can no longer be done manually.[2] This more fundamental dependence can change the relationship of workers to the work, often decentralizing responsibility and authority.

The fourth aspect is the demand for *more public information*. Public institutions are subject to ever greater scrutiny, grounded in the basic idea of openness in government. Openness of government is an important value. In addition, certain types of government information have value in the marketplace as well, or can improve the functioning of markets. Accordingly OMB Circular No. A–130, for example, proposes that agencies "disseminate information on equitable and timely terms." As discussed below, sound dissemination practices are essential to U.S. competitiveness.

Finally, all these forces create new demands for *security and privacy*. As the government automates its records on individuals, new kinds of privacy concerns arise. For example, computers make the matching of names of beneficiaries across program lines relatively simple, helping to eliminate fraud and abuse. A list of veterans receiving benefits can be matched with a list of persons delinquent on government student loan payments. The Computer Matching and Privacy Protection Act of 1988 establishes due process protection for individuals subject to those matches. For example, a benefit may not be denied solely on the basis of a database "hit." Similarly, interconnecting Federal databases via networks creates a vulnerability which agencies must plan for. The Computer Security Act of 1987 provides that Federal computer systems which handle sensitive information should be protected by security measures "commensurate with the risk and magnitude of the harm" that may occur. These laws, which respond to the ubiquity of information brought on by advances in information technology, help to regularize the complex balancing act Federal officials must perform between these opposing demands.

In sum, long-standing organizational and expectation structures, and at times the Federal officials associated with those structures, find themselves under attack. These structures include work processes, peer group arrangements, the location of decision-making and expertise, the availability of information about government, and privacy expectations.

Wax Seals and the Model T

As with most new technologies, the uneven reliability of information technology creates delays and failures. In the twelfth and thirteenth centuries, paper began to be used to document agreements among individuals that, for the previous two millennia, had been oral. Skepticism prevailed as to the trustworthiness of such paper agreements as compared with agreements reached during real, human discussions witnessed by community leaders.[3] Elaborate security measures, such as wax seals and special papers, were devised to

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[1] An international computer-to-computer network used primarily by the research and education community for electronic mail and file transfer.

[2] The National Academy of Sciences points out that the Social Security Administration (SSA) is no longer able to bring new applicants into the social security system without automation. Board of Telecommunications and Computer Applications, National Research Council, "Systems Modernization and the Strategic Plan of the Social Security Administration," (Washington, D.C.: National Academy of Science, 1990).

"With the growth of automated systems, knowledge increasingly comes to be lodged in software, further reducing the skill requirements of lower-echelon jobs, transforming them into machine-oriented procedures. As this process continues, the organization arrives at a point where most of its technical knowledge is embodied in software, and very little of it is developed or required in the course of ordinary professional or clerical activities." Shoshana Zuboff, *In the Age of the Smart Machine*, (Basic Books, New York, 1988).

[3] See, for example, "Trusting Writing," in Clanchy, *From Memory to Written Record: England, 1066–1307* (Cambridge: Harvard University Press, 1979).

substitute for the word of the elders. Use of these measures was required into the nineteenth century for many written agreements to be legally binding. Government contract documents were required to be signed and "attached together by a ribbon and seal."[4]

Although today a fax signature is generally admissible in a court of law, debate continues, often appropriately, as to the necessary institutional and technical arrangements for the security of electronic business transactions. The uncertainty that this debate creates delays the implementation of improvements that could substantially reduce costs and errors.

A comparison between information technology and automobiles is often used to illustrate the rapid improvement in performance, size, and price of information technology.[5] Similarly, comparison as to reliability suggests information technology's current stage of evolution. PC applications seem to fail as often as the Model T automobile did, service availability is as spotty as filling stations were in the 1920's, and to get anywhere fast you have to know how to fix it yourself. All this makes it hard to field technology on a large scale.

Information Economics—At the Edge

Finally, the increasing economic value of information, both as a commodity in trade and as an input to production and organizational processes, increases the importance of Federal decisions about information resources. Three examples, the dissemination of government information, Federal research in advanced information technology, and the effect of Federal policies on the U.S. information industry, illustrate the rising stakes in Federal information resources.

Government (Federal, state and local) information is valuable in the marketplace. Markets depend on sound and timely economic statistics. Decisions ranging from determining the amounts of Federal benefits to the efficient targeting of direct mail depend on accurate census data. Geographic and climatological information generated by NASA and National Oceanographic and Atmospheric Administration (NOAA) satellites allow farmers to apply fertilizer more efficiently, local governments to formulate environmental policy, and public safety officials to prepare for natural disasters. As information in electronic form is so easily copied and distributed, it does not behave in the marketplace as a normal economic good.[6] As more valuable information is created, the stakes involved in Federal decisions about its availability will increase as well.

Second, as information grows in economic importance, so does the importance of the Federal investment in advanced information technology. The High Performance Computing and Communications Initiative is a research program funded in small part by the Federal Government, with the bulk of funding coming from industry and research universities. It is designed to support Federal scientific agency missions, and is actually a three-part experiment. It supports the development and testing of new computing and communications technologies—machines able to process trillions of bits per second and nationwide networks that can transport billions of bits per second. Next, it provides support for advanced research using such techniques as image visualization to attack problems ranging from remote medical diagnosis to global climate change. The final, and perhaps most complicated part, is the experiment in technology transfer and cooperation among U.S. industry, the Federal Government, and the education community. As this initiative evolves, expectations grow as to its beneficial effects on productivity and education. It raises many questions as to the appropriate Federal role in technology development.[7]

Third, a strong information industry is of growing importance to the U.S. economy and its international competitiveness. Accordingly, the Government should do what it can to promote—and should not inhibit—that competitiveness. Thus the benefits of allowing Federal employees to hold software copyrights and the law enforcement benefits of restricting the introduction of digital telephone equipment must be balanced against their potential harm to this important industry.

Ultimately, the increasing economic importance of government information resources means that technologists and information policymakers no longer may expect autonomy (or isolation) as systems developers

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[4] Act of June 2, 1862, 12 Stat. 411.

[5] If cars had followed microchips, a Cadillac would carry 60 passengers at 1000 miles per hour, cost $100, and be the size of a deck of cards.

[6] "To conclude, information as a commodity displays economies of scale in production, monopoly power in exchange, positive external effects, and public goods properties in its supply, with incentives for traders to cheat." Estrin and Holmes, *French Planning in Theory and Practice*, (London: George Allen & Unwin, 1983).

[7] On a more prosaic level, the increasing number of Federal information technology acquisitions worth several billion dollars each, coupled with the decline in weapons system acquisitions, increase the political attention given these programs.

and operators. They must take into account a much larger community of interest. For example, the Congressional Research Service reports that Congress passed 339 new laws relating to information and information technology between 1977 and 1990.[8]

Three forces converge on Federal officials. The technology's newness makes its deployment and associated policymaking uneven. Its effect on organizational and expectation structures creates unpredictability and a potential for conflict. And the increasing value of information means decisions become more public with more players.

THE U.S. INFORMATION INFRASTRUCTURE AND ITS FEDERAL COMPONENTS

Information: Where and When We Want It

The High Performance Computing Supplement to the President's Fiscal Year (FY) 1992 Budget makes reference to the development of a broad, privately operated national information infrastructure. It notes that "such an infrastructure would allow consumers, businesses, and schools and government at all levels to share quality information and entertainment when and where they want it at a reasonable cost."

This vision defines the users of such an infrastructure—consumers, businesses, and schools and government—in a manner consistent with the tradition of universal service embodied in the Communications Act of 1934. It promises the sharing of "quality information and entertainment." While quality entertainment is a matter of personal taste, five criteria can be used to describe quality information. Quality information is reliable, timely, user-friendly, appropriate to the audience, and available from diverse sources. Federal agencies, as creators and distributors of public information, should concern themselves about the information's quality when acting as catalysts in this evolving vision.

The consideration of "reasonable costs" of course provides a counterbalance to the vision of a ubiquitous, instantaneous, full-service information utility. Increasingly, we see efforts to institutionalize "basic" service in public information offerings, to ensure that some capability is available to everyone. "Lifeline" telephone rates and the Cable Act of 1992's requirement to regulate "basic" cable television service are two examples that reflect upon the truth of the aphorism that, "although information wants to be free, people generally want to be paid."

The Role of the Federal Government

What is the Federal role in infrastructure development? What is the niche, the position, the expectation of the Federal agency in the information age? It has sometimes been considered the function of government in the U.S. to provide the information infrastructure. Indeed, an early model of government-operated information infrastructure, the Postal Service, provides useful historical perspective on the importance of universal access to information.[9] Like the railroads, but unlike roads and highways, the U.S. telecommunications infrastructure was generally developed and is held privately. Today it is evolving, as are communications infrastructures in much of the world, into a market-based, competitive system. Thus it is not obvious what the best model is for Federal Government action in information infrastructure development.

Both the public and private sectors will participate in the creation of an improved, national, information infrastructure. But Federal officials have a special responsibility in that creation, given the roles and responsibilities of the Federal Government in the information arena. The Federal Government produces information resources, uses and makes policy for their use, acts as a catalyst for their development, and delivers services through them.

The Federal Government is the world's largest producer of information. As described earlier, Federal information has increasing value in the marketplace, and its continued availability is key to a robust national infrastructure. As a user, the Federal Government is no longer the "800 pound gorilla" it once was, but it remains an influence in the market, particularly when it employs the most advanced

[8] This statistic does not include laws affecting the procurement of information technology. Chartrand and Bortnick, "Information Policy and Technology Issues: Public Laws of the 95th Through 101st Congresses," (Washington: Congressional Research Service 91-369 SPR, July 1, 1991).

[9] The Congress's responsibility "to establish post offices and post roads" stems from Article I of the Constitution of the United States. From the outset, newspapers and other publications have enjoyed free or lower cost carriage in the postal system.

technology to meet mission requirements. Thus in supercomputers, in geographic information systems, in image processing, and in expert systems, government sets *de facto* standards and influences the direction of new technology.

In limited areas, the Federal Government is the national policymaker and regulator. Here, it must give absolute priority to the broadest national interest in a different manner than when it is acting as a user of technology or information. As user, its focus is properly first on the agency mission that the information resources must support. As regulator, both the Government's right to play and the rules of play are different. The Federal Communications Commission regulates the provision of interstate telecommunications services and the use of the electromagnetic spectrum "so as to make available, so far as possible, to all the people of the United States a rapid, efficient, Nation-wide, and world-wide wire and radio communication service." [10] This is an extremely complex area, where each technology (wire communications, radio communications, broadcast, cable television, etc.) is regulated differently. Clearly as technologies converge, new approaches are needed. Similarly, intellectual property rights—in particular the copyright of information—are guaranteed, and in some cases enforced, by the Federal Government.

Fourth, the Government functions as a catalyst. It leads by example, promotes competition, and convenes disparate interests. For example, in the privacy area, Federal Government protection of information about individuals is demonstrably stronger than in the private sector. In the open systems area, the Commerce Department's National Institute of Standards and Technology has convened an open systems users group that is bringing industry and government users and suppliers together to implement national standards. The High Performance Computing and Communications Program is one of the best examples of a catalytic public-private partnership.

Finally, the Federal Government functions as a service provider. Recognition of this role drives the increasing emphasis to view information technology as a resource in improving service to the citizen. Computers are helping the IRS reduce the number of erroneous taxpayer notices and increasing voluntary compliance with the tax code. FTS 2000 "800" service allows the Government to stay open longer, directing after hours calls from the east to the west coast office. These practices illustrate appropriate Federal responses to the rising expectations of consumers, who have become accustomed to high quality, information-rich service from the private sector.

RESPONSE OF THE FEDERAL INFORMATION RESOURCES MANAGEMENT COMMUNITY

How should the Federal Information Resources Management (IRM) community respond in this dynamic environment? Given the diverse roles of government, what should the IRM community do to prepare to participate in the development of the evolving national information infrastructure?

Principally, the task is to get the IRM house in order. Several particular activities can be taken over the next several years to do this. First, the IRM community should act to improve public confidence in the Federal Government's ability to acquire and use information technology. Credibility is key to being an effective player. Several initiatives are underway to correct an unbalanced perception that failures outnumber successes in Federal IRM. Both GSA and GAO have begun to collect examples of agency "best practices" in systems development, information management, information policy, and information technology acquisition.

Second, the IRM community should work to foster more cooperative relations between the public and private sectors. The Government's ability to play its multiple roles require trust between government and industry. This trust can be built by creating opportunities for constructive dialogue and sharing of experiences. In addition, new ways of interacting will be required. The IRM community can experiment with different ways of forming partnerships with industry to develop infrastructure and deliver service. Groups such as the Industry Advisory Committee of the Federation of Government Information Processing Councils have begun this work by sponsoring useful forums for government and industry to share information and discuss common problems.

[10] Communications Act of 1934, Section 1 (47 U.S.C. 151).

Finally, the IRM community should work to build a Federal *service delivery* infrastructure—using information technology better to perform its missions. At root this requires new partnerships within and across agencies. Agency IRM officials should initiate and forge links to their financial and program delivery counterparts, and across agencies in cooperative functional groupings. Specifically, these partnerships could support: improving interagency coordination in service delivery; testing new citizen-service technologies such as kiosks; increasing the active dissemination of government information; reducing administrative burden and paperwork through the use of information technology; and, creating policies and incentive structures that encourage innovation. In this area, the Federal Information Resources Management Policy Council has established an Interagency IRM Infrastructure Task Group. OMB is sponsoring a monthly, governmentwide forum that is removing legal, regulatory, and standards barriers to the transfer of business and government information electronically. OMB has issued a proposal to revise its guidance on information dissemination, and will continue to support agencies' work in infrastructure development, building on cost-effective initiatives already underway.

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