A Digital Government for the 21st Century

A recent workshop sponsored by the National Science Foundation, the Government Information Technology Services Board, and the National Institutes of Health investigated the use of information technology within the federal government. A final report on the findings of that workshop was issued in June. This column reflects a summary of those findings; the full report can be found at www.isi.edu/nsffinal.html.

A partnership between government agencies and the IT research community has succeeded in the past for the benefit of the nation. The most notable example is the emergence of the Internet as the basis for broad scientific, cultural, civic, and commercial discourse, evolving from what was originally a government-supported networking research project.

The collaborative development of a new applied research domain is critical to help meet the growing information service demands in the U.S. Applied research that considers real-world operating constraints can provide valuable new problems and insights for the academic research domain, leading to new demonstrable and deployable systems of the Internet, and toward more advanced, integrated global systems. A unique opportunity exists for a new paradigm for interaction between government and citizen; an opportunity to invent a digital government for the citizens of the 21st century.

At the end of this extraordinary century of scientific achievement and technological innovation, the U.S. is poised for a radical shift in the manner in which individuals learn and work, conduct their business, and are entertained and informed, arising from the innovation of IT. While this shift affords unprecedented opportunities, it also challenges government agencies to dramatically improve the information services they provide to the public. Federal, state, and local governments are all striving to meet citizens’ rising expectations for easy, fast, secure, and accurate interactions, even in an environment of shrinking staff and budgets.

There are expectations that IT will allow the government to improve operations and services delivery, but these hopes are tempered by the failure of several widely publicized modernization efforts costing taxpayers billions of dollars with few discernible results.

A related challenge is cultural: most industrial and government information systems managers have management and goals that
do not usually value investment in R&D. Moreover, many government agencies procure expensive and complex information systems without the benefit of sufficient interaction with each other or with the R&D community. At the same time, many U.S. industries have reduced their investment in basic and applied research. Hence, IT suppliers may produce fewer innovations from their laboratories. Federally funded basic and applied research in academia and national laboratories need to assume larger roles in the development of federal information services to address this issue.

The disconnection between providers of private and public information services and the IT research community is of great concern. Because information plays many roles in government agencies (as a currency of exchange, as an important by-product of their missions, as the carrier of work flows and services), it is essential that as agencies restructure and reengineer to exploit these new efficiencies, the R&D community and other sectors form new relationships.

The new network-centric world will present other societal challenges beyond the pragmatic concerns of efficient and affordable government information services. For example, the public’s right to know is a fundamental tenet of any democratic society, yet there is a growing concern about the potential dangers to individual rights and privacy arising from electronic access to a variety of personal information. This concern recently caused the Social Security administration to shut down its online pension benefit information system.

A second important example is the new opportunity for civic discourse made possible by wired citizens interfacing directly with government. A digital government will allow public access to government information and services, and group participation in discussions at any time and from anywhere on the globe with the required security and trust.

This vision is a distinct possibility but will require government, in collaboration with the R&D community and information service providers from all sectors, to define and implement a bold new research agenda, supported by new investments in IT. These issues are clearly resonating within the broad federal policy arena.

A digital government presents great technical and intellectual research challenges, but also promises great value and can provide valuable new insights and interesting new applied research problems leading to deployable new systems. Thinking of federal information services as a laboratory means a huge variety of sources and systems are available to invent new and very advanced applications. Typically, academic research laboratories simply don’t have sufficient tools or sources of information and data to explore real-world problems. Instead, abstractions are studied in closed, controlled environments.

Research that considers real-world operating constraints can lead to new insights that reduce the complexity of real-world problems. Students immersed within a real-world context can learn how to apply the knowledge acquired from their academic studies to large problems of great potential impact, thus helping to ensure the next generation of knowledge workers can impact the federal enterprise. In summary, applied research in federal information services offers unique challenges unavailable in basic theoretical research. Building, nurturing, and leveraging relationships with federal information service providers and the research and education community supported by sufficient long-term funding for applied research, training, and advanced education, is key to developing a critical mass of researchers and students to work on truly large scale demonstrable applications of benefit to the public.

Research topics with a special focus on the unique characteristics
of the federal information services domain might include storing and archiving information, finding and accessing information, integrating information from multiple sources, mining and knowledge discovery, universal access to information, validating and visualizing information, and security, privacy, and e-commerce.

These and other research topics will enable a whole new range of advanced applications. The following are some examples:

- Crisis management for natural disasters can be driven by information services that link, summarize, and present critical information on demographics, utility maps and geospatial data to guide and assist in rapid evacuations and force deployment, reducing loss of life and property. Concomitantly, collaboration technologies may bring together the special expertise of remote individuals to participate in group decision making to jointly solve and manage a live crisis.

- Economic and statistical data integrated across multiple federal agencies to provide a more accurate near-term view of economic activity and to inform the public of its government’s activities in health, education, and welfare.

- A new Federal Information Infrastructure for a digital government will lead to new ways in which people and government employees can interact, make decisions, share ideas, and collaborate on common problems. It is conceivable that virtual agencies might develop, bringing together spheres of common interests in multiple agencies with interested groups of citizens to solve a common problem. Traditional lines of responsibility among agencies can thus be broken down to accommodate new interests and special problems more effectively. Policy makers may be able to easily tap in to the talents and expertise of people from the private sector, and across agencies in the public sector.

- Intelligent transportation systems are a distinct possibility. Real-time integration of information from databases, sensors, and toll point-of-sale terminals might make it possible to optimize at huge cost savings travel and distribution of goods.

R&D in computer and information science and technology, as well as research in statistics and the social sciences, is funded by many federal agencies, universities, and businesses. What is necessary now is to define a new range of cross-disciplinary applied R&D objectives with the needs of the federal information services community in mind, applying that R&D to the problems and data within that arena.

Although many federal agencies understand the potential of an integrated and interoperable Internet and intranet approach to support their missions, most federal information still resides in vertically integrated legacy systems designed for specific applications, data sets, and mission areas. These systems have been maintained in stovepipe fashion and have grown individual cultures in the service community without attracting the interest of the R&D community. This disconnection between information services and R&D is by no means limited to the federal sector, but is mirrored in the private sector and causes concerns there as well. Information resource managers, both federal and private, are painfully aware that improvements and fundamental changes within these stovepipes have been difficult, for example, cross-stovepipe integration.

A horizontally coordinated alternative to stovepipe systems is emerging, with the potential to provide a transition strategy from legacy systems, through the interoperable layers of the Internet protocols, and toward a more advanced multidimensionally integrated federal enterprise. This system structure separates the applications that support their users from the underlying objects (databases) and reconnects them through an intermediate layer of services and such middleware functions as authentication, synopsizing, and translation. To effect this move from vertically integrated legacy systems toward multidimensional integrated information sets is a significant research problem with very high potential payoff; it represents a national challenge for federal information systems.

Many applications will share common middleware component technologies in this new structure. What these middleware component technologies may ultimately be serves as a conceptual domain for applied R&D research. For example, protected interfaces and wrappers to legacy systems will be needed to support new trusted services and enable
the graceful transition to Internet-based applications when they are upgraded. Existing databases can be encapsulated with object interfaces so they are available with appropriate security to the Intranet of the federal enterprise. Applications can thus be developed effectively through middleware and services that access underlying object bases mediated by authentication, access control, auditing and accountability mechanisms, indexing, synopsizing, translation, and searching services. These horizontal systems provide a scalable, distributed, and portable capability heretofore not possible nor previously contemplated by federal information service providers. The middleware can move easily to new platforms and systems preventing its own potential legacy problem to keep pace with growth in function and scale of new systems.

Recommendations
There is a clear indication of growing federal awareness of the potential impact of these technologies within the government sector. However, even though R&D opportunities in federal information services are apparent, a major hurdle for the R&D community to gain is access to the actual problems and source material that comprise these services. We believe the following balanced goals will lead to a better informed environment for collaboration:

**Recommendation 1. Coordinate multiagency efforts to focus on priority problems.** To maximize the chance for broad applicability and uptake of innovative technologies across multiple agencies, a coordination body should serve as the primary conduit for R&D activities in federal information services. Coordination with other government efforts involving the National Information Infrastructure should be stressed.

**Recommendation 2. Inform the research community.** Initiate a number of workshops and information exchanges to familiarize the IT R&D community from all sectors about the capabilities of and unique problems faced by government agency information services. This process should result in a broad understanding of the applied research agenda within federal information services. Invite researchers, developers and students from universities, industry and national laboratories, hosted by collaborating federal agencies to identify targets of opportunity.

**Recommendation 3. Bridge the culture gap between researchers and federal ISPs.** The research community will not become connected with federal information service providers unless the means for professional advancement and career development are clearly available to sustain their professional interests. Therefore, a community of researchers from several disciplines (CS, statistics, and the social sciences) devoted to federal information services applied research and student education should be encouraged, nurtured, and supported to establish new courses, technical organizations, conferences and symposia, and formal journals with academic relevance and excellence.

Internship programs in providing summer research opportunities to students should be established to broaden their academic studies. We believe the issues confronted by the operational and development centers of the federal information services community could form a broader model for cooperation between industry, government, and universities to help speed the development of the knowledge worker who will need to compete in the 21st century.

**Recommendation 4. Initiate advanced technology pilot projects.** These projects, along with infrastructure testbeds and other prototype activities are central to bridging the range of activities from R&D to information service areas that have little R&D background. The recommended
advanced technology pilot projects suggest how the government should initiate a process of community linkage. These suggestions should not be viewed as a call for a formal procurement program for specific advanced technology pilot projects of limited function and duration. Rather, these pilots should serve as a first step in a long-term process, nurtured by a funding program that seeks continual renewal of fielded systems, incremental improvements and new services, all driven by persistent public input.

**Recommendation 5. Fund a substantial number of advanced technology pilot projects and basic exploratory research projects through broad agency announcements.** We believe the DARPA model of funding or procuring research is the best model to consider for federal information services R&D. Here, a program need is identified, and through multiagency funding and cooperation, a Broad Agency announcement becomes the most effective way to focus attention to solve the problems. Two types of projects are envisioned, advanced technology pilot projects of substantial size and cost, and more focused applied and exploratory research.

Advanced technology pilot projects are expensive, cannot necessarily be done solely by graduate students, and must have enough demonstrable results to persuade agencies to procure a final deployable system. Furthermore, the R&D activities cannot be done in place. Federal agencies cannot be expected to provide development capability within their operational centers, but rather additional facilities will be needed to build systems alongside or possibly remotely over high-speed communication lines.

We envision advanced technology pilot projects requiring several senior researchers or faculty principal investigators, several graduate students, full-time programmers and system designers, and substantial equipment, storage, and communication costs. Such projects will cost on the order of $1 million to $2 million each per year. Moreover, projects involving multiple agencies will need larger investments.

More basic exploratory research projects involving a senior researcher, several graduate students or post docs, and modest equipment expenses are typically funded around the $500,000 level.

It is difficult to imagine smaller grants could effectively address the complex issues discussed. Furthermore, it is likely that a substantial number of projects will be needed to address the range of issues and problems. It is also important these projects be conducted concurrently and collaboratively since the computer and information systems fields are moving too quickly to force a sequential effort.

We emphasize this effort needs to be funded incrementally, to keep pace with new developments and larger mandates that may emanate from successful projects.

**Recommendation 6. Provide stable funding for a program of applied research, technology transfer, and training/education activities in the federal information services domain.**

Leverage and direct the Information Technology Innovation Fund administered by the General Services administration to broaden its range of activities from near-term production improvements to shared infrastructure, technology transfer, and advanced technology pilot projects. This will assist multiple agencies in reengineering work processes to deploy the technology solutions and artifacts developed. Seek other sources of R&D funding; solicit agency resources and identify cost sharing opportunities.

The best investment strategy to realize the full potential of IT is one that is based on a constant level of funding over long periods of time with occasional larger investments when breakthroughs are discovered. At a constant level of investment, the nation will be able to benefit from the continual improvements in performance and cost of fielded systems. It is also quite natural for people to continually develop, innovate, and grow. The systems fielded by the federal government ought to keep pace with these new developments and expectations.

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