Strategies and Priorities for Information Technology at the Centers for Medicare and Medicaid Services

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Strategies and Priorities for Information Technology at the Centers for Medicare and Medicaid Services

Edward H. Shortliffe and Lynette I. Millett, *Editors*

Committee on Future Information Architectures, Processes, and Strategies
for the Centers for Medicare and Medicaid Services

Computer Science and Telecommunications Board

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Preface

The Centers for Medicare and Medicaid Services (CMS) was originally chartered in 1965 to provide prompt payment of provider claims for the purpose of ensuring that certain elderly and vulnerable groups would receive timely and effective medical treatment. Critical to the agency's work is its information technology (IT) infrastructure. In the past 45 years, in response to numerous statutory, policy, and budgetary measures, the scope and scale of the services CMS provides have significantly increased. This dynamic environment has led to new IT challenges for the organization. Key among IT issues is the need for CMS to position itself to ensure not only the continuity of its core operations, many of which are stressing the aging capabilities of systems that are currently in use, but also the capacity to rapidly and successfully manage new mission mandates that require changes to this core IT infrastructure, with an emphasis on data and system integration.

Central to many of the changes underway at CMS is the 2010 Patient Protection and Affordable Care Act, which includes numerous mandates aimed at moving from fee-for-service payment to value-based payment. This is a paradigm shift for CMS and one for which it has only a few years in which to prepare. Although CMS's mission is broader than payment, reforming payment is a component of meeting other national goals, such as the drive toward integrated health care delivery systems. Moreover, reforming payment is inevitably going to change the operations and culture of CMS, because all of the newly proposed approaches require it to think more about impacts on quality and performance. CMS's current IT

systems, which are predominantly claims-based, were not developed to satisfy the data and information needs of the new mandates and payment programs.

With these looming realities in mind, CMS turned to the National Research Council to conduct a consensus study to strategize about how to modernize CMS's business processes, practices, and information systems effectively to meet today's and tomorrow's demands, including how to build in the flexibility to deal effectively with changing requirements. The statement of task for the project is given in Appendix A. Composed of experts on large-scale enterprise computing, health care policy, health care quality, health care outcomes, large-scale data use and database operations, and health IT, as well as CMS itself, the Committee on Future Information Architectures, Processes, and Strategies for the Centers for Medicare and Medicaid Services was recruited for this effort. In the process of developing and recommending a CMS IT strategy and vision, the committee received input from a number of system experts, researchers, policy analysts, and others, both internal and external to CMS. Briefers to the committee are listed in Appendix B. Biosketches of the committee members are provided in Appendix C.

The committee delivered an interim report containing its initial observations on these issues, as well as its preliminary thoughts on the most promising paths going forward, on December 9, 2010.[1] Its final report builds on the work of the committee's first report, providing deeper discussion of many topics tackled in the interim report as well as the committee's recommendations. This final report was developed based on input the committee received over the course of four in-person information-gathering meetings—including one at CMS's headquarters in Baltimore in April 2011 and four additional information-gathering teleconferences. This input was supplemented by a site visit to CMS headquarters in January 2011 by a committee subgroup that focused on key technical issues. The committee also held several deliberative meetings and teleconferences in order to weigh the information given to it and to come to consensus on the recommendations.

As the committee delved into the details of the CMS environment from a technical perspective, it became clear that it would be unrealistic to provide a system-by-system assessment of what is currently in place, or even of the overall system architecture (which has evolved organically in response to legislative mandates over the years). CMS is a large organization, with myriad contractor and stakeholder relationships in addition to

[1]NRC, 2010, *Preliminary Observations on Information Technology Needs and Priorities for the Centers for Medicare and Medicaid Services: An Interim Report*, Washington, D.C.: The National Academies Press.

its own internal organization and culture, and it would not be feasible for an external study committee to attempt a comprehensive review of every issue that was touched on during the information-gathering component of its work. Even answers to questions such as the total IT budget for CMS and how it is allocated, and estimates of cost and personnel for ongoing and prospective activities, were difficult to ascertain, given the complex ways in which IT dollars are spread among the operating offices and centers, including the Office of Information Services. What *was* clear were the historic tendency to provide IT funding on a program-by-program basis, confirmed at essentially every meeting with CMS staff, and the proportionately small budgetary elements available for infrastructure and modernization. The committee's findings and recommendations reflect its decision about the scoping of the study effort, emphasizing the larger notions that were clear and proposing approaches that would help CMS to work out a detailed planning and implementation approach that would be beyond the ability of the committee to specify fully in the time available for preparing the report.

We were fortunate to be able to weigh in on such a remarkably significant topic at a critical time in the evolution of CMS and in U.S. health care. The U.S. health care landscape is undergoing major changes that will affect nearly every person in some way, and CMS is at the epicenter of that shift. However, this fluid dynamic meant that the committee had to be agile as well, as the "way things are" in one month often changed into the "way things used to be" the following month. I commend the members' ability to comprehend quickly not only the new information that was presented to them, but also its significance, and I appreciate their considerable efforts to ensure that the report would remain relevant in spite of the dynamic environment in which it was developed.

I also wish to thank the CMS staff. Not only were they responsive to the committee's requests for information, but they were also truly hospitable in hosting both the subcommittee's January 2011 site visit and the entire committee's visit in April 2011. My thanks are also extended to the other experts who took the time to brief the committee; each of them thoroughly and thoughtfully responded to the questions asked and provided insights that allowed us to make the report richer. Finally, I thank the remarkable CSTB staff—Lynette Millett, Emily Ann Meyer, Enita Williams, Eric Whitaker, and Jon Eisenberg—for their efforts in steering the committee's work, striving to master the domain, coordinating the meetings and speakers, and editing and revising report material.

Edward H. Shortliffe, *Chair*
Committee on Future Information Architectures, Processes, and Strategies for the Centers for Medicare and Medicaid Services

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's (NRC's) Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Michael Carey, University of California, Irvine,
Janet Corrigan, The National Quality Forum,
John Halamka, Beth Israel Deaconess Medical Center,
Carl Kesselman, University of Southern California,
Stephen Parente, University of Minnesota,
Frank A. Perry, Science Applications International Corporation,
Kevin Schulman, Duke University School of Medicine,
Michael Shabot, Memorial Hermann Hospital,
Michael Stonebraker, Massachusetts Institute of Technology,
Kevin Sullivan, University of Virginia, and
Gail Wilensky, Project HOPE.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was monitored by Charles E. Phelps, University of Rochester, and coordinated by Susan L. Graham, University of California, Berkeley. Appointed by the NRC, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

Summary and Recommendations

The Centers for Medicare and Medicaid Services (CMS) is the agency in the Department of Health and Human Services responsible for providing health coverage for seniors and people with disabilities, for limited-income individuals and families, and for children—totaling almost 100 million beneficiaries. Collectively, these programs make CMS the largest purchaser of health care in the United States. CMS interacts with thousands of health care providers across the country, ranging from individual physicians to hospitals large and small, as well as with other providers such as ambulance services and rural health centers. The agency's core mission was established more than four decades ago with a mandate to focus on the prompt payment of claims, which now total more than 1.2 billion annually. To fulfill that role, CMS processes more than 3 million eligibility inquiries and makes more than $1 billion in fee-for-service payments daily.

Recent legislation has given CMS new and expanded responsibilities for driving national improvements in areas such as the greater efficiency of health care services, the elimination of health disparities, the support of health care quality, the adoption of health information technology, a drive toward value-based purchasing, and the collection and analysis of data to promote health and wellness. CMS also has responsibility for testing innovative care and payment models and for overseeing the newly established state-based insurance exchanges.

With CMS's mission expanding from its original focus on prompt claims payment come new requirements for the agency's information

technology (IT) systems. These new challenges arise even as CMS must cope with the growth of the "baby boom" Medicare population and continue to meet challenging day-to-day operational requirements and to make frequent adjustments to its business processes, software code, databases, and systems in response to changing statutory, regulatory, and policy requirements. Complicating matters further, the efforts to evolve its systems come in the midst of changes to the nation's health care IT more broadly.

CMS's ongoing operational requirements are currently being met with a very large and complex set of hardware, software, and communications systems that vary considerably in age, capability, and sophistication. The ability of these systems to continue to keep up with the ongoing changes and new missions demanded of them is an understandable source of concern. CMS asked the National Research Council to review its plans for its IT capabilities in light of these challenges and to make recommendations to CMS on how its business processes, practices, and information systems can best be developed to meet today's and tomorrow's demands.

The recommendations and conclusions offered by the Committee on Future Information Architectures, Processes, and Strategies for the Centers for Medicare and Medicad Services cluster around the following themes: (1) the need for a comprehensive strategic technology plan; (2) the application of an appropriate meta-methodology to guide an iterative, incremental, and phased transition of business and information systems; (3) the criticality of IT to high-level strategic planning and its implications for CMS's internal organization and culture; and (4) the increasing importance of data and analytical efforts to stakeholders inside and outside CMS.

The committee notes the significant benefits of modernizing and transforming CMS IT and the costs of not doing so. CMS has an opportunity now to plan strategically for necessary advances and needs to move quickly. Given the complexity of CMS's IT systems, there will be no simple solution. Although external contractors and advisory organizations will play important roles, CMS needs to assert well-informed technical and strategic leadership. The committee argues that the only way for CMS to succeed in these efforts is for the agency, with its stakeholders and Congress, to recognize resolutely that action must be taken, to begin the needed cultural and organizational transformations, and to develop the appropriate internal expertise to lead the initiative with a comprehensive, incremental, iterative, and integrated approach that effectively and strategically integrates business requirements and IT capabilities. CMS has an opportunity now to effect these needed transformations—the technology exists to do what must be done.

CMS'S INCREASINGLY DYNAMIC AND CHALLENGING OPERATIONAL CONTEXT

The nature, scope, and scale of the changes with which CMS is grappling are significantly greater than past transitions it has successfully weathered (such as the successful implementation of Medicare Part D, which was itself a large challenge). The variety of new activities for which CMS is responsible, the new legislation to which it must be responsive, the pending proposals that it must monitor, and the changing shape of health care broadly are all part of a highly dynamic context in which the agency operates. Just during the course of this study, CMS was tasked with major new efforts such as ensuring the implementation of meaningful-use regulations and overseeing development of the health insurance exchanges called for in the Patient Protection and Affordable Care Act (PPACA).

Such additional responsibilities reflect the fact that the needs and demands of CMS's customers and stakeholders are changing. And CMS must manage the overall integration of its programs, processes, and systems while fighting fraud, providing the required levels of security and privacy, and achieving new efficiencies. In addition to anticipated changes to CMS's own programs, the broader health care, practice, and policy environments are undergoing significant change, including ongoing evolution of technology and changes in policy expectations regarding transparency, fraud resistance, timeliness, and the greater involvement of key stakeholders. Importantly for this study, virtually all of the new initiatives and activities CMS is being asked to cope with have significant implications for its IT infrastructure and systems. IT is at the heart of virtually every CMS business interaction, process, and decision.

Rising health care costs are a central challenge facing the nation, and CMS is expected to play a major role in addressing such costs and their impact on federal spending. As the country heightens its efforts to improve care quality and control the costs of care it will rely increasingly on CMS to be at the forefront. Indeed these expectations have been described in recent legislation. The study committee concurs with the views expressed by CMS in meetings and discussions that serious work is needed to prepare the agency's business and information systems for the future and that investment in CMS's IT is critical to controlling costs in the long term.

RECOGNIZE THAT A COMPREHENSIVE STRATEGIC TECHNOLOGY PLAN IS CENTRAL TO CMS'S MISSION AND EFFECTIVENESS

The committee agrees with views it heard from CMS and others over the course of the study that the status quo is not a realistic option. If the

programs CMS administers were to remain fundamentally static and the only issue were the growth in claims volume driven by an aging population, it is possible that CMS's current systems could be evolved and adapted to satisfy the anticipated growth in transaction volume. However, the programmatic requirements that CMS must meet now and in the rest of this decade present an extreme challenge to fulfillment through the structure of its existing systems. The necessary changes cannot be delayed given the agency's legislative mandates.

While the status quo is insufficient, simply urging major "systems modernization" is also not adequate. Industry experience has repeatedly reinforced the lesson that "big bang" approaches to systems modernization almost always fail. Such approaches are difficult to execute and, even when the end-state seems clear, their record of success is poor. Moreover, such approaches often ignore the fact that new systems change the environment in which they operate, and hence the future requirements to which they are subject. At the same time, reactive, year-by-year and program-by-program approaches to upgrading CMS systems also will not work to meet the new and emerging demands on CMS. There should be no expectation on the part of CMS or its stakeholders, including Congress, of an "ultimate" or finished CMS IT system.

Although this report focuses on information technology systems, IT systems and the organizations that support them do not exist entirely independently of other parts of the CMS enterprise. This interdependence has two implications: (1) developing a coherent and effective vision for IT is dependent on a vision for CMS as a whole, and (2) IT should be viewed throughout the agency and by stakeholders as a central vehicle for supporting the effective performance of CMS's activities, businesses, and programs. To get to a vision for future IT at CMS, the agency itself should have a clear expression of how it intends to, or believes it will, function in the future. Such a vision will likely anticipate CMS programmatic extensions into quality, safety, equity, and value management and will need to account for an increasing frequency of legislative and regulatory mandates that will change CMS programs and requirements. Thus, CMS itself needs a strategic plan that is broadly accepted; it will be an evolutionary document that will require periodic updating as mandates are refined, experience is amassed, and the health care delivery system as a whole changes. In concert with the agency's strategic plan, a well-aligned strategic *technology* plan is also needed.

A comprehensive strategic technology plan provides a vision to help guide an organization as it executes on programs and projects with a clear sense of strategic priorities, while minimizing the risk of wasting resources on applications and projects that are redundant. A strategic technology plan offers a strategy for the deployment of technology and

clearly defined responsibilities for the use and application of technology. The IT environment in CMS is too complex to rely on outmoded ways to keep the CMS business functioning and thriving. To balance the many crucial and changing demands to move the organization forward, strategic technology planning, coupled with a business-driven IT governance process, will be needed. Instituting strategic technology planning integrated with CMS business planning can serve as a catalyst that effectively brings together the dynamics of cross-enterprise communication and summarizes key, relevant data to inform decision making.

CMS's Office of Information Services (OIS) has developed or is in the process of developing many components of a strategic technology plan as outlined here. The plan and meta-methodology described in this report are a generalization of that described by OIS itself in, for example, its enterprise and shared services plan, enterprise data environment, and OIS-wide architectural and life-cycle guidelines, among others. OIS has articulated the need to formalize and define services that can be shared across its various businesses. The documents seen by the committee also suggest a governance model that spans the business and IT organizations, involving all stakeholders. The committee applauds this direction in CMS, and nothing said here should contradict the ideas expressed in those documents. The committee uses its own terminology in this report only for consistency and clarity.

Recommendation: CMS should develop a comprehensive strategic technology plan that supports and extends the ability of CMS to achieve its envisioned mission. Particular emphasis should be focused on ensuring that CMS has the necessary data, information, and IT capabilities to effectively implement legislatively mandated, value-based payment programs.

The plan should articulate an IT vision consistent with the evolving mission of CMS as mandated by Congress, and cognizant of a rapidly evolving health care system. The plan should be fundamentally informed by the various stakeholders in CMS IT and by a clear and comprehensive view of both the current state and projections of the future state. The plan should be broadly communicated both within CMS and to all of its stakeholders and serve as a roadmap for future IT initiatives.

The CMS strategic technology plan should:

- Be evolutionary and incremental.
- Explicitly articulate CMS's core technical competencies and consider what IT functions and activities might be carried out by the private sector or other public agencies.

- Identify as many shared services as possible and create a shared services model across all CMS business organizations.
- Emphasize systems leveraged across programs to reduce unnecessary redundancies; emphasize using existing proven technologies wherever possible; and prioritize standards-based solutions.
- Include an enterprise architecture framework; explicit prioritization and a roadmap; an assessment of human capital requirements; and periodic planned review and iteration of the plan itself.

A strategic technology plan for CMS is needed against which to plan, act, and make ongoing refinements based on experience. The rationale for the development of such a plan is multifaceted; the plan would:

- Rationalize the process of making the difficult, and necessarily long-term, decisions about systems replacement, evolution, modernization, and transformation.
- Contextualize the funding requests for IT and provide a mission-driven rationale for and prioritization of individual initiatives and funding requests.
- Drive toward coordination of efforts to garner increased efficiencies.
- Ensure that the entire complex organization and its stakeholders understand the overall direction and intent of use of IT at CMS.
- Identify long-term needs for resources, and align those resources effectively.
- Mitigate execution risk; in large organizations, many projects fail because of failure to recognize the coming interdependencies.
- Facilitate the alignment of the core and contracted parties.

Not only is federal IT management—and IT management, in general—notoriously difficult, but federal budget constraints and funding models also place additional pressure on agencies to maintain, and even increase, productivity in spite of limited financial resources. Agencies such as CMS are typically not allocated sufficient funds to modernize or upgrade existing systems in an enterprise-wide integrated fashion, and as a consequence must cope with the dual challenge of (1) program-by-program stove piping that makes it difficult to properly integrate programs or achieve the efficiencies (programmatic and operational) that would result and (2) inconsistent year-by-year funding that makes it difficult to do long-term planning of the sort possible with capital budgets. A sustained funding approach is needed that recognizes the benefits of investment in enterprise-wide modernization and transformation over the long term.

Conclusion: To achieve the needed modernizations and transformations that are basic to the realization of CMS's vision and execution of its strategic technology plan, a sustained, predictable, and appropriate investment is needed, including investments in enterprise information technology infrastructure and integration. Without such investment, CMS's modernization and transformation efforts are unlikely to succeed.

A forward-thinking strategic technology plan is essential to coping with ongoing changes in mandates and requirements both now and in the future. At the same time, there are also mandated near-term activities that cannot wait for a comprehensive plan and should be addressed now. It is important, however, not to completely decouple efforts to meet immediate needs from long-term thinking. There are benefits that accrue from linking long-term planning to fast-track programs: for instance, reinforcement of the need for some pragmatics in longer-term planning efforts and clarification of the urgency of the longer-term planning efforts so that they do not drag on indefinitely. Shorter-term efforts may have to be thought of as prototypes of a sort, aimed at gathering the more precise knowledge needed to serve as the basis for more solidly conceived and implemented permanent solutions to be implemented in subsequent iterations.

Recommendation: In parallel with developing a strategic technology plan, CMS should undertake fast-track efforts to satisfy immediate and near-term needs and mandates. These efforts should be well defined and constrained in scope and, to the extent possible, serve as a testing ground for longer-term strategic choices.

EMBRACE A COMPREHENSIVE, INCREMENTAL, ITERATIVE, AND PHASED APPROACH

A strategic technology plan lays a foundation and articulates a vision. But just as important is a comprehensive operational approach to modernization and/or transformation of the information infrastructure and systems. For the purposes of this report the terms "modernization" and "transformation" refer to two ends of a spectrum of possible transitions for components of an information system. Modernization refers to modest or evolutionary transitions; transformation refers to significant or revolutionary transitions. The committee's discussion of modernization and transformation is presented at an abstract (meta-) level that sets forth conceptual models for business roles and processes.

The approach to modernization and transformation recommended in this report has two phases. The first phase focuses on the modernization

or transformation of the business aspects of CMS and the establishment of a plan for the business systems (the people, processes, services, and information required to operate and meet all the business requirements of a specific CMS business role), in the process defining the business requirements. The second phase focuses on the modernization or transformation of CMS IT systems, is guided by the plan for the business systems, and creates a plan for the information systems (the systems required to build, develop, operate, and evolve one or perhaps multiple business systems).

Both phases follow the same pattern: (1) understand the source systems of interest and how they interrelate, (2) choose a starting point—a component to be transitioned, (3) understand the relevant target systems, (4) develop a mapping between the source and the target systems, and (5) implement the mapping and transition. At that point, choose the next component to transition and iterate through the cycle again—recognizing that the source systems of interest will have changed based on the results of the transition. Iteration, an incremental approach, and, perhaps most importantly, the strategic integration of business and IT are fundamental to the recommended meta-methodology.

At the end of each roll-out, the incrementally updated target becomes the source for the inevitable subsequent efforts needed. This is true at both the business and the information system levels. That is, this process will repeat indefinitely in an iterative fashion as each transition task is accomplished. The source and target systems will be in a state of constant change that will have to be accounted for at each stage of the iteration. Each of the transition tasks should begin tactically, by looking at the most critical systems, and build to a more complete view. Representatives of the relevant business roles and functions, as well as those with relevant technical specializations, should be involved in the process.

Recommendation: CMS should plan and execute the incremental, iterative, and phased modernizations and/or transformations of its business systems and their corresponding information systems, documenting and integrating business and information technology requirements within a comprehensive enterprise architecture framework.

One element of CMS's transformation will be to build on current work on data modeling to move toward a more consistent health information model that can guide all work and ensure more uniform conventions to support system integration and standardization. With such a model in place, the expensive task of creating customized, one-of-a-kind interfaces between disparate systems can be simplified and may be eliminated altogether. Data could be more integrated and more

shareable internally, and when necessary, externally. In addition, the time to create and the cost to build new systems, integrate legacy systems, or extract data from any system could be improved. Having a more comprehensive health information model for health care data in the organization would also help ensure that any future systems being developed will follow well-articulated semantic and syntactic interoperable guidelines and standards, which themselves may be modified and adjusted over time as needed. The development of such a model will take time and will require frequent iteration and continuing evolution.

Recommendation: CMS should develop, implement, and maintain—revising and updating on an ongoing basis—an enterprise-wide health information model as the agency's authoritative information model representing the structure and content of all shared information that is created, collected, maintained, used, and exchanged across the organization and with external partners.

EMPHASIZE ACHIEVING CULTURAL AND ORGANIZATIONAL TRANSFORMATION

The organizational environment and cultural acceptance of major changes in the roles, use, and architectural assumptions of IT systems and processes bear significantly on the success and effectiveness of modernization and transformation efforts. If the need for modernization or outright transformation is inadequately understood, especially by CMS organizational leaders or the users and stakeholders who will be most affected, even the best-intended and well-designed projects may fail.

Thus the kinds of changes in IT outlined above have to occur in the context of both internal adaptations in the CMS organization and a cultural adaptation that embraces the notion that CMS's business functions are intrinsically tied to IT. IT is not simply a support service and mechanism for implementing programs but rather an integral component of the strategic directions of the agency. CMS has special challenges in this regard, because its agenda and priorities are often defined by external forces such as new legislation. But much of how CMS does what it does is determined internally, based on organizational structures, planning and decision-making conventions, internal availability of staff and resources, and relationships.

In the committee's view, there are related cultural and organizational transitions needed at CMS that would have positive repercussions for nearly all of CMS's activities:

- A cultural shift from viewing IT as simply an operational necessity to embracing IT as a critical strategic element;
- A cultural shift away from viewing IT leadership as overseeing a support group, complementing but not an integral part of the leadership mainstream, and toward viewing IT leadership as playing a key role in planning, designing solutions, and advising CMS business leaders regarding suitable approaches to their own responsibilities;
- An organizational shift from a mission centered on transaction processing to a mission centered on data, information, and information management;
- An organizational shift from a focus on paying claims to a focus on driving a combination of payment with improvements in quality, safety, and equity of health care and outcomes for individuals and populations; and
- An organizational shift from relying on heroics from IT staff to ensuring a sustained investment in and commitment to infrastructure, resources, and staff.

The committee believes that in order to meet emerging and future needs, CMS should undergo an organizational and cultural transformation, actively integrating IT as a strategic partner in its business and deepening its internal IT core competency critical to CMS in several areas.

Recommendation: CMS should integrate high-level IT leadership into CMS's general strategic planning to ensure participation of IT and harmonization between the strategic technology plan and CMS's overall strategy at the highest levels of the agency.

IT strategic planning requires engagement and ownership at the highest levels of the CMS organization and cannot be effectively driven by CMS's IT organizations alone. As indicated by information the committee gathered, CMS recognizes the importance of this engagement and is taking steps in this direction. Historically IT has been viewed, both in industry and government, as a tactical resource. Experience and the literature have both shown, however, that it is not possible to make strategic decisions without considering the impact *on* IT and the impact and potential *of* IT.

Given the strategic and operational importance of IT in CMS, the highest levels of the organization should be involved in the governance of the transition. High-level governance efforts should ensure that the systems modernization and transformation efforts achieve CMS's goals. In addition governance should provide direction with respect to major changes to core processes, resolve policy issues raised by the implementa-

tion, address problems encountered during the transition, and approve, if necessary, the commitment of additional resources. IT governance should be developed to oversee the full set of CMS IT strategies, policies, and operations. The governing body that serves this function should be led by a senior business leader at the agency, and members of the body should be drawn from the senior leadership team.[1] The governance function should include business integration, alignment of business and IT, collaboration, strategic coordination, and planning—rather than focusing solely on operational and technology considerations. This function should have primary responsibility for developing CMS's strategic technology plan, implementing the proposed meta-methodology, and managing the change process.

In particular, governance mechanisms should be established for shared services, enterprise architecture framework, and the health information model. The transformation and modernization efforts are critically important to the agency; thus IT governance bodies should be structured so that senior leaders, including the CMS administrator, are well aware of the needs and efforts underway, are willing and able to integrate the planning into their business thinking, and are well informed so as to take advantage of opportunities that such planning provides.

Adjusting the role of the Office of Information Services to better reflect the criticality of IT to agency strategy will be important. From an organizational and cultural perspective, an important part of the solution will be clear, continuing, and effective communication, not only at an operational level but also at a strategic level, between IT leadership, senior leadership, and the other CMS units. A first step is membership of IT leaders on the relevant internal committees—including those that oversee and set directions for the CMS organization at the highest levels. The agency's chief information officer has to be an active part of the top management team for the agency—included not just on the organizational chart but also at the table when major operational and strategic decisions are made and contributing fully to the broad management of CMS.

Both planning meetings about long-term strategic goals and day-to-day planning meetings regarding business requirements and the appropriateness and feasibility of IT solutions should involve and expect the contributions of IT leadership. As with the development of CMS's strategic technology plan as a whole, these processes must be iterative as

[1]CMS currently has several IT governance bodies, e.g., the Executive Steering Committee, Information Technology Investment Review Board, and Configuration Control Board. These bodies are important. However, they focus largely on technical, tactical, and operational issues, as opposed to more strategic or policy-related issues at the intersection of business needs and IT.

experience is gained and as new requirements arise. In the absence of IT leadership, major strategic decisions can be made without recognizing the IT opportunities or challenges that are involved, resulting in either missed opportunities or poorly informed plans that project unrealistic expectations onto the IT staff or infrastructure.

CMS would benefit from the counsel of leaders from organizations in the public and private sectors that have effected significant IT-enabled organizational transformations. Inevitably, CMS will encounter issues and challenges for which the advice and insights of others who have tackled similarly scaled transitions would be very useful. Given the complexity of CMS's environment and mission, it is important that those insights be as well informed as possible about the agency's efforts and activities as well as its broad stakeholder communities. Developing such knowledge will require time and engagement on the part of the advisors in order to develop a deep understanding of CMS. An advisory panel of such leaders should be formed and structured in a way that enables them to obtain a clear understanding of CMS and its challenges and that fosters the frank exchange of ideas on an ongoing basis.

As for other federal agencies, the context is complex within which cultural (attitudes, experiences, beliefs, and values of an organization) and organizational (structures and processes) transformation will occur at CMS. The agency will have to address the core components of business transformation—people (including external stakeholders and Congress), processes, and technology—all while operating under intense public scrutiny, coping with federal funding idiosyncrasies, and adjusting to frequent leadership transitions.

Recommendation: CMS should rapidly and coherently continue to improve its overall information technology and business process governance structures and to better integrate them as follows:

- **The Office of Information Services should be fully involved from the start in discussions with CMS business units regarding new requirements, programs, and processes.**
- **OIS should assume and be given more direct oversight and coordinating responsibility over the agency's enterprise IT resources, including coordination and communication of business requirements.**
- **CMS should institute ongoing access to and dialogue with individuals and institutions from public and private sector organizations that have experience in designing and implementing large-scale IT-enabled modernizations and transformations.**

Enhance Crucial Skill Sets—Technology, Informatics, and Innovation

CMS's development of its strategic technology plan and implementation of the committee's recommended meta-methodology will require the introduction of new skill sets into CMS and the strengthening of existing skills—in particular in the areas of technology and management of technology change, and informatics. There are also opportunities to enhance the role of CMS's new Innovation Center.

CMS's IT organization should be augmented and changed in some key areas. In the committee's view, the CMS IT staff's current commitment to the CMS mission, to getting the job done, and to the welfare of the public is notable. The group has shown unusual resourcefulness and inventiveness in successfully executing a number of difficult projects under significant time pressures, overcoming the challenges of outdated software and enormous complexity, and largely recognizing the need for positive organizational and cultural changes such as those outlined in this report. Moreover CMS's staff continues to manage well a massive IT operation. To enable an effective response to the near and intermediate demands of payment reform and other responsibilities placed on CMS, these existing competencies should be strengthened.

The evolving CMS mission hinges on public trust, and maintaining patient privacy and data security is one component of that trust. CMS must provide secure IT services to maintain patient and provider privacy. Creating a truly secure system can be especially challenging in an IT environment fashioned by disparate subcontractors, especially when the competing goals of access, openness, and transparency are implemented.

The recruitment, retention, and training of IT professionals within CMS must reflect not only technical skill requirements but also organizational, management, and planning capabilities. The ability to manage subcontractors is critical, but so also is the ability to manage and respond to internal CMS organizational and cultural issues. Although soliciting and receiving advice about technology from contractors can be useful, the ultimate decisions about which technologies should be explored, evaluated, and deployed must reside with CMS and should be based on the judgments of people whose principal obligations are to CMS and the success of its missions and who can draw on deep insights and expertise in IT. Key decisions need to be made by the agency itself, and those decisions must be rooted in a strong grasp both of CMS issues and considerations, and also be informed by a strong grasp of technology. At its most fundamental, in addition to enhancing and expanding the capabilities and role of IT at CMS, management of large-scale change will require the focused attention of the CMS leadership and the involvement of all CMS staff and its contractors.

CMS's customer and stakeholder base will continue to change, especially with a PPACA-mandated emphasis on clinical care quality and safety as well as health promotion and increased efficiencies and cost savings. The demand for CMS-managed data to support research and other external analytical purposes continues to grow and may change in both character and volume. In particular, the field of biomedical informatics (the scientific discipline) and its application in clinical and public health settings (health informatics) are highly relevant to the current and future needs of CMS and its IT planning, design, and implementations.

As a component of the organizational transformation needed to meet emerging demands, CMS should enhance its capacity in the informatics field, with clear roles in IT design and strategic planning. Informatics experts bring both technical knowledge of computing and communications and a health professional orientation—many are also trained in one of the health professions, and all have substantial exposure to the processes, workflow, sources of error, and culture of health care as well as an understanding of the subtleties of real-world applications and their implications for quality of care and patient safety. Informatics organizations generally exist separately from the related IT organization and typically provide internal support in the form of analytical capabilities, taking into account the broad mandates and functions of an organization and tying them together both tactically and strategically, and they can help to bridge the technical and business functions of an enterprise.

The creation of the CMS Innovation Center, mandated by Congress under the PPACA, has provided an excellent opportunity for the agency to propose, test, and evaluate new concepts that may influence the directions of the organization for years to come. Although the emphasis thus far has been on new payment models that could enhance quality while reducing costs, the center's authorization includes investigation of new models of service delivery. Given the close relationship between IT infrastructure and the CMS enterprise information architecture, the committee believes that the Innovation Center could also be investigating innovative IT to support CMS's mission. This prospect becomes particularly intriguing and attractive in light of the new PPACA mandates to move into areas related to quality, equity, safety, and maintaining the public's health. For example, CMS still has to decide how best to respond to the new mandates for gathering clinical indicators, and the Innovation Center could play a key role in exploring those options.

Recommendation: CMS should enhance and strengthen the agency's capabilities as follows:

- **Enhance or extend the skills of CMS staff in data management, architecture management, technology infrastructure management, technology investigation and evaluation, and security.**
- **Build a dedicated capacity in informatics, placing such experts in strategic and planning roles that complement those provided by the IT organization.**
- **Explicitly broaden the activities of CMS's Innovation Center beyond exploration of payment models to include the exploration and evaluation of creative information technology and informatics opportunities that will support the mission of the agency.**

ANTICIPATE A DATA-CENTRIC FUTURE

CMS's role in the U.S. health care mosaic will be pivotal as the nation shifts to improved approaches for organization, payment, consumer engagement, understanding of bioscience foundations of health, and data management for health care. This transition will take place over many years, but some key shifts are already underway. At every stage, the capacity to improve decision making throughout the entire system will depend on having not only access to timely data but also the capacity to transform the raw data first into information and ultimately into intelligence to support future planning and action.

CMS is in the process of transforming itself from being focused primarily on retrospective payment for health services for segments of the population to a focus on clinical data, information, and information management while still fulfilling its traditional mandates. Several trends in health care illustrate this broad need for a more data-centric approach, including the diffusion of electronic health records (EHRs), changes in practitioner relationships, efforts toward comparative effectiveness, monitoring for improvement of quality and reduction of disparities, and increased consumer access to and demand for health and medical information.

In the aggregate, these trends regarding data will interact in ways to produce both additional work and new requirements for CMS. While the ultimate result of this convergence is not completely known, the drive to achieve great value for health care for both individuals and populations is not at all likely to abate, especially in light of the demographic pressures and size of the financial investment the nation is making in health care services.

Data are essential to and underpin nearly all of the efforts CMS is undertaking—and are an essential driver for the development of a CMS strategic technology plan, motivate the recommended meta-methodology, and are a key impetus for the organizational changes discussed above.

The discussions above are all driven, at least in part, by CMS's new and changing relationship to data and information: the data and information collected by CMS are now used extensively within the agency for analytic purposes, such as various quality efforts, policy analysis, combating fraud, informing consumers, managing payments, and, more recently, understanding racial and ethnic disparities and contributing to their reduction.

In addition, outside researchers, many of whom are investigating quality-related research questions, currently make extensive use of the data sets generated by CMS, although there are concerns about access related to timeliness and expense. Many of the modernization and transformation steps discussed throughout this report will make data integration easier (for example, integrating the reports from Medicare Managed Care with those from fee for service), leading toward earlier release of data. Much earlier release of survey data will support the best use of this important information. However, approaches to gathering this data and sorting out how to make it available and to whom cannot be envisaged adequately until all stakeholders have been engaged and are contributing to the discussion on an ongoing basis. Doing that incremental and ongoing engagement is part of the committee's recommended approach and is essential to devising future mechanisms for data management.

Recommendation: CMS's strategic technology plan should support CMS's own needs for data and also take into account use of CMS data by other authorized users for research and analytic purposes. With it CMS should:

- **Clearly articulate the process by which claims-based and clinical data furnished by providers that receive meaningful-use incentives will be made available to authorized users for analytic purposes.**
- **Collaborate with the health services research, equity-focused, and quality communities to define claims-based, clinical, survey, and other data sets that can be made available in a more timely fashion.**

CONCLUSION

The urgency of the challenges faced by the nation regarding the cost and quality of health care, and the central role that CMS plays in meeting these challenges, spotlight the need for a 21st-century information infrastructure at the agency. The committee's recommendations are offered not

only to CMS, but also to Congress, and CMS's stakeholders. Indeed, every American has a stake in the success of CMS's efforts. CMS must cope with frequently changing demands, continue to operate its core functions at scale, and modernize and transform its systems and culture to handle new demands, all while facing a constrained and uncertain funding environment. Sustained funding and appropriate integrated governance will enable the agency to meet the demands that the nation is placing on it. Critically embedding IT in strategic conversations and planning at the agency is also essential. CMS should develop a comprehensive strategic technology plan that is well aligned with the agency's overall strategy and that embraces a comprehensive flexible, incremental, iterative, and phased approach to business process and system transformation, in the service of its important national mission.

1

Essential Considerations and Background

Since its inception, the organization now known as the Centers for Medicare and Medicaid Services (CMS)[1] has played a critical role in providing access to health care for the nation's aged and most vulnerable citizens. This role has only increased in importance over the years in light of program expansions, the changing demographics and aging of the U.S. population, increasing health care costs, serious public health challenges, and the growing prominence of electronic health records (EHRs) and other e-health efforts—all in the face of having to operate under increasingly tight federal budgetary constraints. By providing a brief overview of the agency's core tasks and its roles with respect to its relevant stakeholder communities, its responsibilities as a result of recent legislative mandates, and the current state of its information technology (IT) environment, this chapter attempts to capture the extent and complexity of the information enterprise that CMS is on the way to becoming. This is the context for the report's discussion in subsequent chapters of CMS IT infrastructure and approaches the agency might take to ensure effective use of IT in accomplishing its mission.

CMS'S MISSION, ROLES, AND STAKEHOLDERS

In 1965, Congress amended the Social Security Act (P.L. 89-97) by adding Title XVIII, Health Insurance for the Aged and Disabled, which

[1]Formerly the Health Care Financing Administration.

established Medicare, and Title XIX initiating Medicaid. Medicare, Medicaid, and related programs are currently managed by CMS within the Department of Health and Human Services.

In general, work that CMS currently performs helps to fulfill either its mission as a health care insurance provider or reflects its mandate to help improve health care quality. CMS's core tasks include "processing billions of claims, addressing millions of inquiries and appeals, and conducting thousands of health care facility inspections and complaint investigations. CMS manages and supports its prescription drug plans, Medicare Advantage plans, employer-sponsored retiree health care coverage, and various administrative grants. The agency works with various states, regions, and providers to facilitate enrollment of millions of eligible recipients and to develop policies for cost-effective and quality health care."[2]

In addition, CMS is responsible for several other key programs such as managing quality standards and training at clinical laboratories, advancing the national e-health agenda, and engaging in research and demonstration projects to improve claims reimbursement and quality of care.

The agency directly employs approximately 4,000 people, two-thirds of whom are based at its Maryland headquarters. CMS also has 10 regional offices throughout the United States,[3] and CMS headquarters has 11 main functional divisions.[4] In addition to its own staff, CMS currently relies on approximately 80,000[5] contractors involved in claims processing and employed as front- and middle-office staff in the Medicare Administrative Contractor offices, as well as in building, managing, and maintaining its numerous IT systems.

As a result, CMS has a diverse and complex cast of stakeholders invested in its mission, and by extension in the performance of its sys-

[2]CMS, 2006, "Achieving a Transformed and Modernized Health Care System for the 21st Century: CMS Action Plan 2006–2009," document, formerly available at http://www.cms.hhs.gov/MissionVisionGoals/Downloads/CMSStrategicActionPlan06-09_061023a.pdf.

[3]CMS, 2011, "CMS Programs & Information," website, available at http://www.cms.gov/, last accessed July 31, 2011.

[4]The divisions are the Center for Medicare; Operations (which includes the Office of Financial Management, the Office of Information Services, and the Office of E-Health Standards and Services); Center for Medicaid, CHIP, and Survey & Certification; Center for Medicare and Medicaid Innovation; Center for Consumer Information and Insurance Oversight; Office of Clinical Standards and Quality; Center for Strategic Planning; Office of Executive Operations and Regulatory Affairs; Center for Program Integrity; Office of Legislation; and Office of the Actuary. For more information regarding CMS organizational structure, see the CMS organizational chart, last updated August 1, 2011: CMS, 2011, "Department of Health and Human Services: Centers for Medicare and Medicaid Services," chart, available at http://www.cms.gov/CMSLeadership/Downloads/CMS_Organizational_Chart.pdf, last accessed August 1, 2011.

[5]Laurie Maatta, 2011, "CMS Systems Scope and Scale," presentation to the committee, January 13, site visit.

tems and in the effectiveness of its IT infrastructure. The most prominent among these stakeholders are those linked to CMS in its role as an insurer: CMS's varied beneficiary subgroups rely on CMS-provided insurance to ensure their access to quality health care providers.

Major Roles—Health Insurance Provider and Promoter of Quality

Health Insurance Programs

CMS provides insurance through the Medicare (Parts A, B, C, and D), Medicaid, and CHIP programs, and each claims process is administered separately.[6] "Collectively, these programs make CMS the largest purchaser of health care in the United States, [covering more than one-third of the U.S. population] and interact[ing] with thousands of health care providers across the country ranging from individual physicians to hospitals large and small, as well as with other providers such as ambulance services and rural health centers."[7] For the Medicaid and CHIP programs, CMS shares administrative responsibility with individual states. In most cases management is state administered, but CMS is tasked with ensuring mandatory state coverage for eligible participant groups (including newly eligible groups under the PPACA),[8] evaluating and approving state Medicaid programs,[9] and processing state claims for program reimbursement for dual eligibles.[10]

Recent legislation, notably the Patient Protection and Affordable Care Act (PPACA), continues to expand CMS's role in the medical insurance area, extending coverage to new groups and for new health services. CMS is also responsible for managing the Center for Consumer Information and Insurance Oversight, which will implement provisions of the PPACA related to health insurance and will oversee state-based insurance exchanges.

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[6]Julie C. Boughn, 2010, "CMS Systems Briefing," presentation to the committee, via teleconference, July 23.

[7]NRC, 2010, *Preliminary Observations on Information Technology Needs and Priorities for the Centers for Medicare and Medicaid Services: An Interim Report*, Washington, D.C.: The National Academies Press

[8]CMS, 2011, "Medicaid Program: Eligibility Changes Under the Affordable Care Act of 2010: Proposed Rule," *Federal Register* 76(159):51148-51199.

[9]CMS, 2011, "Medicaid Program: Eligibility Changes Under the Affordable Care Act of 2010: Proposed Rule," *Federal Register* 76(159):51148-51199

[10]Congressional Research Service, 2010, *Medicaid and the State Children's Health Insurance Program (CHIP) Provisions in PPACA: Summary and Timeline*, R41210, Washington, D.C.: Library of Congress, available at http://www.nahu.org/legislative/resources/Medicaid%20and%20the%20State.pdf.

Medicare. Medicare is a federally sponsored health insurance program for people age 65 and older, or those under 65 with eligible permanent disabilities or conditions such as end-stage renal disease; it supplements Title II of the Social Security Act, which provides federal "retirement, survivors, and disability insurance benefits."[11] When the Medicare program was first implemented in 1966, 19 million people were enrolled.[12] Today, the program provides medical insurance for more than 47 million people. Medicare has four parts—Parts A (Hospital Insurance), B (Medical Insurance), C (Medicare Advantage), and D (Prescription Drug Coverage)—each with different enrollment and eligibility criteria, as well as different administrative policies and procedures (see Box 1.1).

Medicaid. Medicaid, which provides health insurance for eligible low-income individuals and families, is a state-administered program, and each state has some discretion as to how it manages the program and determines eligibility (i.e., how income is counted). Providing coverage to some eligibility groups is mandatory, meaning that all states must cover them; providing coverage to others is optional. For the coverage that is optional, each state sets and enforces its own guidelines regarding eligibility and services.[13] States also are responsible for developing and maintaining their own IT infrastructures to support their programs,[14] and many of the issues regarding these systems are similar to those experienced by CMS, such as the need for personnel who can support both legacy and more modern systems and the lack of a dedicated funding source.[15] Legislation at both the federal and the local levels that redefines eligibility categories from time to time creates ongoing administrative and technical challenges for both CMS and state administrators in data management, claims processing, and rapidly changing business practices. The PPACA establishes a uniform state level of support starting in 2014.

[11]Barbara S. Klees, Christian J. Wolfe, and Catherine A. Curtis, 2009, "Brief Summaries of Medicare & Medicaid Title XVIII and Title XIX of the Social Security Act," Baltimore, Md.: CMS, available at https://www.cms.gov/MedicareProgramRatesStats/downloads/MedicareMedicaidSummaries2009.pdf, last accessed July 29, 2011.

[12]CMS, 2010, "Key Milestones in CMS Programs," website, available at http://www.cms.gov/History/Downloads/KeyMilestonesinCMSPrograms.zip, last accessed July 29, 2011.

[13]States may also determine the amount and duration of services offered within federal guidelines provided that the (1) limits must result in a level of services sufficient to reasonably achieve the purpose of the benefits and (2) limits on benefits may not discriminate among beneficiaries based on medical diagnosis or condition.

[14]Thomas Donovan, 2011, "New York State Department of Health: Health IT," presentation to the committee, February 17-18, Irvine, Calif.; Chris Cruz and Larry Dickey, 2011, "Medi-Cal," presentation to the committee, February 17-18, Irvine, Calif.

[15]Chris Cruz and Larry Dickey, 2011, "Medi-Cal," presentation to the committee, February 17-18, Irvine, Calif.

Children's Health Insurance Program. The Children's Health Insurance Program (CHIP) was created by Congress in 1997 as a means to provide insurance to children from birth to age 19 if they are uninsured and do not otherwise qualify for Medicaid.[16,17] CHIP provides a capped federal grant to states[18,19] funded through a tax on cigarette purchases. The legislation required states to develop a separate program for CHIP, to expand an existing Medicaid program to cover children eligible for CHIP insurance, or to do some combination thereof. CHIP charges families a monthly premium for coverage. Often, a state's school systems or other social service organizations play an important part in enrolling eligible children and families in CHIP.[20,21]

Quality Initiatives

CMS not only provides insurance, but also promotes quality health care. Some of CMS's efforts toward quality improvement include:

- *Funding for graduate medical education.* To ensure a sufficient number of treatment providers for Medicaid-eligible patients, CMS helps to support graduate medical education programs by making "payments to hospitals that train residents in approved medical residency training programs, based on the number of residents the hospital has on staff."[22]

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[16]CMS, 2009, "State Medicaid Director Letters, May 11, 2009," memorandum, Baltimore, Md.: CMS, available at http://www.cms.gov/SMDL/downloads/SHO051109.pdf, last accessed July 29, 2011.

[17]This program is under Title XXI of the Social Security Act as amended by the Balanced Budget Act (BBA) of 1997 (P.L. 105-33).

[18]Congressional Research Service, 2008, "Medicaid; A Primer," RL33202, Washington, D.C.: Library of Congress, available at http://aging.senate.gov/crs/medicaid1.pdf, last accessed July 29, 2011.

[19]Nancy Bearss, 2010, "Medicaid," in *Encyclopedia of Cross-Cultural School Psychology*, Caroline S. Clauss-Ehlers, ed., New York, N.Y.: Springer.

[20]On October 30, 2009, the Department of Health and Human Services (HHS) awarded $40 million in federal funds to outreach grants to establish new public and private partnerships to increase CHIP enrollment. See HHS, 2009, "Secretary Sebelius Awards $40 Million to States to Find, Enroll Children in CHIP, Medicaid," website, available at http://www.hhs.gov/news/press/2009pres/09/20090930a.html, last accessed July 29, 2011.

[21]On February 3, 2011, HHS issued a press release announcing an additional $40 million in funds available for new grants to "states, community-based organizations, school systems and others to support their outreach and enrollment activities." See HHS, 2011, "Two Year Anniversary of Children's Health Insurance Law Sees Millions of Newly Insured Children, Families," website, available at http://www.hhs.gov/news/press/2011pres/02/20110203b.html, last accessed July 29, 2011.

[22]CMS, 2005, "Medicare Policy Clarifications on Graduate Medical Education Payments for Residents Training in Non-Hospital Settings," document, available at https://www.cms.gov/AcuteInpatientPPS/Downloads/nonhospQA.pdf, last accessed July 31, 2011.

BOX 1.1
Medicare Parts A, B, C, and D

Medicare Part A is hospital insurance for those over 65.[1] Those who are eligible for premium-free coverage are automatically enrolled in Part A if they are already receiving Social Security retirement benefits, disability benefits, or railroad retirement checks. Otherwise, individuals must contact their local Social Security office (or enroll online at the Social Security website)[2] 3 months prior to their 65th birthday to sign up for Medicare.[3] Services covered under Medicare Part A include hospitalization, up to 100 days of care in skilled nursing facilities, post-institutional home health care and visits, and hospice services. Payment of claims under Part A of the Medicare program is the largest component of health care spending for CMS.

Medicare Part B is a supplemental medical insurance program. Individuals become eligible at the same time they are eligible for Medicare Part A, but must enroll in the program and pay a monthly premium for the coverage. Slightly fewer than 5 percent of eligible beneficiaries will pay a higher premium based on their income, whereas low-income beneficiaries may be eligible for state assistance in meeting their premiums. Medicare Part B covers physician services and supplies, laboratory services, durable medical equipment, prosthetics and orthotics, outpatient hospital services, and limited home health care services.

Medicare Part C, called the Medicare Advantage program (formerly Medicare+Choice program), was established as part of the Balanced Budget Act of

[1]Those who pay a monthly premium for coverage include individuals who did not pay enough into Medicare while working or are otherwise not entitled to Social Security, or who were disabled but returned to work, thereby losing their eligibility for free Part A.

[2]Social Security Administration, 2011, "Medicare," available at http://www.ssa.gov/pgm/medicare.htm, last accessed July 31, 2011.

[3]According to the Social Security Administration, "If you are not already getting retirement benefits, you should contact us about three months before your 65th birthday to sign up for Medicare. You can sign up for Medicare even if you do not plan to retire at age 65." See Social Security Administration, 2011, "Signing Up for Medicare," website, available at http://www.socialsecurity.gov/pubs/10043.html#part5, last accessed July 31, 2011.

• *Survey and certification of health care facilities.* Under Section 1864 of the Social Security Act, CMS plays a critical role in setting safety and performance standards; providing oversight and quality control for a number of laboratories, health care facilities, and treatment centers; and certifying new provider facilities. One notable example is CMS's role in the Clinical Laboratory Improvement Amendments of 1988 (CLIA) program.

1997 and modified under the Medicare Modernization Act of 2003[4] and under the Patient Protection and Affordable Care Act. Part C provides the option to enroll in private health plans—such as managed care—and may provide additional benefits and lower copayments than in the regular Medicare part A or B plans. Participants in Part C must also participate in both Medicare Parts A and B, elect coverage under Medicare Part C, and pay required premiums (including Part B premiums, and possibly additional Medicare Advantage premiums).[5,6,7]

Medicare Part D is a prescription drug program. Made effective January 1, 2006, under the Medicare Prescription Drug, Improvement, and Modernization Act (MMA) of 2003,[8] Part D provides an option for obtaining outpatient prescription drugs. Participants must enroll in the program, and eligibility is determined on the basis of their enrollment in other Medicare and Medicaid programs. All Part D beneficiaries pay a premium for service. The 2003 MMA requires that Medicare Part D plans support electronic issuance of prescriptions. Current participation is voluntary, with incentives provided to the care providers that participate.[9]

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[4]Kaiser Family Foundation, 2010, "Medicare and Medicare Advantage Fact Sheet," #2052-14, September, available at http://www.kff.org/medicare/upload/2052-14.pdf, last accessed July 31, 2011.

[5]The PPACA and the Deficit Reduction Act of 2005 (P.L. 109-171) each made a number of specific coding rules changes and adjustments to Medicare Advantage. The Medicare Prescription Drug, Improvement, and Modernization Act (MMA) of 2003 (P.L. 108-173) also revised Part C expanding coverage.

[6]See http://www.medicare.gov/choices/advantage.asp.

[7]The PPACA, amended by the HCERA of 2010, reduces federal payments to Medicare Advantage plans over time and provides bonus payments to plans receiving high ratings for quality. See the section "Quality Initiatives" in this chapter.

[8]Prior to 2006, from 2004 to 2006, help with paying for prescription drugs not otherwise covered by Part A or Part B came through prescription drug discount cards, which were provided to beneficiaries on a voluntary basis and at limited cost (except to those entitled to Medicaid drug coverage) and which, for low-income beneficiaries, provided transitional limited financial assistance for purchasing prescription drugs and added a subsidized enrollment fee for the discount cards.

[9]CMS, 2011, "Electronic Prescribing (eRx) Incentive Program Overview," website, available at http://www.cms.gov/ERxIncentive/, last accessed, July 31, 2011.

• *Laboratory testing.* As mandated by CLIA,[23] CMS shares responsibility with the Food and Drug Administration (FDA) for the oversight of clinical laboratories responsible for medical diagnostic testing. Irrespective of the size and service volume, when testing is considered either moderate or complex, CMS is required to do a survey every 2 years to

[23]CMS, 2006, "CMS Initiatives to Improve Quality of Laboratory Testing Under the CLIA Program," document, available at https://www.cms.gov/CLIA/downloads/060630.Backgrounder.rlEG.pdf, last accessed July 31, 2011.

ensure adherence to clinical quality standards and to provide appropriate training of personnel and fiscal management.

- *Quality improvement organizations.* Quality improvement organizations (QIOs)[24] are CMS contractors, usually not-for-profit entities, located in every state and in most U.S. territories. Staffed with health care professionals who are legally charged with improving the quality of care for beneficiaries, QIOs ensure that Medicare pays only for reasonable and necessary services provided in an appropriate setting. QIOs also address individual beneficiary complaints.
- *Reduction of disparities.* Although CMS has addressed the issue of disparities through QIOs and other program efforts, the agency has now been charged, pursuant to the Health Information Technology for Economic and Clinical Health (HITECH) provisions of the American Recovery and Reinvestment Act of 2009 and the PPACA, to reduce health disparities as a key strategy for ensuring the delivery of quality and equitable care to Medicare and Medicaid beneficiaries. A prerequisite to achieving this aim, as mandated by Congress, is the availability of data disaggregated by race, ethnicity, primary language, and other factors. The primary source of demographic data on Medicare beneficiaries is the Social Security Administration (SSA). Other sources of data for CMS beneficiaries are state Medicaid agencies, Medicare Advantage providers, surveys, and CMS supplemental efforts to repopulate data missing from SSA records or to obtain data during Medicare enrollment via postcards and other means. In addition, disaggregated data will be collected by providers receiving EHR meaningful-use incentives administered by CMS, as one of the core eligibility requirements. CMS was required under the Medicare Improvements for Patients and Providers Act to report to Congress in September 2011 on effective methods for ongoing data collection and for measurement and evaluation of health disparities.[25]

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[24]NRC, 2006, *Medicare's Quality Improvement Organization Program: Maximizing Potential* (*Series: Pathways to Quality Health Care*), Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=11604, last accessed July 31, 2011.

[25]It should be noted that CMS race/ethnicity data are of uneven quality with respect to accuracy and completeness, as documented by reports produced by HHS, IOM, and other agencies, as well as testimony received by the committee. For example, although SSA modified its data collection practices in 2008 to follow the format required by the Office of Management and Budget, the new procedures apply only to new Social Security and SSI claims and to replacement number and lost card applications. These revised OMB standards do not apply to applications filed before 2008 or to applications received under SSA's Enumeration at Birth process, which precludes the collection of race/ethnicity data because of state restrictions. See NRC, 2009, *Race, Ethnicity, and Language Data: Standardization for Health Care Quality Improvement*, Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=12696, last accessed September 14, 2011; SSA, 2008, "Agency Information Collection Activities: Comment Request," *Federal Register* 73(56):15252-

In addition, programs such as Hospital Compare[26] make data on hospital performance available on the web for consumers and have an important impact on hospital reputation and consumer choice. One speaker noted at a committee meeting that "reporting systems, particularly those serving as a basis for public reporting, need to be up to date if they are to inform patients' choice and accurate if they are to be used to rate provider quality."[27] Considered by some to be difficult to navigate, the current Hospital Compare website also limits comparison to just three hospitals at a time.

CMS Has Many and Varied Stakeholders

CMS's stakeholders in addition to its insurance beneficiaries can be identified by considering CMS's various roles. For example, Medicare Part A provides hospital insurance; hospitals, therefore, have a direct stake in CMS's IT efforts, relying on effective IT for prompt, accurate reimbursement of claims. Health care providers have a similar stake through Medicare Part B and other programs. CMS's role in administering Medicare Part C adds other insurance companies to the growing list of stakeholders, and Medicare Part D's prescription drug benefits expand that list even further to include drug companies and pharmacies. Finally, through the Medicaid and CHIP programs, individual states are interested in the accuracy and reliability of CMS systems.

Looking beyond those that interact with the agency directly, researchers are another critical set of stakeholders who have expectations of CMS and its IT infrastructure. They are seeking increased access to clinical-level information (such as aggregate outcomes and events data) for diverse populations as well as more-accurate administrative and claims information to support research on comparative effectiveness and the evaluation of new care-delivery models.[28]

The involvement of all these stakeholders, and the need for sensitivity to their requirements and the challenges they present, have there-

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15253, available at http://edocket.access.gpo.gov/2008/pdf/E8-5716.pdf, last accessed September 14, 2011; Agency for Healthcare Research and Quality, 2010, *Race, Ethnicity, and Language Data: Standardization for Health Care Quality Improvement*, 10-0058-EF, Rockville, Md.: AHRQ, available at http://www.ahrq.gov/research/iomracereport/, last accessed September 14, 2011; and Institute of Medicine, 2008, *Challenges and Successes in Reducing Health Disparities: Workshop Summary*, Washington, D.C.: The National Academies Press.

[26]HHS, 2011, "Hospital Compare," website, available at http://www.hospitalcompare.hhs.gov/, last accessed July 31, 2011.

[27]Vincent Mor, 2010, "Data Needs as Drivers of Transformation," presentation at workshop, September 27, Washington, D.C.

[28]Vincent Mor, 2010, "Data Needs as Drivers of Transformation," presentation at workshop, September 27, Washington, D.C.

fore become an important part of CMS's planning and design equation, although CMS is of course required to follow legislative directives.

EMERGING REQUIREMENTS FOR CMS

At its inception, CMS had a focus on the prompt payment of claims. Since then, however, CMS has been increasingly called on to leverage its unique position in the health care field to improve the quality of care, eliminate health disparities, promote public health, improve efficiency while reducing spending, and improve patient outcome through the adoption of health IT and the effective collection and utilization of health care data.

A brief timeline of major legislation that has materially extended the activities of CMS shows that in recent years the legislation has become more voluminous, with several major programs introduced in just the last 5 years (Box 1.2). Moreover, as the provisions of the PPACA unfold over the years ahead, CMS will have to respond to a continuing series of sometimes ambitious extensions.

Requirements in Recent Legislation

Recent legislation and policy changes at CMS reflect a growing focus on health care outcomes and quality through the use of data that can serve as indicators of health care quality and equity. Data in this context enable CMS to identify and intervene when providers are performing poorly; to detect and combat fraud and abuse; to increase access to clinical data to improve care when access to such information would help; to enable use of decision support tools by providers; to monitor health disparities and their reduction; and to enable population-wide health.[29] In briefings, CMS's goals for data-driven quality improvement were described as follows:[30] increase access to safe, effective, and efficient care; ensure greater communication between health care providers and their patients; provide proper and effective stewardship of health care services and expenditures; eliminate redundancy of care; ensure that care is evidence-based and outcome-driven to manage and prevent complications from disease and improve overall outcomes; educate consumers about health

[29]See D.J. Friedman and R. Gibson Parrish II, 2010, "The Population Health Record: Concepts, Definition, Design, and Implementation," *Journal of the American Medical Informatics Association* 17:359-366.

[30]Julie C. Boughn, 2010, "CMS Systems Briefing," presentation to the committee, July 23, via teleconference.

BOX 1.2
Accelerating Timeline of Major CMS Legislation

The Medicare program has been substantially modernized and revamped since its enactment in 1965. The changes have come in ever shorter intervals: from 1965 to 1983 (Prospective Payment) to 1997 (Medicare + Choice) to 2003 (Modernization and Part D: prescription drugs) to 2009 and 2010 (HITECH and PPACA).

The accelerated pace of major changes reflects the centrality of health care in national policy and the expectation that the Medicare program can be used to shape the health care system in general. For example, HITECH establishes incentives for the "meaningful use" of electronic health information; the PPACA provides for the creation of "exchanges" wherein the federal government subsidizes the insurance of people whose income is below three to four multiples of the federal poverty levels; and the Improper Payments Elimination and Recovery Act of 2009 amended the 2002 act and expanded current government program auditing processes for agencies such as CMS that are high-volume claims payers.

In 2003 Congress created the Medicare Part D prescription drug program to add coverage of prescription drugs for Medicare beneficiaries. The Medicare+Choice (or Medicare Advantage) program was established under the Balanced Budget Act of 1997 to give Medicare beneficiaries the option of enrolling in a number of private plans instead of the traditional Medicare plan. The Health Insurance Portability and Accountability Act (HIPAA) of 1996 created a minimum national standard to protect personal health information and electronic medical records.

Before passage of these comparatively more broadly scoped and time-accelerated pieces of legislation, legislation affecting CMS traditionally entailed more incremental changes to the various fee schedules used to determine physician, provider, and supplier payment under Medicare. For example, the Tax Equity Fiscal Responsibility Act of 1982 (P.L. 97-248) expanded Medicare service to include coverage for hospice care for beneficiaries. In 1984, the Deficit Reduction Act of 1984 transformed Medicare payment processing through the establishment of various fee schedules such as the Medicare durable medical equipment, prosthetics/orthotics, and supplies fee schedule, and clinical laboratory fee schedule.[1]

This legislative trend of increasingly rapid expansion of CMS's roles and mission has led to a growing need for agile technical infrastructure to support it. Further, the shrinking time window from the passage of legislative mandates to deadlines for deployment adds an increasing layer of risk, underscoring the pressing need for robust information systems that can enable CMS to keep pace.

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[1]Office of Legislation and Policy, Health Care Financing Administration, 1984, "Deficit Reduction Act of 1984: Provisions Related to the Medicare and Medicaid Programs," *Social Security Bulletin* 47(11):11-15, available at http://www.ssa.gov/policy/docs/ssb/v47n11/v47n11p11.pdf, last accessed August 2, 2011.

care quality and efficiency and improve transparency generally; and reward providers of quality health care.

One way that CMS is moving toward these broader goals is through the Accountable Care Organization program, which was established in the PPACA.[31] An accountable care organization (ACO) is a recognized legal entity under state law and is composed of a group of ACO participants (providers of services and suppliers) that have established a mechanism for shared governance and that work together to coordinate care for Medicare fee-for-service beneficiaries. ACOs enter into a 3-year agreement with CMS to be accountable for the quality, cost, and overall care of traditional fee-for-service Medicare beneficiaries who may be assigned to it. Recent legislation[32] and subsequent rule making mandate that while Medicare "would continue to pay individual providers and suppliers for specific items and services as it currently does under the fee-for-service payment systems," ACOs must nevertheless reach specified cost-reduction and quality performance goals in order to qualify for various financial incentives.[33]

Several recent mandates and requirements are described briefly below:

- *American Recovery and Reinvestment Act (ARRA) HITECH meaningful use of electronic health records plus additional oversight tasks*. The HITECH provisions of ARRA, consisting of a number of subsections relating to uses of person-specific health information, create additional oversight requirements for CMS (Subtitle D). In addition, the statute promotes meaningful use of electronic records by health professionals throughout the country (described in greater detail in Box 1.3). Examples of demonstrated meaningful use include electronic exchange of health information; e-prescribing; and measures of clinical quality. Beginning in 2011, incentive programs under Medicare, Medicaid, and CHIP provide payments and IT funding to eligible health care providers as they adopt, implement, upgrade, or demonstrate meaningful use of EHR technology.
- *Reduce improper payments and increase efficiency*. CMS contracts with

[31]The Patient Protection and Affordable Care Act (PPACA) (P.L. 111-148), §3022.

[32]"Section 3022 of the PPACA requires the Centers for Medicare & Medicaid Services (CMS) to establish a shared savings program to facilitate coordination and cooperation among providers to improve the quality of care for Medicare fee-for-service beneficiaries and reduce unnecessary costs. . . . Eligible providers, hospitals and suppliers may participate in the Shared Savings Program by creating or joining an Accountable Care Organization, also called an ACO." See CMS, 2011, "Shared Savings Program," website, available at http://www.cms.gov/sharedsavingsprogram/, last accessed July 31, 2011.

[33]CMS, 2011, "Shared Savings Program," website, available at http://www.cms.gov/sharedsavingsprogram/, last accessed July 31, 2011.

payment intermediaries to process and pay claims submitted by health care providers on behalf of Medicare recipients. The Improper Payments Elimination and Recovery Act (IPERA) of 2009[34] amended the 2002 act and expanded current government program auditing processes to better identify programs that are susceptible to improper payments. The 2009 act further specifies that required reporting occur every 3 years and include a statement of whether the reporting agency has sufficient resources with respect to internal controls, human capital, and information systems and other infrastructure to prevent improper payments. The act also identifies risk factors to be used for assessing such payments. The PPACA and the Health Care and Education Reconciliation Act (HCERA) of 2010 add layers to the payments process and require CMS to adjust Medicare rates over time.

- *Reduce fraud and abuse in payments.* CMS's Center for Program Integrity has been the agency's coordination arm for combating fraud and abuse in payments since 1996, and additional requirements were added in 2005. The PPACA has several sections (for example, §6409 and §6402) targeting abuse and fraud that will require additional CMS activities. Similarly, the HCERA has even more provisions designed to reduce fraud.
- *Reduce health care disparities.* The HITECH provisions of 2009 and the PPACA of 2010 include a number of provisions designed to reduce health care disparities, primarily by requiring relevant health agencies to collect and analyze data on racial and ethnic disparities in health care as specified in section 4302. The statute also gives some teeth to CMS's role in reducing health disparities by making the capture of relevant data a requirement for federally sponsored health care providers.
- *Improve health care quality and patient outcomes and engagement in research.* CMS has been given a number of new opportunities and corollary challenges to assist the nation in innovative ways to improve system performance. An example is the CMS Innovation Center, established under the PPACA and funded at $10 billion in appropriations over a decade to support innovations. The Innovation Center has the unique authority to transition successful innovations into widespread practice.
- *Engage in modernization efforts.* CMS has a number of federally man-

[34]A White House memorandum, "Finding and Recapturing Improper Payments," followed on March 10, 2010. On March 22, 2010, OMB issued government-wide guidance on the implementation of E.O. 13519; see also the Improper Payments Information Act of 2002 (IPIA), Deficit Reduction Act (DRA) of 2005, and False Claims Act of 1986.

BOX 1.3
HITECH and CMS—Meaningful Use

The HITECH provisions of the American Reinvestment and Recovery Act were designed to create significant and measurable improvements in population health through the use of information technology (IT) while also stimulating the economy during a financial crisis. The act focuses on use of health IT to meaningfully improve local practice, foster measurement and reporting of quality and disparities, and promote the sharing of clinical data among health care providers. The program works by providing monetary incentives and penalties to health care providers based on their adoption and use of health IT. Specifically, providers are required to adopt a certified electronic health record (EHR), to use the health record meaningfully, to report quality measures, and to exchange information electronically.

Initially, a definition of "meaningful use" and its related quality measures is first proposed by the Meaningful Use Workgroup and the Quality Measures Workgroup of the Health Information Technology Policy Committee of the Office of the National Coordinator of Health Information Technology (ONC). The Policy Committee modifies and adopts the definitions, providing them to ONC. Based on these recommendations and its own work, ONC makes recommendations to CMS, which in turn generates an interim rule and, after public comment, the final rule on definitions of meaningful use and quality measures. Certification of EHRs is based specifically on the functions needed to support meaningful use. Additional workgroups provide input on issues such as privacy and security and exchange of health information.

The program is intended to focus on health outcomes that are aligned with the national health priorities. The Policy Committee and its workgroups have derived a framework from the National Priorities Partnership to organize instances of mean-

dated modernization efforts[35] underway that are carrying forward from prior years. For example, as noted in its strategic plan, "CMS is replacing its legacy Medicare accounting systems, maintained by both CMS and its current Medicare fee-for-service contractors, with the new Health Care Integrated General Ledger Accounting System (HIGLAS)—a state-of-the-art electronic, integrated financial accounting system . . . full implementation of HIGLAS [is expected] by 2011."[36] In 2007, management of the CHIPS state grants began using HIGLAS, and staged implementation for HIGLAS across Medicare and Medicaid will continue through 2012.

• *Implement ICD-10 and evolving national and international health data standards.* The shift from ICD-9 (the International Statistical Classification

[35]NRC, 2010, *Preliminary Observations on Information Technology Needs and Priorities for the Centers for Medicare and Medicaid Services: An Interim Report*, Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=13061, last accessed July 31, 2011. For more about HITECH, see Box 1.3.

[36]CMS, 2011, *CMS 18-Month Plan for Enterprise & Shared Services*, July 7.

ingful use. It includes five areas: improve quality, safety, and efficiency, and reduce health disparities; engage patients and families; improve care coordination; improve population and public health; and ensure adequate privacy and security protections for protected health information. The program is organized as a collection of objectives within each area along with measures to determine if the objective has been met. Meaningful use is divided into sequential stages in which objectives evolve from data capture, decision support, and quality measurement, to continuous quality improvement and structured data exchange, to actual quality, safety, and efficiency improvements and patient self-management.

The program has several IT implications for CMS. To create a forward-looking yet feasible final meaningful-use rule requires that CMS understand EHRs and other health information technology, including understanding the technologies' current functions, current status, and evidence base of what outcomes can actually be achieved, and near-term research of what may be possible in the future. In the committee's view, CMS has developed a coherent and bold yet feasible rule.

The actual implementation of the program is a significant logistical undertaking. Many thousands of providers will register for the program, and they will attest to some measures and submit concrete numbers for others. CMS must verify the submissions, audit as appropriate, and pay incentives or assess penalties. This multiyear program requires keeping track of previous years' progress and payouts for each provider. Furthermore, several aspects of this program overlap other programs, including the Accountable Care Act's quality measurement provisions. The programs must therefore be coordinated, using common standards and submission methods and reducing duplication of reporting effort, leading to efficiencies such as the proposed shared services organization. CMS must also monitor progress in the HITECH program, and so it will need robust data-warehousing capabilities.

of Diseases and Related Health Problems, 9th Revision) to ICD-10 has many implications for CMS (as discussed further in Box 1.4).

Increasing Demands Related to Data

In association with its expanding scope, CMS must now collect an increasingly diverse and complex set of data. These data are intended to improve CMS's ability to assess the quality, safety, and efficiency of care; address issues of variations in care; determine the appropriateness of care; support research; and combat fraud. This growth in the diversity and scale of data to be collected is accompanied by the requirement that CMS extend its core competence of providing transaction-oriented IT capabilities needed to support its day-to-day insurance operations, such as claims payment, to include significant data analytic capabilities.

In addition to collecting data during the claims payment process, CMS conducts beneficiary surveys, collects supplemental clinical information on patients in settings such as nursing homes and home health

BOX 1.4
ICD-10 Implementation at CMS

In the next 3 years, the transition from the International Classification of Diseases (ICD) 9th edition code set (and U.S. clinical modifications) to the ICD 10th edition code set will be one of the largest business, operational, and technical transformations in health care, in general, and for CMS in particular. The code set, which is used to describe patient-level diagnoses for all settings and procedures for inpatient encounters and is fundamental to decisions regarding payment of or denial of claims, is deeply embedded in most systems and business operations within the agency, from program eligibility and billing systems to operations related to quality, patient safety, clinical analysis, research and even fraud and abuse prevention and detection. Full transition and compliance with the new code set (and phase-out of the old code set) are required under HIPAA regulations by October 1, 2013.

CMS plays a dual role when it comes to implementing ICD-10. As a HIPAA-covered entity, CMS is subject to implementing ICD-10 to conduct business with providers, other payers, vendors, and other trading partners. CMS is also the oversight regulator and enforcer of the ICD-10 regulations, and in that capacity it has created a number of avenues to communicate with the industry and has provided resources and tools to assist the industry in achieving compliance.

Transitional Steps Taken by CMS

CMS work on the ICD-10 transition started in 2007 with an initial analysis of the business processes, systems, and operations in the agency that could be affected by the ICD-10 transition. A more comprehensive impact analysis for planning and implementation of ICD-10 was completed in mid-2009 and used as the basis for the overall agency strategy to transition to the new code set.[1] The impact analysis found 17 functional areas (defined as a set of specific CMS policies, activities, and systems, such as Medicare as a Secondary Payer (MSP) or Provider Cost Reporting) organized into 7 major business areas (defined as a broad collection of functional areas that combine to achieve a key business objective for the agency, such as Medicare fee-for-service claims processing) to be directly affected by the transition to ICD-10. The 7 business areas identified in the report, and their assessed impact, were as follows:

- Medicare fee-for-service claims (including claims processing, payment policy, coordination of benefits, and other functions)—very high impact;
- Risk adjustment—very high impact;
- Quality (including quality assessment tools, quality measurement and payment initiatives and quality improvement activities)—high impact;
- Medicare integrity—high impact;
- Research, evaluation, and demonstrations—moderate impact;
- Medicaid (including Medicaid operations, integrity, and policy)—moderate impact (Note: does not include state Medicaid programs and their operations); and
- Medicare call center—low impact.

[1]CMS, 2009, "ICD-10 Impact Analysis for Planning and Implementation," Version 3.0, July, available at https://www.cms.gov/ICD10/downloads/CMS_ICD-10_ImpactAnalysis.zip.

Since the completion of the impact assessment, CMS has been progressively implementing a comprehensive ICD-10 project management plan under the direction of the Office of E-Standards and Services (OESS).

One of the key transitional steps toward ICD-10 will take place January 1, 2012, when the entire health care industry will be required to move to the new version of the standard for electronic health care administrative transactions (i.e., claims submission, claims payment, eligibility, etc.)—namely, version 5010. This transition is necessary to support ICD-10, because the current version (4010) does not have the capability to carry ICD-10 codes. CMS is leading the industry and is on target with the implementation of 5010.

Challenges and Opportunities Ahead

Achieving compliance with ICD-10 by October 1, 2013, represents a formidable challenge to CMS, given the extent to which the code set is built into many business and operating processes and systems, the size of CSM operations, and the complexity of its systems. However, ICD-10 is much more a business and operating challenge than a technical and information systems issue. Some of the organizational challenges identified in the impact assessment phase include:

- *Distributed ownership and collaborative governance*. CMS will have to coordinate an enterprise-wide effort of this size across multiple independent divisions, units, projects, and systems in a timely and coordinated manner;
- *Program and system interdependencies*. CMS must coordinate the interdependencies between discrete projects affected by ICD-10 and cross-cutting themes related to ICD-10 affecting multiple programs and units—for example, having an enterprise-wide crosswalk approach between ICD-9 and ICD-10; and
- *Competing initiatives*. In addition to ICD-10—CMS and OESS specifically—is challenged with having to implement several other agency-wide initiatives and oversee national health care reform efforts that may detract from the ICD-10 transition.

One of the opportunities that the ICD-10 transition offers CMS is to consider phasing out legacy systems for certain functions, when the costs and benefits to remediate and upgrade those systems and applications to meet the ICD-10 requirements will be offset by the value and benefits offered by a new system.

CMS can also leverage the greater granularity and specificity of the new ICD-10 code set to establish more effective processes and perform and execute more refined controls in areas such as quality, patient safety, population health management, and fraud and abuse. This will be particularly valuable under the new Accountable Care Organizations program.

Another opportunity for CMS is to leverage the ICD-10 code set to explore more effective outcomes-based payment and reimbursement policies, including the new health care reimbursement approaches envisioned in the Patient Protection and Affordable Care Act.

care, receives reports on serious hospital errors, and collects quality-related information of various types from hospitals and providers. All of this information is used within CMS and elsewhere in the government to feed analyses of the present and future condition of the Medicare program. Most, although not all, of these data are eventually made available to outside researchers either with personally identifiable information removed or under agreements that strictly protect patient privacy. Table 1.1 lists some of the various sources of data now held by CMS. These sources and uses of data are described in greater detail in Chapter 5 and Appendix D.

Within the government, CMS information is the source for the trustees' annual report on the health of the Medicare program, the Medicare Payment Advisory Commission's "data book" on the current state of the

TABLE 1.1 Sources and Content of Some of the Data Held by CMS

Source of Data	Data Description
Claims for Medicare Parts A, B, C, and D	All claims contain basic diagnostic information as well as information on date, the type of service provided, and the identity of the prescribing physician. Managed care plans serving Medicare beneficiaries are required to submit extensive "benefit utilization" reports that include encounter data. This information is merged into the fee-for-service data sets to generate a comprehensive view of facts such as hospital discharges. Part D providers are required to submit detailed reports of the drugs prescribed as well as to identify the prescriber and the pharmacy that filled the prescription(s).
Supplemental clinical data sets	This information is intended for use in both monitoring quality and assigning patients to payment groups. Information is collected on nursing home patients, home health care patients, patients in rehabilitation facilities, and those in psychiatric facilities.
Quality surveys	Data from quality surveys done by the joint commission and by state agencies and entered into the Online Survey and Certification and Reporting database.
Opinion surveys	The Medicare Current Beneficiary Survey is a rolling survey of beneficiaries that includes questions on out-of-pocket costs, services used, and the experience of care. The Health Outcomes Survey measures outcomes for individuals enrolled in Medicare managed care. A survey specific to patients' experience of hospital care is also conducted.
Financial reports	All institutional providers paid under Part A must submit annual financial reports.

TABLE 1.1 Continued

Source of Data	Data Description
Demographics	Information on providers and institutions participating in the Medicare program, including information on the ethnicity of providers, is collected at the time of request for a Medicare number. Since CMS receives most of its data on Medicare beneficiaries from the Social Security Administration, accurate and complete demographic information is often lacking, posing a challenge in terms of identifying and reducing racial disparities in health status, outcomes, and treatment. Data on Medicaid and other CMS beneficiaries is similarly incomplete.
Quality reporting	Hospitals, nursing homes, and others are required to report on some quality indicators. Physicians have an incentive to participate in voluntary quality reporting. In addition, beginning in 2015, physicians who fail to report quality data will be penalized by a 1.5 percent payment reduction and a 2.0 percent payment reduction for each subsequent year.[a] Data available includes experience reports and lists of those who successfully participated in previous years (the most recent data are for 2009).[b]
Quality analyses	For the purpose of QIOs. These data are, by law, not available for general use.

[a]CMS, 2011, "Physician Quality Reporting System: Statute Regulations Program Instructions," website, available at https://www.cms.gov/PQRS/05_StatuteRegulationsProgramInstructions.asp.

[b]CMS, "Physician Quality Reporting System formerly known as the Physician Quality Reporting Initiative—Overview," available at https://www.cms.gov/pqrs/, last accessed August 3, 2011.

Medicare program, and other analyses of the trends in Medicare carried out by agencies such as the Government Accountability Office. Outside researchers also make use of these data sets in materials such as the series of atlases in practice variation produced by Dartmouth.[37] CMS currently manages the escalating external demand for its available data files by using an external contractor, the Research Data Assistance Center, which provides support to researchers applying for use of data files. Congress requires that researchers pay the costs of preparing and releasing data sets; as a result the information is often beyond the reach of younger or less well funded researchers. The other concern expressed by the outside

[37]The Dartmouth Institute for Health Policy and Clinical Practice, 2011, "Dartmouth Atlas of Health Care," website, available at http://www.dartmouthatlas.org/, last accessed August 8, 2011.

research community is the long delay—approximately 2 years—before data sets are available.

THE CURRENT STATE OF INFORMATION TECHNOLOGY AT CMS

The process of implementing, managing, and maintaining key information technologies is challenging, and the federal government is no exception. Although there have been a number of noteworthy initiatives, including the establishment of IT priorities within the office of the federal CIO,[38] a new focus on shared services,[39] and the 25-point IT reform plan issued in December 2010,[40] federal government IT still faces a number of challenges in reaching these goals, especially at a time of significant budgetary constraints. Not only is federal IT management—and IT management, in general—notoriously difficult, but federal budget constraints also place additional pressure on agencies to maintain, and even increase, productivity in spite of limited financial resources. CMS, like other federal agencies, is typically not allocated sufficient funds to modernize or upgrade existing systems in an enterprise-wide integrated fashion, and as a consequence must cope with the dual challenge of (1) program-by-program stove piping that makes it difficult to properly integrate programs or achieve the efficiencies (programmatic and operational) that would result and (2) inconsistent year-by-year funding that makes it difficult to do long-term planning of the sort possible with capital budgets.

It is likely a political reality that the bulk of CMS funding for IT will continue to be allocated on a program basis. A challenge for CMS is to implement enterprise-wide planning in this context. Indeed, program-by-program funding and implementation are likely to reduce the efficiency and efficacy of the resulting IT capabilities.

A promising strategy for accommodating common needs while living within individual program budgets is to allocate costs for shared services as service fees charged to individual programs. CMS and HHS are cur-

[38]White House Office of the Chief Information Officer, 2011, "Closing the Technology Gap," website, available at http://www.cio.gov/module.cfm/node/priorities, last accessed July 31, 2011.

[39]Both within the government broadly and within the Department of Health and Human Services. See, for example, Vivek Kundra and Richard Spires, 2010, "Update on Federal Data Center Consolidation Initiatives," memorandum, October 1, Washington, D.C.: White House Office of the Chief Information Officer, available at http://www.cio.gov/Documents/Update-Federal-Data-Center-Consolidation-Initiative.pdf, last accessed July 31, 2011. See also CMS, 2011, *CMS 18-Month Plan for Enterprise & Shared Services*, July 7.

[40]Vivek Kundra, 2010, *25 Point Implementation Plan to Reform Federal Information Technology Management*, December 9, Washington, D.C.: White House Office of the Chief Information Officer, available at http://www.cio.gov/documents/25-Point-Implementation-Plan-to-Reform-Federal%20IT.pdf, last accessed July 28, 2011.

rently exploring how such a fee-based system could be implemented. Such a system will take effort to put in place but would result in more flexibility to meet broader infrastructure development needs within existing resources, and the committee encourages the continuation of this work.

To fulfill its core function of paying providers for services to beneficiaries, CMS processes more than 3 million eligibility inquiries and makes more than $1 billion in fee-for-service payments daily.[41] So that it can provide these services, CMS has established a number of information systems families both internal and external to the organization. Each system family consists of a number of existing CMS application systems integrated by means of automated and human processes to meet the requirements of a specific CMS business role or function. Some of these systems families include:

- Medical Beneficiary Membership Systems,
- Medicare Claims and Utilization Data Systems,
- Medicare Pricing Systems,
- Medicare Fee-for-Service Claims Processing Systems,
- Provider Management Systems,
- Medicaid and Children's Health Insurance Program Systems,
- Business Intelligence and Data Access Systems,
- Healthcare Quality Systems, and
- Medicare Financial Management and Payment Systems.

The committee's impression is that each CMS systems family was developed rather independently using infrastructure technologies current at the time of development, and each has been enhanced over time to address ongoing and changing requirements. There was not a well-defined enterprise architecture framework in place to guide their development. Because of the age and nature of the infrastructure (some CMS systems families were created more than 40 years ago, some when CMS was not yet an agency and the programs were organized under other systems and divisions), many systems families are less flexible than those built on more modern infrastructures. It is the committee's understanding that there was typically little design for or anticipation of data sharing; thus interoperation, integration, enhancement, and sharing of data across systems families is often costly, risky, and time-consuming.

Over the years, the President and Congress have expanded CMS's core functions and increased the complexity and sophistication of its

[41]Julie C. Boughn, 2010, "CMS Systems Briefing," presentation to the committee, July 23, via teleconference.

activities. CMS has done an exceptional job of creating the IT infrastructure necessary to support these extensions, often within extremely short time frames and in response to rapidly evolving requirements—such as the implementation of Medicare Part D, which was accomplished well within the statutory deadlines with full required functionality. The systems implementation required setting up connections not only among several federal agencies but also with health insurance plans and pharmacies—all of which was done quickly and successfully. The Part D implementation also included the deployment of websites that allowed the customers to easily access information about their options, make comparisons among plans, and, after making a selection, proceed to enroll.

Nevertheless, as CMS's roles have expanded, integration among and within systems families has become increasingly necessary to meet functional (for example, automated end-to-end fee-for-service claims payment) and non-functional (such as increased interoperational efficiency) needs. The heterogeneity of the underlying technologies and solutions for integrating them have resulted in interoperation between information systems that is both lower in quality and more expensive than it might otherwise have been. Even in spite of the increased integration, CMS itself has documented 700 business processes and identified the potential for approximately 100 shared functions or services.[42] Hence, as "silos" or "stovepipes" some CMS information systems have poor interoperability and insufficient flexibility.

CMS reported to the committee that legacy application and data systems are frequently re-purposed for emerging needs, and that an unprecedented volume of change and complex interactions demand disciplined processes and extensive testing. Core business operations are conducted through intricate file transfers and batch processing, and there is an escalating growth in claims volume. Newer business processes have been added using more modern technologies. There are separate claims flow and data requirements, for instance, for institutional providers versus individual practitioners due in part to how the systems have evolved over time. CMS reported that many interactions, combined with large and often aging systems, render the CMS systems world brittle and resistant to nimble change.

In terms of the architectural and integration challenges, in the committee's view, CMS, as a large, ongoing enterprise, has the usual mix of near-obsolete hardware and software as well as modern technologies and systems (the committee saw references to, for instance, CICS and COBOL, as well as Oracle and other modern database technologies). Chapters 2

[42]Vish Sankaran, 2011, "Healthcare in the US & the Role of CMS," presentation to the committee, CMS site visit, January 13-14, Baltimore, Md.

and 3 offer the committee's assessment of and recommendations for modernizing CMS's business and information systems.

The acceleration in the diversity and complexity of activities expected of CMS is likely to continue for the foreseeable future. As the country heightens its efforts to improve health care quality and reduce the costs of care, it will rely increasingly on CMS to be at the forefront. Indeed these expectations have been described in recent legislation (see Box 1.2 and the section "Recent Legislation" above). The committee is aware that the CMS Office of Legislation plays an important stakeholder management and engagement role in striving to ensure that congressional mandates are not misaligned with current CMS IT capabilities. See Box 1.5.

Absent changes, it is likely that current CMS IT solutions will hinder CMS's ability to meet its requirements efficiently. There is thus a risk that CMS IT applications and infrastructure will become a barrier to national efforts to improve care. In addition, the time and costs of fulfilling accelerating congressional requirements will become a material barrier to progress in meeting congressional mandates. With regard to data, CMS IT leadership notes, "But in order to [improve quality], the IT infrastructure that you need from a data perspective and a mining perspective and an analysis perspective, is probably a little bit of an order of magnitude over and above what we have today, especially when you think about quality data, claims data, [and] master data of beneficiaries and providers."[43] CMS is aware of these challenges and is making strides toward addressing them.

WHAT THIS REPORT DOES AND DOES NOT DO

The committee was tasked with reviewing the current state of CMS's technical infrastructure and systems architecture and the current plans for its evolution, and with making recommendations to CMS on modernizing its business processes, practices, and information systems to meet today's and tomorrow's demands—including how to build in the flexibility to cope with changing requirements. The rest of this report offers the committee's analysis and recommendations on how CMS can move forward most productively. In discussions and deliberations throughout the study, briefers, CMS staff, and committee members spoke frequently of the need to modernize systems. The committee believes that transformation will be necessary as well. The report also considers the dynamic legislative and budgetary environment in which CMS operates and attempts to speak to perennial challenges rather than short-term responses to specific items of

[43]Julie C. Boughn, 2010, "CMS Systems Briefing," presentation to the committee, July 23, via teleconference.

BOX 1.5
CMS's Office of Legislation and Congressional Mandates Affecting CMS IT

The Office of Legislation serves as a liaison between Congress and CMS. Historically, Congress has been very interested and involved in the Medicare and Medicaid programs. The Office of Legislation addresses congressional inquires regarding CMS and its programs and serves as a resource to authorizing committee staff when they are drafting legislation that affects CMS. The office works with CMS internally to ensure that the agency itself understands what various statutes require, and also works with Congress to keep it informed about how statutes are being implemented. Information is provided in the form of briefings, hearings, or other communications to Congress. The office interacts most frequently with such authorizing committees as the House Ways and Means Committee, the House Energy and Commerce Committee, and the Senate Finance Committee.

Advising on preparation of legislation is a key function of the office. Because the Medicare and Medicaid programs are very budget driven and very complicated, even small changes in the program can affect how large sums of money are spent, and legislative changes can have significant implications for the programs. Therefore, when Congress is considering new legislation relevant to CMS, the Office of Legislation provides help in clarifying the underlying goal that Congress is trying to achieve, whether the goal can be accomplished in the way that Congress is considering implementing it, or whether the goal is more reasonably accomplished in some other manner that CMS can implement. Such implementations might result in new regulations or in changes to CMS's information technology systems. Jennifer Boulanger, deputy director of the Office of Legislation, noted, "If we can't program [the proposed legislation], we can't do it," emphasizing the point that the capability of existing systems to handle the new or additional demands imposed by legislation is a critical factor in the successful implementation of a new congressional mandate.[1] When congressional proposals reach the point of being legislative language, the Office of Legislation will usually begin to engage staff from relevant components within CMS. This engagement includes communicating to relevant CMS staff what Congress is intending to accomplish. At the same time, the Office of Legislation tries to gather input from CMS program owners and the Office of Information Services

[1]Jennifer Boulanger and Maria Martino, 2011, "Office of Legislation Perspective," presentation to the committee, April 18.

legislation or budgetary mandates. The committee does not offer specific estimates of cost or personnel—such estimates would be unreliable given the rapid rate at which requirements are changing and choices for solutions that might stem from a long-range technical plan.

Reflecting the complexity of the challenges and expectations faced by CMS that are described in this chapter, the committee in its analy-

as to what would be involved in enacting the legislation from a program and IT systems perspective.

Because of its role in helping Congress to craft implementable legislation, the Office of Legislation also interacts a great deal with CMS's own IT personnel to stay informed regarding CMS IT systems capability. This includes keeping apprised of what it takes to change the systems and how often they can be changed. Typically, three primary outcomes for systems changes are required by congressional mandate:

- The required change is relatively simple or of a type that CMS staff is familiar with and that can be implemented as a part of routine CMS maintenance and updates. The quarterly releases, for instance, are a narrow window in which CMS systems are regularly updated and can be used to incorporate additional minor changes. Updates to the different Medicare fee-for-service payment systems typically only require making sure that the time frames for implementing the change coincide with the scheduled quarterly update windows.
- The required change is complex or especially challenging and will involve more extensive disruption to create the necessary system functionality. For example, major Medicare legislative changes can strain the time window for implementing the quarterly update.
- There are cases when, for a variety of reasons, CMS cannot easily make the changes necessary to implement legislation passed by Congress, and Congress has new legislative changes in the pipeline. The Office of Legislation can then step in to communicate the situation to congressional staff. For instance, it may be that at a particular time CMS is at capacity and cannot take on additional programming unless Congress is willing to delay enactment of particularly difficult-to-implement provisions. This type of communication was seen in several of the systems mandates imposed in light of the Y2K phenomenon most recently in the agency's push to implement the various provisions of the PPACA.

Constant communication is required between CMS and congressional staff about what can be done when. The question of what changes to CMS systems must be made in response to a legislative request requires a technical assessment. The Office of Legislation forms working groups as needed to consider how to implement given legislation. For novel or complex congressional changes, working groups will need to have broader discussions, and such changes will involve significant internal discussion between relevant program staff and IT staff.

ses, findings, and recommendations seeks to provide guidance to CMS for building on the agency's considerable achievements while rising to unprecedented challenges. The committee understands the need for CMS to continue to respond to current and emerging demands, which are not infrequently accompanied by extraordinarily demanding timelines and insufficient IT resources. While recognizing these realities, the commit-

tee also seeks to offer guidance to an agency that is poised to take center stage in transforming the nation's health care system. At the same time, it must be recognized that CMS's expanding roles will focus unprecedented attention on its ability to handle new responsibilities effectively.

Chapter 2 urges the development of a comprehensive strategic technology plan at CMS and presents conceptual underpinnings that emphasize the importance of a strategic technology plan that fully recognizes and addresses the centrality of IT as CMS plans to meet its challenges and opportunities. Chapter 3 provides a framework for re-envisioning CMS business and information ecosystems and a meta-methodology for conducting incremental, phased transitions of needed components. Chapter 4 describes the cultural, organizational, technical, and management prerequisites for CMS's transition to an even more capable, nimble, and adaptable agency that uses IT effectively in support of its mission. Chapter 5 discusses the centrality of data to nearly all of CMS's current and future work and describes several ways in which the data and information collected by CMS are used extensively within the agency for a variety of analytic purposes.

2

Toward a Comprehensive Strategic Technology Plan

Health care costs in the United States consume a significant proportion of gross domestic product (GDP) (17 to 18 percent, or nearly $3 trillion, annually[1]) and are increasing at a rate 1.1 percent above the rate of growth of GDP.[2] Issues of health care quality, access, safety, and equity remain pressing concerns as well. Further, compared with health care delivery in other developed economies, the U.S. health care delivery system has been found to be less effective, costing more and returning less.[3]

As the purchaser of health care for a third of all Americans, CMS currently accounts for a large proportion of that cost. In addition, as its covered population grows, and as its mission expands, CMS has a significant role in helping to control the cost and improve the quality of health care. Fundamental to modern businesses are the information and the information technology (IT) they rely on to operate effectively. Thus it is essential

[1]CMS, 2011, "National Health Expenditures Data," website, available at http://www.cms.gov/NationalHealthExpendData/, last accessed August 1, 2011.

[2]Sean P. Keehan, Andrea M. Sisko, Christopher J. Truffer, John A. Poisal, Gigi A. Cuckler, Andrew J. Madison, Joseph M. Lizonitz, and Sheila D. Smith, 2010, "National Health Spending Projections Through 2020: Economic Recovery and Reform Drive Faster Spending Growth," *Health Affairs* 30(8):1-12.

[3]David A. Squires, 2011, *The U.S. Health System in Perspective: A Comparison of Twelve Industrialized Nations,* New York, N.Y.: The Commonwealth Fund, available at http://www.commonwealthfund.org/Content/Publications/Issue-Briefs/2011/Jul/US-Health-System-in-Perspective.aspx, last accessed August 1, 2011.

that, at a minimum, CMS have access to information that could help it to work with the rest of the health care industry to meet those objectives.

Key policy perspectives such as moving toward what the Institute of Medicine calls a learning health care system[4] have to be addressed by CMS, since federal programs are of such scale that CMS's efforts will have significant impact on moving the nation as a whole forward. Indeed, evidence exists that improved quality performance can mitigate costs while also improving outcomes.[5] Although fundamental public policy issues with respect to health care reform, safety and quality enhancement, cost management, and the appropriate federal role in these matters are being debated (issues that are beyond the scope of this report), it is inarguable that CMS must not only ensure the appropriateness of its direct outlays but also support, both proactively and reactively, efforts to reduce costs in the health care system as a whole. No matter what payment models it operates under now or in the future, CMS will have to be able to both fulfill its fiduciary responsibility and ensure that eligible people are receiving appropriate care.

What planning must CMS embrace to fulfill these responsibilities? Central to the effort is that CMS develop a vision of its role in modern health care and strategies for realizing it—an overall strategy for CMS as a whole, along with a strategic technology plan for comprehensive, incremental development of effective information systems, and strategies for quickly addressing near-term issues.

MOTIVATING MODERNIZATION AND TRANSFORMATION AT CMS

For the purposes of this report the terms "modernization" and "transformation" refer to two ends of a spectrum of possible transitions for components and subcomponents of an information system. Modernization refers to modest or evolutionary transitions; transformation refers to significant or revolutionary transitions. Use of the term "modernize" or

[4]A system that is "designed to generate and apply the best evidence for the collaborative healthcare choices of each patient and provider; to drive the process of discovery as a natural outgrowth of patient care; and to ensure innovation, quality, safety, and value in health care." See Institute of Medicine, 2011, *Digital Infrastructure for the Learning Health System*, Washington, D.C.: The National Academies Press, p. 2.

[5]See, for instance, B.L. Hall et al., 2009, "Does Surgical Quality Improve in the American College of Surgeons National Surgical Quality Improvement Program?," *Annals of Surgery* 250:363-376; J.B. Dimick et al., 2004, "Hospital Costs Associated with Surgical Complications: A Report from the Private-Sector National Surgical Quality Improvement Program," *Journal of the American College of Surgeons* 199(4):531-537.

"transform" presumes that the transition being discussed is at one end of the scale or the other.

CMS has done an admirable job in meeting its growing responsibilities over time and has continued to improve its information systems. Since the introduction of a comparatively simple Medicare program in 1965, CMS (as well as its predecessor organizations) has effectively managed to meet its expanding responsibilities and has surmounted significant technology challenges in order to do so. CMS built and manages an extremely complex distributed transaction-processing system for the fee-for-service payment systems for Medicare Parts A and B. CMS also manages a large variety of core payment, monitoring, and reporting systems. Moreover, CMS has delivered robust technology systems to meet the requirements of new programs. It has consistently done so under severe time and budget constraints, a notable example being the delivery of Medicare Part D in 2006.[6]

In spite of these historical successes, however, the challenges facing CMS today are daunting. In order to continue to provide payments according to current requirements, to meet growing requirements for health-care-related data and analysis, and to support new payment models, CMS will have to modernize or transform at least some of its information systems.

Complexity and Dynamism of the Health Care Enterprise

Originally designed to perform straightforward Medicare eligibility determination and to manage and disburse health claim payments to hospitals and medical professionals,[7] CMS's systems are now expected

[6]Considered a successful implementation, the Medicare Part D program entailed complicated interconnections between several federal agencies and deployment of complex websites for users, and was implemented with all statutorily mandated functionality within the statutory deadlines.

[7]To provide some sense of scope and scale, the committee notes that CMS handles 240,000+ new Medicare beneficiaries monthly and must process approximately 200,000 notices of deaths of beneficiaries monthly. There are nearly 3 million eligibility inquiries daily. More than 14 million monthly transactions from Medicare Advantage and Part D plans and more than 1.2 billion Medicare fee-for-service (FFS) claims are processed annually. CMS receives, processes, and stores more than 5.3 million Part D prescription drug events daily. In terms of dollar outlay, CMS makes nearly $1 billion in FFS payments daily and must calculate and pay more than $13.1 billion monthly for Medicare Advantage and Part D (Tony Trenkle, 2010, "CMS Systems," presentation, TechAmerica Federal Committee Meeting, Baltimore, Md., April 20). By Medicare statute, much of the day-to-day administration of the program is delegated to private contractors. Functions such as paying providers (processing reimbursement claims), enrolling providers and suppliers in the Medicare program, educating providers about Medicare billing requirements, and processing appeals are performed by Medicare administrative contractors (MACs), fiscal intermediaries (FIs), and carriers. Gener-

to handle a much more complex and demanding set of activities, including special payments for certain procedures, prescription drug payments, aggressive discovery and recovery of erroneous payments, reporting of Medicare data showing comparisons of medical quality across hospitals and medical practices, differential payments to hospitals that train doctors, and medical provider payments adjusted for actual inclusion of good medical practices as defined by independent medical-professional entities. The 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act and the 2010 Patient Protection and Affordable Care Act (PPACA) also impose new requirements, as described in Chapter 1.

CMS's programs are thus entering a very dynamic phase, with many changes expected or anticipated, including:

- A shift toward pay for performance or value and away from fee for service;
- The need to manage and report on multiple "experiments" in reforming payment for delivery for health care, and potentially to scale them up more broadly depending on the results of the innovations;
- The incorporation and use of some clinical data, and even population health data, obtained from a variety of sources such as electronic medical devices and electronic health record data whose collection is facilitated through HITECH;

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ally, MACs perform these functions for Parts A and B providers, FIs for Part A providers, and carriers for Part B providers. In 2003, the Medicare Modernization Act required the secretary to implement FFS contracting reform and to replace FIs and carriers with MACs by 2011. CMS has contracted with 15 A/B MACs (each responsible for processing the claims from several states) to process Part A and B claims and with 4 durable medical equipment (DME) MACs to process DME supplier claims (CRS, 2010, "Medicare Primer," R40425, available at http://aging.senate.gov/crs/medicare1.pdf, last accessed September 12, 2011). In terms of upcoming procurements, CMS expects to consolidate the present 15 MAC jurisdictions into 10 in a phased process over several years (per information available at https://www.cms.gov/MedicareContractingReform/04_VisionofFutureFeeforServiceMedicareEnvironment.asp, last accessed October 15, 2011). CMS works with nearly 5,000 hospitals (CMS, 2011, "Hospital General Information," available at http://data.medicare.gov/dataset/Hospital-General-Information/v287-28n3, last accessed September 12, 2011), more than 11,000 home health agencies (CMS, 2011, "Home Health Care Facilities," data set available at http://data.medicare.gov/dataset/Home-Health-Care-Facilities/6jpm-sxkc, last accessed September 12, 2011), more than 65,000 DME providers (CMS, "DME Supplier," data set available at http://data.medicare.gov/dataset/DME-Supplier/p7kk-c8cp, last accessed September 12, 2011), approximately 16,000 skilled nursing providers (CMS, 2011, "SNF Provider ID Information," data set available at http://www.cms.gov/CostReports/Downloads/SNFProviderID06302011.zip, last accessed September 12, 2011), and more than 5,000 dialysis facilities (CMS, 2011, "Dialysis Facility Compare—Listing by Facility," data set available at http://data.medicare.gov/dataset/Dialysis-Facility-Compare-Listing-by-Facility/23ew-n7w9, last accessed September 12, 2011).

- New legislative mandates and CMS responsibilities; and
- Changes in public policy expectations, especially increasing expectations regarding transparency, fraud resistance, timely assessments, delivery of care of improved quality and equity, and greater involvement of key stakeholders.

Controlling the growth of health care costs is essential. So-called coordination of care is central to all meaningful health care delivery models that are attempting to address cost issues, including patient-centered medical homes,[8] accountable care organizations,[9] and global payments.[10] Coordination of care is key whether health care delivery models are sponsored by employers, private payers, public payers, or provider organizations. Any practical and scalable implementation of these models requires the exchange of electronic medical data. Moreover, the core infrastructure is already being built, admittedly in fits and starts, for example in the form of provider electronic health record and electronic medical

[8]An approach to providing comprehensive primary care for children, youth, and adults, the patient-centered medical home (PCMH) is a health care setting that facilitates partnerships between individual patients and their personal physicians and, when appropriate, the patient's family. Key principles in this approach to care are personal physician relationships; physician directed medical practice teams with collective responsibility for ongoing, whole-person-oriented coordinated patient care; improved quality and safety; and enhanced access to care that features increased availability, communication, open scheduling, and pay-for-quality approaches. Many private insurers are experimenting with payment schemes to motivate the adoption of the PCMH model, and to test the validity of the hypothesis that the model reduces costs and improves health. (See American Academy of Family Physicians [AAFP], American Academy of Pediatrics [AAP], American College of Physicians [ACP], and American Osteopathic Association [AOA], 2007, "Joint Principles of the Patient-Centered Medical Home," concept paper, available at http://www.acponline.org/advocacy/where_we_stand/medical_home/approve_jp.pdf, last accessed August 1, 2011.)

[9]An accountable care organization (ACO) is a network of doctors and hospitals that shares responsibility for providing care to patients. The intent is to use ACOs to "make providers jointly accountable for the health of their patients, giving them strong incentives to cooperate and save money by avoiding unnecessary tests and procedures." (See Jenny Gold, 2011, "Accountable Care Organizations, Explained," National Public Radio online, January 18, available at http://www.npr.org/2011/04/01/132937232/accountable-care-organizations-explained, last accessed August 1, 2011.)

[10]Global payments are an alternative to the fee-for-service model traditionally used for Medicare payments. They would give hospital and care provider groups lump sums, intended as incentives to increase efficiency and quality of care and to stop patients from returning to the hospital for preventable conditions. The premise is that the fee-for-service payment model does not encourage systematic improvements in health care quality and efficiency, but instead acts as an incentive for care providers to allow patients to remain sick so that they require additional medical services and treatments. (See Robert Steinbrook, 2009, "The End of Fee-for-Service Medicine? Proposals for Payment Reform in Massachusetts," *New England Journal of Medicine; Health Policy and Reform*, available at http://healthpolicyandreform.nejm.org/?p=1247, last accessed August 1, 2011.)

record systems, electronic prescriptions, and state-level health information exchanges, and in the networking of intelligent medical monitoring devices. It seems clear that there is no turning back from the digitization of health care.[11]

In terms of meeting legislative requirements, CMS has begun to handle new types of clinical data[12] and is working with states to set up insurance exchanges with eligibility determination, subsidy determination, and interfaces with other insurance programs.[13] States are also involved in actually administering and disbursing meaningful-use incentive payments. These efforts require new systems. To accomplish the necessary coordination requires working with systems not only across CMS, but also across federal agencies, states, local governments, and profit/nonprofit entities. Such coordination would be a complex challenge even if all participants had unlimited resources and were working cooperatively with each other.

Irrespective of any future legislative changes that might once again modify the role of CMS, if CMS is to continue as a purchaser of health care in any form, it will almost certainly have to go beyond paying for "encounters" to paying for "episodes" and outcomes, integrated across financial and clinical dimensions. Further complicating matters, major changes are occurring in how health care data are collected and used to measure the effectiveness of specific clinical options. Consistent collection of rich data at the point of care can and will provide near-real-time sources of information that will form the basis of a learning health care system. Although CMS's role and specific responsibilities with respect to such data are in flux, the agency clearly will have to be able to cope with changes in the broader health care system of which it is a part.

In addition to anticipated changes to CMS's own programs are the significant changes that the broader health care, practice, and public policy environments are undergoing, including:

- Ongoing evolution and increasing sophistication of technology and a constantly changing set of technical options;
- An increasing need to manage the delivery of care based on medical advances empowered by genomics and proteomics;
- An infrastructure involving widespread use of electronic health records and regional data repositories;

[11]Institute of Medicine, 2011, *Digital Infrastructure for the Learning Health System: The Foundation for Continuous Improvement in Health and Health Care: Workshop Series Summary*, Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=12912, last accessed August 1, 2011.

[12]42 CFR 495.8, Demonstration of meaningful-use criteria.

[13]42 CFR 425.5, Accountable Care Organizations.

- Uncertainty and some ambivalence regarding the essential value of access to health data for populations and individuals as a good competing with privacy concerns;
- Growing awareness of the diverse needs of racial/ethnic and other populations experiencing disparities in health care;
- Increasing needs to integrate important non-clinical health-related data with clinically generated medical data to assess and improve health; and
- Consumer access to online medical information and social networks.

Centrality of Data to Modernization and Transformation Efforts

CMS's systems today are meeting current requirements but are challenged to meet emerging demands. Considering just the data layer, CMS information systems consist of silos of data stores for each major CMS program—Medicare Part A (hospital), Part B (outpatient), Part C (managed care), and Part D (prescription drugs)—in addition to data stores for quality clinical data, and other special data sets. Over the years, software has been added to meet new requirements for data breakouts and data interchange between the stores corresponding to Parts A, B, C, D, and other data stores. Some integrated databases have been developed to meet the needs for specific analyses, but these integrated data stores are not designed for (nor readily capable of) the interoperability and flexibility required for emerging (but not yet completely defined) new mission requirements.

There are software code bases specific to the various program silos, with some containing legacy code dating back 40 years. Such software has been continuously modified, resulting in transactionally robust but difficult to maintain sets of independent systems. Today it is time-consuming and costly for CMS to effect even annual or quarterly routine changes that legislative mandates require.[14] And new mandates require new applications (or another layer of code) that then introduce additional complexity and new opportunities for breakdowns and errors.

It was possible, albeit challenging, to manage these systems when the add-ons and new requirements demanded, in essence, more detailed data breakouts within the individual systems (corresponding to programs). Increased efforts to reduce payment errors and fraud, among other needs,

[14]Examples include updates to the various fee schedules used to determine provider payments such as for ambulance services; clinical laboratory testing; durable medical equipment, prosthetics, orthotics, and supplies; pharmaceutical reimbursements; and physicians fees schedule. (See CMS, 2011, "Fee Schedule—General Information," website, available at https://www.cms.gov/feeschedulegeninfo/, last accessed August 1, 2011.)

have meant that new, larger, and more time-sensitive data sets have to be matched with data within these systems and across data sets corresponding to Parts A, B, C, D, and other silos (storing data associated with individuals and providers). To begin to address these sorts of challenges, CMS has developed some data warehouses, such as the chronic condition data warehouse.[15] But increasingly, added demands will continue to change how CMS accesses and stores information and are likely to require ever greater flexibility in how CMS analyzes data.

If the programs CMS administers were to remain fundamentally static and the only issue were the growth in claims volume driven by an aging population, it is possible that CMS's current systems could be evolved and adapted to satisfy the anticipated growth in transaction volume. However, these systems, built for different purposes and in a different era of technical sophistication, appear to lack the flexibility that might enable their expeditious evolution to address emerging challenges. The status quo is, therefore, not a realistic option.

In summary, not only is CMS faced with a near-term growing and complex workload, but its role is also central to addressing rapidly growing health care costs and the U.S. federal budget deficit. The programmatic requirements that CMS must meet now and in the rest of this decade require underlying changes in its systems that will be extremely challenging to meet through the structure of its systems today, and these changes cannot be delayed given the agency's legislative mandates.

THE VALUE OF INCREMENTAL APPROACHES

Although the daunting and substantial challenges confronting CMS might suggest a need for creating, all at once, a large all-encompassing system through one huge development effort, such "big bang" approaches to systems modernization almost always fail.[16] Even when the end-state

[15]As noted on its website, http://www.ccwdata.org/, "The CMS Chronic Condition Data Warehouse (CCW) provides researchers with Medicare and Medicaid beneficiary, claims, and assessment data linked by beneficiary across the continuum of care. In the past, researchers analyzing data files were required to perform extensive analysis related to beneficiary matching, deduplication, and merging of the files in preparation for their study analysis. With the CCW data, this preliminary linkage work is already accomplished and delivered as part of the data files sent to researchers."

[16]See, for example, Edward Cone, 2002, "The Ugly History of Tool Development at the FAA," website "Baseline," available at http://www.baselinemag.com/c/a/Projects-Processes/The-Ugly-History-of-Tool-Development-at-the-FAA/, last accessed August 1, 2011; NRC, 2004, *A Review of the FBI's Trilogy Information Technology Modernization Program,* Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=10991, last accessed August 1, 2011; Vivek Kundra, 2010, *25 Point Implementation Plan to Reform Federal Information Technology Management,* December

seems clear, the record of success of such approaches is poor. Often they are driven by a technology agenda, thereby missing the principal business objectives, or "requirements creep" results when large-scale approaches attempt to solve too many problems at once. "Big bang" projects are, by their nature, so extensive and complex that the sheer technical task is simply too large for all but the most technically sophisticated organizations.

It is also important to note that the requirements that would be fulfilled by very ambitious large systems cannot be expected to remain fixed over time. Large systems take many years to develop, during which time the underlying initial needs often change. To succeed, such systems must have the ability to hit a moving target. Further complicating this situation is the observed fact that successful systems are themselves agents of change. Especially in cases where a new system brings unprecedented capability to stakeholder groups (especially new ones), the advent of the system and its capabilities often change the perceptions, expectations, and desires of these communities. Thus, the arrival of a new system can wash back upon the overall system in the form of needed change that is often not cosmetic, but instead can be radical.

In recognition of the drawbacks and risks of the big bang approach, the committee urges that CMS pursue an incremental approach to the development of the information systems that will be needed. But the nature of this incremental approach requires careful consideration and planning. A reactive, year-by-year and program-by-program approach to upgrading CMS systems, for example, is unlikely to succeed in meeting the new and emerging demands on CMS; nor is separate incremental consideration of new requirements, new communities, and new programs. By contrast, a comprehensive approach implemented incrementally can help to head off the issues that arise when increments are considered in isolation.

Successful information systems and data repositories must change and evolve constantly, in size, in reach, and in the stakeholder constituencies that interact with them. The reason for this ongoing evolution is the organic nature of the relationships between information services and human stakeholders. It has been widely observed that new kinds of information and new systems for making information available entice new users, and stimulate new uses by previous users.

The challenges that CMS faces cannot be met simply by upgrading

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9, Washington, D.C.: White House, Office of the Chief Information Officer, available at http://www.cio.gov/documents/25-Point-Implementation-Plan-to-Reform-Federal%20IT.pdf, last accessed August 1, 2011; NRC, 2010, *Critical Code: Software Producibility for Defense*, Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=12979, last accessed August 1, 2011.

information technology. In some sense, all of IT resolves eventually to the processing of data by computers, databases, operating systems, and networks. Some of the most critical and difficult challenges are those arising from understanding and addressing stakeholder needs and CMS business considerations. These considerations are the ones that must be articulated in order to create the precise requirements that are to be met by information technologies. A strategy that emphasizes pursuing a comprehensive incremental approach to understanding and ultimately meeting the needs and requirements of CMS stakeholder communities and CMS internal business units will, in the committee's view, serve CMS and the country well.

To be most effective, modernization and transformation efforts need to be focused on specific and concrete business issues and objectives, not on information technology per se. However, business decisions should be made with a clear understanding of the capabilities of advanced IT solutions.

CMS's mission and organization are very complex—of the scope and scale of the largest private enterprises and other large federal agencies. As a result only evolutionary, iterative approaches are likely to succeed. The tension between meeting routine demands for processing and claims payment while simultaneously developing the flexibility and capacity to move toward newer capabilities will have to be managed carefully.

THE IMPORTANCE OF AN OVERALL STRATEGIC PLAN FOR CMS AS A WHOLE

Although this report's focus is on information technology systems, IT systems and the organizations that support them do not exist independently of the other parts of an enterprise. Developing a coherent and effective vision for IT at CMS is dependent on establishing a vision for CMS as a whole. IT should be seen throughout the agency, by Congress, and by stakeholders as a means for supporting the effective performance of CMS's activities, businesses, and programs. In order to establish a compelling vision for IT at CMS, the agency itself must have a clearly expressed view of how it intends to (or believes it will) function in the future. Thus, CMS will need to develop a strategic plan that is broadly accepted; its strategy will be recorded in an evolving document that will require periodic updating as mandates are refined, technology progresses, stakeholder communities are engaged increasingly effectively, experience is amassed, and the health care delivery system as a whole changes.

As CMS develops a long-range vision of its role in the health care system, that vision will have to be refined iteratively over time, but core elements of the vision are almost certain to persist, forming the backbone of

new generations of IT systems. New delivery models, widespread use of electronic health records, and new kinds of registries tracking population health data and performance information mean that CMS not only will have to continue to focus on its traditional fee-for-service business model but also will have to establish an increasing focus on supporting a fee-for-performance model. This new emphasis will likely entail developing new capabilities, such as mechanisms for devising and assessing approaches to defining and collecting the measurements that will be needed to support effective comparisons of cost and quality.

More evidence-based medicine within a large-scale learning health care system[17] may mean that CMS will have to be prepared to handle growing amounts of clinical information (Chapter 5 addresses this issue in more detail). CMS will increasingly find itself in the information business rather than being primarily a transaction processor. More coordination of care will mean that CMS must be prepared to look beyond medical care in the narrow sense and engage productively with data regarding broader social determinants of health—the economic and social conditions that affect people's lives and health—in order to make valid assessments of quality and outcomes. What is needed, rather than a "medicalization" of the social determinants, is a shift from a medical model to a more comprehensive health model. A clear understanding of how this shift will or should evolve does not yet exist. However, such a transition is integral to any U.S. effort to move toward a sustainable and balanced approach to providing a sensible value- and science-driven array of health care services.[18]

The foundation for this vision already exists at CMS, as articulated in the "Triple Aim":[19]

> Improving the U.S. health care system requires simultaneous pursuit of three aims: improving the experience of care, improving the health of populations, and reducing per capita costs of health care. (p. 759)

[17]See the Institute of Medicine's *Learning Health System* series of workshop reports, published by the National Academies Press, Washington, D.C.

[18]A number of recent reports have cited this need to consider additional socioeconomic factors in improving health care quality. See, for example, NRC, 2009, *Race, Ethnicity, and Language Data: Standardization for Health Care Quality Improvement*, Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=12696, last accessed August 1, 2011. See also NRC, 2011, *Improving Access to Oral Health Care for Vulnerable and Underserved Populations*, Washington, D.C.: The National Academies Press, available at http://www.nap.edu/catalog.php?record_id=13116, last accessed August 1, 2011.

[19]Donald M. Berwick, Thomas W. Nolan, and John Whittington, 2008, "The Triple Aim: Care, Health, and Cost," *Health Affairs* 27(3):759-769.

The perspectives of stakeholders are vital. Whether they be internal to CMS, other government entities, beneficiaries, researchers, or the public at large, the ultimate users of systems must fundamentally guide what CMS IT provides and how it delivers it. The future needs of the stakeholders are uncertain, even to them, and indeed, some important stakeholder communities may not currently realize their future importance as stakeholders. Their perspectives, nevertheless, must be weighed heavily as they become known. This can be done most effectively through an incremental approach in which stakeholder communities are identified and engaged increasingly effectively over time.

DEVELOPMENT OF A COMPREHENSIVE STRATEGIC TECHNOLOGY PLAN FOR CMS

Information technology, medical technology, the shape and form of the U.S. health care system, and CMS's role and mandate will always be evolving and will thus, to some extent, remain a moving picture. Within this evolving context, a strategic technology plan for CMS is needed to guide planning, acting, and making ongoing refinements based on accumulating experience. CMS's strategic technology plan should be grounded not only in admittedly difficult projections about the future but also in a clear assessment of current conditions. Among the current technical issues at CMS that have become evident, for example, has been the historical tendency for little sharing of resources among CMS systems families, along with resulting redundancy that not only increases run-rate costs but also significantly complicates any new development—issues that CMS is aware of and has taken steps to begin to address. This type of systematic analysis should be continued and accelerated to identify not only the potential "shared services" but also the direct and indirect cost implications and finally to serve as the baseline for the modernization and transformation of systems.

Especially important are the connections between a CMS strategic technology plan and the agency's overall strategic plan: the technology plan must explicitly tie to and support an overall CMS strategic plan and vision. In addition, IT strategic planning requires engagement and ownership at the highest levels of the organization and cannot be effectively driven solely by IT organizations within CMS. According to information the committee was able to gather, CMS recognizes the importance of this engagement. However, IT's role cannot simply be to take orders. Although IT historically has been viewed, both in industry and in government, as a tactical resource, experience and the literature have shown that it is not possible to make strategic decisions without considering their impact on IT and the impact of IT. In this case, IT refers both to IT systems within

the organization and, in a broader sense, to technological evolution and developments in the external environment.

An effective strategic technology plan also requires an understanding of who all the stakeholders are and what their needs are, a clear statement of business objectives, and a documented and coherent view of the current state of IT across the enterprise. The plan should help maintain a focus on reduced overlap in functionality among systems, the leveraging of existing technologies, a standards-based orientation, and an agency-wide understanding that the plan is dynamic and iterative.

The strategic technology plan should be based on a clear and well-articulated understanding of the current and anticipated funding flows and structures. How are resources within CMS allocated for IT sustainment, modernization, and transformation? What proportions are allocated to each? What is the expected magnitude of the modernization and transformation workload compared to the size of the IT workforce?

Because funding for enterprise IT efforts typically is most readily available when it is tied to specific programmatic or other objectives in legislation, CMS's strategic technology plan should be sufficiently broad and flexible to encompass opportunities for funding that might arise out of specific program mandates, but also detailed enough to serve as a roadmap for long-term modernization and/or transformation of CMS's systems. The plan, which will of necessity be iterated as CMS's mission and the broader environment within which it operates continue to change, should be developed incrementally, guided in part by the impacts, results, and acceptance within the relevant stakeholder communities of initial efforts and systems.

In the committee's view, development of a CMS strategic technology plan is critical. The rationale for the development of such a plan is multifaceted—such a plan would contribute to realizing the following benefits:

- Rationalize the process of making the difficult, and necessarily long-term, decisions about systems replacement, evolution, and transformation. Without an overarching plan, effort and resources are often deployed suboptimally or even incorrectly.
- Provide context and background for the funding requests for IT, and provide a mission-driven rationale for and prioritization of individual initiatives and funding requests.
- Foster coordination of efforts to gain increased efficiencies—reducing solely program-based systems development.
- Ensure that the entire complex CMS organization and its stakeholders understand the overall direction and intent of IT use at CMS. Widespread understanding of and support for key objectives are critical to achieving the coherence in complex systems that can allow for flexibility

within and between units as they adapt to meet changing objectives over time.

- Identify long-term requirements for resources and align those resources effectively. As discussed further in Chapter 4, CMS needs to have enough in-house technology expertise to make sound technology decisions on its own without having to rely on contractors. Although it must inevitably depend on contractors for advice and up-to-the-minute information, CMS should reserve for itself final decisions that are based on sufficiently deep in-house understanding of underlying information and computer science and technology.
- Mitigate the risks in execution of IT systems modernization and transformation by recognizing current and potential future interdependencies among systems.
- Facilitate the alignment of the core and contracted parties.

In addition to incorporating the principles outlined above, a strategic technology plan should also include four key components: an enterprise architecture framework, explicit priorities and a roadmap, human capital requirements, and periodic planned review and iteration of the plan itself—each discussed in more detail below.

Enterprise Architecture Framework

The environment in which CMS operates is large, complex, and challenging. CMS has multiple functions and roles, each of which is supported by one or more information ecosystems—the IT required to build, develop, operate, assess, and evolve one or perhaps multiple business functions, including the people who design, build, maintain, and operate the systems—what CMS refers to as a "family of systems." Information ecosystems[20] are complex; no single individual can understand one in totality. Different families of systems are managed by different groups; in the case of CMS, some of these groups are internal to the organization, managed by CMS employees in whole or in part, and some are external to CMS. Just as with some business functions, information ecosystems may also be externally created and maintained. The CMS "families" of related

[20]Inherent in the nature of an information ecosystem is the fact that it is very broad and diverse and that it is constantly growing, encompassing and interconnecting ever more diverse entities. An information ecosystem includes various information repositories and the information-processing capabilities that build and use them. But it also encompasses entire stakeholder groups that are the clients and contributors that provide both the rationale for the information repositories and the sources of the raw data and aggregated information contained in the repositories.

and interdependent technologies are examples of information ecosystems, and they include both internal and external components.

Although one might assume that each business function maps directly to a single information ecosystem, this need not be the case. For example, within CMS, the systems that support Medicare Parts A and B fee for service include processes that rely on systems for determining eligibility, and they provide data that may be shared with other functions. A "global information ecosystem" is a notion that encompasses the entire set of information ecosystems in an enterprise.

To properly document, plan, and execute any modernization or transformation of a complex global ecosystem, it is necessary to take a structured approach. The discipline of enterprise architecture (EA) provides one such approach. A common EA framework is that of Zachman[21] (the originator of the term)—and the committee's recommended approach reflects some of the foundational concepts articulated by Zachman, namely: begin with an overall CMS strategic plan, translate its priorities to a set of future target/re-engineered business processes, and ensure that the business processes drive the information ecosystems' modernization or transformation.

It is the complexity of ensuring that different aspects of an enterprise maintain an overall integrated approach that drives the need for a disciplined and coherent approach to IT modernization or transformation. Without such an approach, short-term or ad hoc IT programs will lead to unforeseen difficulties, will drive up lifetime costs, and will not serve the business needs of the enterprise.

The purpose of the EA discipline is to have a documented target at the ecosystem level and a target for each of the component systems of the ecosystem, all of which serve to provide a description of a coherent whole. Having a target, even while recognizing that it will move, permits components of a large and complex organization to advance in the same direction. At a more tactical level, an EA establishes target standards and rules of the road for individual component types, for instance, databases, servers, languages, and libraries.

An EA framework, once created, is used in planning and in driving prioritization. EA is also used in execution of a plan as a method for understanding interdependencies and of course, incorporating standards. A risk is that the EA function can become a bureaucratic roadblock without sufficient compensating benefit.

[21] John Zachman, 1987, "A Framework for Information Systems Architecture," *IBM Systems Journal* 26(3).

Explicit Priorities and a Roadmap

Prioritization is critical to the effectiveness and success of a strategic technology plan. Not every need is equal, not every item is an imperative, nor is every scenario equally likely. In addition to articulating future capabilities, a strategic technology plan must also identify current platforms that are having increasing difficulty in meeting requirements—so-called burning platforms—and must assess risks and define near-term mitigation strategies. A roadmap that articulates how an organization is expected to move from its current state to its anticipated target state is critical. For example, given that CMS already has a robust transaction processing system, enhancements to that system should be considered carefully and be made according to a well-architected, phased delivery and implementation plan. An effective roadmap provides clear direction but includes the capacity for course corrections, since flexibility is key to accommodating the kinds of uncertainties inherent in the CMS environment.

CMS should seek to leverage modernized and/or transformed systems across programs in order to increase efficiencies and reduce redundancies. Although CMS is unique in some ways—with the result that there will not always be off-the-shelf solutions to its unique issues—CMS should develop its own solutions only when other alternatives have been seriously evaluated and rejected.

At the same time, adapting to changes in technology will be an ongoing challenge. Emerging technologies should be evaluated carefully with respect to known requirements and adopted opportunistically; unproven trends should be avoided. Achieving this capability will require expansion and strengthening of in-house technological skill sets. An emphasis on adhering to open, or at least published, standards will maximize long-term benefits. A strategic technology plan can help to reinforce this goal, forestalling deployment of ad hoc or heavily proprietary solutions in the heat of demanding requirements, or in the expectation of short shelf life.

A CMS strategic technology plan will serve as a roadmap for future IT-related efforts only if everyone in the agency is, at the very least, aware of its existence and importance. It is crucial that a well-crafted strategy be recognized as a necessary tool and not viewed as an expensive doorstop.

Human Capital Requirements

Understanding human capital resources and requirements is a critical component of any strategic plan. A CMS strategic technology plan should outline what types of personnel will be needed for the future (for example, clinical informaticians, data architects, and so on) and articulate a strategy for obtaining those skills. The plan should identify which

technical skills need to be CMS core competencies, which the agency should then move rapidly to put in place. Clearly articulating a strategy and plan regarding in-house staffing versus contracting is also important. Contracting for near-term work early on to make quick progress will likely be required in parallel with building up internal capacity to deal with longer-term issues.

To most effectively meet its mandates and make progress in developing systems to support its mission, CMS should carefully consider and clearly articulate what its core technical competencies need to be. This strategizing effort should include deciding what IT services CMS must provide for itself and what can be handled by other parties. For IT products and services that might be left to others to provide, CMS should determine how best to help foster a vibrant marketplace for those products and services in the health care sector. CMS's strategic technology plan should include explicit rationales for such decisions based on value and performance and should incorporate ongoing review to determine if current approaches are working. Chapter 4 elaborates on human capital needs in more detail.

Periodic Planned Review

Multiyear plans are inevitably subject to modification based on changing priorities and a changing landscape of technology, policy, and on-the-ground exigencies. A strategic technology plan must account for uncertainties and evolution in a rapidly evolving health care delivery and payment system as well as changes to and uncertainties about CMS's role. Planning at CMS, as in any government agency, will also need to account for the uncertainties associated with constant changes in its mandates and expectations as expressed in legislation and rule making. Moreover stakeholder groups will change over time—in who they are, what they want, and how their importance should be weighted. There are also inevitable changes in and uncertainty about technology.

Periodic review is essential to ensuring an effective strategic technology plan. It will be important to institutionalize the process of continually reexamining and updating priorities and to implement a governance structure that can ensure resolution of conflicts and clarity of leadership to achieve sufficient momentum for action. Potentially even more challenging is coping with evolving, competing, and conflicting long-term visions and aspirations for the agency itself. Competing visions of the health care system, of CMS's role, and of technical evolution need to be acknowledged and reflected in evolving plans.

The strategic technology plan should articulate and continually update the goals for the target ecosystems that will result from all mod-

ernization and transformation efforts. Iterative development of a comprehensive view will be ongoing and continuous: CMS should expect that the need to change and evolve its IT systems will be continuous and perpetual. There should be no expectation on the part of CMS or its stakeholders, including Congress, of an "ultimate" or finished CMS IT system. Long-range strategic planning should not be based on the expectation of such a system. CMS should instead plan for continuous iteration, and should be guided by the continuous pursuit of an increasingly broad and well-articulated global view—expressed as its strategic technology plan—of both its business and the systems that support the satisfaction of its business requirements. Chapter 3 addresses operationalizing this approach in more detail.

NEAR-TERM ISSUES—ADDRESSING THEM QUICKLY

A forward-looking strategic technology plan is essential to coping with ongoing changes in mandates and requirements both now and in the future. However, requirements such as several provisions of HITECH and the PPACA that affect CMS in the near term, as described in Chapter 1, will have to be addressed now in parallel with the development of a strategic technology plan. Although it may be ideal to wait for completion of a strategic plan, fast-track programs developed in parallel are often required to deal with the realities of stakeholder demands. It is important, though, not to completely decouple meeting immediate needs from maintaining a long-term perspective. Sometimes it is necessary, and even wise, to take an expeditious approach in the short term, even at the potential cost of longer-term difficulties. For instance, implementing a relatively "quick and dirty" version of a new function might be reasonable in the short term to, say, resolve uncertainty about the value of and demand for that function. Such a step, however, should be taken only with full cognizance of the technical debt incurred: that is, if, for example, the function does turn out to be valued, it may be necessary to make follow-on investments to integrate the functionality into the larger strategic vision and into business and information ecosystems.

Among the possible benefits of linking long-term planning to fast-track programs are the imposition of some pragmatism in longer-term planning efforts, which might otherwise devolve into purely theoretical exercises, and the forcing of hard decisions that can help to clarify longer-term planning, keeping it from dragging on indefinitely. Shorter-term efforts might have to be thought of as prototypes of a sort, aimed at gathering the more precise knowledge and understanding that can serve as the basis for more solidly conceived and implemented permanent solutions to be implemented in subsequent iterations.

To ensure success in addressing both tactical and strategic challenges, it is essential that fast-track efforts be focused on demands that are both well defined and reasonably constrained. In the context of a steadily developing comprehensive strategic plan, approaches such as the following might keep near-term projects on track and contribute to their effectiveness:

- Identify some services or capabilities that will be needed in a future global ecosystem and for which there is a very clear understanding of what to do, and then begin to create and instantiate these services or capabilities. Despite some risk that what appears to be clear will eventually prove to be more complicated than originally thought, a careful choice of services or capabilities is likely to forestall any dramatically wrong outcomes, and any subsequent adjustment (if necessary) would be modest.
- Take an element of the larger strategic framework and ask what pieces of it can be accomplished in less than *N* months. Then do those pieces, even if their place in the overall sequence is less than ideal.
- Take a plan for addressing a specific business function and ask which pieces really require an understanding of the ecosystem by focusing in a disciplined way on defining those components while at the same time moving ahead on those pieces that are truly unique to the specific system.
- Recognize that "quick and dirty" implementations of some functions can provide great business value. When explicitly acknowledged as eventually "throw away," such efforts do not diminish the importance of disciplined, longer-term planning.

The following list of examples of fast-track efforts that might be undertaken soon is neither prioritized nor meant to be exhaustive:

- Make CMS claims data available to support assessment of experimental programs internally (for example, ACO models, innovation demonstrations, and so on). The timescale for evaluation of programs, delivery models, and so on should not be constrained by access to data.
- Provide CMS claims data quickly and efficiently to qualified external organizations such as the state-level All Payer Claims Databases (APCDs).
- Provide faster access to CMS claims data for pre-pay fraud detection, which may involve better integration of Medicare and Medicaid data.
- Develop and implement processes for CMS to collect needed data from clinical registries, electronic health records where they exist, and patient surveys.

The enormous challenge of moving from a siloed set of information ecosystems to information ecosystems that can support the needs of new applications and new requirements cannot be underestimated. Chapter 3 provides guidance in the form of a meta-methodology for planning a comprehensive incremental modernization and transformation of CMS systems.

3

A Meta-Methodology for the Modernization and Transformation of Business and Information Ecosystems

This chapter offers a meta-methodology for modernizing and transforming the business and information systems of the Centers for Medicare and Medicaid Services (CMS). This abstract (meta-level) discussion concerns conceptual models of the business roles and processes under consideration. The approach described is simultaneously comprehensive and incremental, combining top-down guidance for establishing global context with bottom-up specificity regarding what is transitioned and how.[1] This is distinct from a "big bang" approach that would attempt to transition everything at once—as Chapter 2 indicates, such an approach would be unlikely to succeed. The committee's exhortation is that individual modernization or transformation efforts move forward within an understood comprehensive context, as opposed to piecemeal or program-by-program as has traditionally been done.

CMS's Office of Information Services (OIS) either has developed or is currently developing many components of the plan outlined in this chapter, including its shared services plan,[2] an enterprise data environment

[1]The committee is aware that a more concrete and tactical approach than what is described here is desirable. Indeed, during its input gathering the committee had several discussions with CMS about the question of specificity and tactics. Given the nature of the study and limited time and resources, the committee ultimately decided that a meta-methodology was as tactical an approach as it could offer.

[2]CMS, 2011, *CMS 18-Month Plan for Enterprise & Shared Services*, Baltimore, Md.: CMS, July 7.

(EDE),[3] and OIS-wide architectural and life-cycle guidelines,[4] among others. The approach described here combines and generalizes activities already underway in OIS and provides a meta-methodology to guide future efforts toward modernization and transformation. The proposed meta-methodology should be viewed as augmenting CMS's already-existing plans for modernization with a larger context and confirming some of the actions and principles of which the committee was made aware by the CMS Office of Information Services during the course of this study (see Appendix B for a list of committee meetings and briefers).

The methodology has two goals: first, it provides these components with a context that includes the full scope of CMS; second, and more importantly, it links the information technology (IT) components with the corresponding elements at the business level to create a context within which the relevant multidisciplinary teams can collaboratively plan and execute the CMS-wide modernization or transformation of all CMS systems. Thus, a specific contribution of this proposed method is the combination of an ecosystems perspective in concert with clearly articulated interactions and interrelationships between the business side and information technology.

The meta-methodology described here is a generalization (and perhaps, formalization) of that described by OIS itself. In its 18-month plan for enterprise and shared services,[5] CMS lays out the need to formalize and define services that can be shared across its various businesses, suggesting a useful list of such services, including master data management, portals, and identity management. The plan also suggests a governance model that spans the business and information technology organizations. The committee applauds this direction in CMS, and nothing here is meant to contradict the intent of this plan.

The meta-methodology that the committee proposes is necessarily abstract. A specific method—that is, one specific to CMS systems—requires an extremely detailed understanding of those systems. The committee had neither the resources nor the charter to acquire that depth of understanding of CMS systems. Detailed knowledge of CMS systems is only a part of the picture, however. As the outline of the meta-methodology below reveals, an end-to-end plan requires a comprehensive knowledge not just of the CMS systems but also of the business and information

[3]CMS, 2010, *Modernizing CMS Computer and Data Systems to Support Improvements in Care Delivery*, Version 1, IT Modernization Program, December 23, available at http://www.cms.gov/InfoTechGenInfo/downloads/CMSSection10330Plan.pdf, last accessed July 27, 2011.

[4]See CMS, 2011, Technical Reference Architecture (TRA) Standards, available at http://www.cms.gov/SystemLifecycleFramework/TRAS/list.asp, last accessed July 27, 2011.

[5]CMS, 2011, *CMS 18-Month Plan for Enterprise & Shared Services*, Baltimore, Md.: CMS, July 7.

ecosystems of which they are a part. An undertaking of this scope and scale must be addressed incrementally, over a period of 10 to 15 years. The committee's view is that CMS is moving forward appropriately, given the constraints under which it must proceed.

For purposes of consistency and clarity of definition the committee uses its own terminology in this report. (The glossary in Appendix F defines important terms.) CMS may have its own terms for the concepts used and defined here. The first section below describes a conceptual model and language used to describe the meta-methodology.[6] The second outlines the approach, which has two phases: Phase 1 focuses on the modernization and transformation of the business ecosystems, and Phase 2 addresses the modernization and transformation of the information ecosystems. Both phases are detailed further in Appendix E. Finally, the third section describes the preparations necessary for the transformation to succeed.

MODEL AND TERMINOLOGY

A major business is a complex affair. Businesses typically perform a number of business roles, each with its own objectives and requirements. For example, one of CMS's roles is to pay claims; its objective for that role is to pay all legitimate claims (and to avoid paying any that are fraudulent), and it is required to do so within a certain period of time. To meet its objectives, the business role follows a set of business processes and leverages a set of business services. Business service is a business organization concept; it does not refer to any specific implementation—automated or non-automated. In CMS's role as claims' payer, for example, it must generate a check (a business service). Business services may be shared across multiple business roles. For example, the check-generation service might also be used in conducting a procurement role of buying office supplies from vendors. If the services are shared, they are referred to here as shared business services. (In its enterprise and shared services plan,[7] CMS refers to such business services, shared CMS-wide, as enterprise services.)

In this report, a business ecosystem consists of the people, processes, services, and information required to operate all aspects of a specific busi-

[6]The terminology selected for use in this report is not unique; CMS should adopt the terms with which it is most comfortable, taking into account relevant U.S. federal guidance and standards.

[7]CMS, 2011, *CMS 18-Month Plan for Enterprise & Shared Services*, Baltimore, Md.: CMS, July 7.

ness role that is independent of other business roles.[8] An ecosystem for a given role can be seen in various ways, including as an operational model and as a business model for that role. A complex organization such as CMS will involve many roles and hence many business ecosystems. These may not all be internal to CMS—that is, CMS business ecosystems also interact with external business ecosystems. For example, the claims payment business ecosystem must interact with the Social Security Administration (an external business ecosystem) concerning eligibility. The union of *all* of the business ecosystems bearing on the business is referred to here as the global business ecosystem.

A design objective for business ecosystems in an enterprise is to achieve as much reuse of common services among ecosystems as possible, taking into account considerations such as cost, governance, and architecture. Reuse typically increases efficiency and reduces costs. People, processes, services, and information can be shared across ecosystems. Ecosystems continuously evolve, reflecting and corresponding to the continuous evolution of the business roles that they characterize.

Because the modernization and transformation of a global information ecosystem constitute an enormously complex task, it is critical to begin by adopting standards and conventions that foster a common understanding of the various architectures, systems, and services being modeled. As described in Chapter 2, an enterprise architecture (EA) framework sets the standards for structure, properties, and behavior to which each layer of the architecture should adhere. As an example, one piece of the EA framework would be information architecture standards. See Box 3.1 for a description of the several architectural layers that must be taken into account. CMS has identified the need for such standards in its plans, for instance, the enterprise data environment. It correctly identifies the Enterprise Data Environment (EDE) as central and critical to the future of CMS.

CMS has business and information ecosystems in place, such as the medical beneficiary membership systems, the Medicare claims and utilization data systems, the Medicare pricing systems, and many others. CMS refers to these as CMS systems families, by which the committee assumes that CMS means several information systems used to accomplish what

[8]Independence of business roles is not meant to imply that there must be a complete lack of sharing of resources or services. Systems implementing separate business roles can and likely should share lower-level services. A purpose of independence at the business level is to distinguish roles. Sharing of services occurs at a different level—that of implementation. For example, human resources functions and payroll activities can serve all organizations within an enterprise, even if the system dealing with sales, for example, is compensated under rules completely different from those that govern the IT system; payment in both is made using the same shared services—people, systems, and other resources, for example, for issuing checks.

BOX 3.1
Component Architectural Layers of an Information System

Understanding and updating the target global information ecosystem and its component architectural layers to ensure its alignment with the global business ecosystem should be part of CMS's overall modernization and transformation plan. These concepts are described briefly below.

- The process architecture describes the structure, properties, and behavior of the processes in an information system.
- The applications architecture describes the structure (e.g., logical organization, data flows), properties, and behavior (e.g., interactions) of the applications (e.g., functionality) needed to support a business process. Often, these are thought of as software services that implement corresponding business services. A software service is an abstraction that represents the execution of some set of actions as part of a process in an information ecosystem. Software services are implemented in modern enterprise architectures by means of remotely invoked procedures and service-level agreements with business units. Service-orientation is an architectural objective for CMS application architectures.
- The information architecture describes the structure, properties (e.g., formats), and behavior (e.g., flows) of the storage and management of information within a specific information system, with emphasis on information exchange among applications and processes.
- The infrastructure architecture describes the structure, properties, and behavior of the technology infrastructure (i.e., hardware and software) components of an information system. The infrastructure architecture does not include information or applications in the information or applications architectures.
- Network, storage, and other architectures not discussed in this report describe other details of how the information systems are realized.

in this report is called a business role. The committee did not observe a concept in CMS analogous to what this report calls a business ecosystem, and it suggests that CMS begin approaching modernization and transformation within this broader context.

This report refers to existing constructs as sources: for example, source information ecosystems. It refers to desired constructs as targets: for example, target business ecosystems. Such targets could be the result of modernizing or transforming one or more sources, or they could result from new requirements. If CMS wants a new business service that combines the functions of two existing business services, the new target business service will be created from those two source services. Once a target is envisioned, how the target transitions to or is derived from one or more sources is specified in a process known as mapping. Mapping, like the

terms "source" and "target," can apply to any construct defined above. Mappings can relate multiple sources to multiple targets, for example, to represent the need to combine parts of several source ecosystems into a single target ecosystem or to show that multiple targets are derived from or consolidated to produce a single source.

OVERVIEW OF THE META-METHODOLOGY

The meta-methodology recommended by the committe for transitioning—modernizing or transforming—CMS systems consists of two phases. Phase 1 establishes a plan for the business ecosystems, in the process defining the business requirements. Phase 2, guided by the plan for the business ecosystems, creates a plan for the information ecosystems. Both phases follow the same pattern: understand the source ecosystems of interest and how they interrelate, choose a starting point, understand the relevant target ecosystems, and develop a mapping between the source and the target ecosystems. The plan for the business ecosystems guides the plan for the information ecosystems, which is also guided by relevant standards for the global information ecosystem (GIE) and the EA framework.[9] An objective of this proposed meta-methodology is to achieve agility in modifying plans and designs as required by constant and unanticipated changes.

In brief, the meta-methodology proceeds as follows:

- Phase 1 is for understanding and planning the modernization or transformation of business ecosystems. It consists of three tasks:
  - —The first task is to identify and characterize the source business ecosystems of interest and to create a model of the full source global business ecosystem (GBE).
  - —The second task is to design a set of target business ecosystems and a target global business ecosystem, paying particular attention to opportunities to consolidate and redesign business roles and processes by identifying commonalities and potential shared services.
  - —The third task is to develop a transition plan that will map roles and processes of the source GBE to the target GBE.

[9]A simple example of a plan is one in which one source ecosystem is transformed to a target ecosystem to accommodate new requirements, such as new legislation or regulations. In this case, the target global business ecosystem (GBE) is identical to the source GBE with the exception of the ecosystem to be transformed. The plan delineates the mapping of the source ecosystem within the source GBE to the target in the target GBE. In other words, the target ecosystem is almost never a completely "blank piece of paper"; instead, in the proposed incremental method, only the ecosystem being transformed changes.

• Phase 2 is for transitioning—modernizing or transforming—the corresponding information ecosystems. This phase starts by drawing on the standards as needed to guide the mapping and then follows the same sequence (source, target, and mapping) as in Phase 1, guided by the decisions made there and by the relevant standards. Then, the IT systems must be modernized or transformed. This phase therefore has five tasks:

—The first task is to develop or enhance, as needed, already established standards to guide the design of any common components of the target GIE, including an EA framework.

—The second task is to identify and characterize the source information ecosystems that are relevant to the business ecosystems identified in Phase 1, and to model the source GIE that implements that GBE (if that was not done in a previous incremental step).

—The third task is to characterize the desired target information ecosystems to support the target GBE.

—The fourth task is to develop mappings between the source and the target information ecosystems, creating a plan that can be sequenced so that individual technical transitions can be conducted one at a time.

—The fifth task is as follows: For each transition identified in the fourth task, plan a technical process that follows its own sequence: a process that (1) creates a development version of the newly envisioned technical ecosystem, (2) tests and evaluates this version against requirements and against relevant changes, and (3) moves this information ecosystem to production once the requirements are satisfied, replacing the source information ecosystem.

At the end of each such rollout, the incrementally updated target becomes the source for the inevitable subsequent transitions to face CMS. This is true at the levels of both the business ecosystems and the information ecosystems. That is, this process will repeat indefinitely in an iterative fashion as each individual modernization or transformation task is accomplished. Activities in Phase 1 and Phase 2 will be taking place simultaneously, since efforts toward one transition will inevitably need to begin before an earlier transition is completed. The source and target information ecosystems will be in a state of constant change that will have to be accounted for at each stage of the iteration. The committee proposes this methodology as a new life-cycle methodology for CMS.[10]

[10]Although the committee's recommended approach is presented abstractly, it embeds the notions of iteration and incrementalism, which are well studied in the literature regarding software-intensive systems. See, for example: **Craig Larman and Victor R. Basili, 2003, "Iterative** and Incremental Development: A Brief History," *IEEE Computer* 36(6):47-56; Barry W. Boehm, 1985, "A Spiral Model of Software Development and Enhancement," *Proceedings of the International Workshop on Software Processes and Software Environments*, New York: ACM

An immediately recognizable iteration scenario is one in which a key stakeholder (e.g., Congress) creates a new business requirement (e.g., a new program), or changes an existing role (e.g., making changes to rules about CMS operations). Completing such an iteration will require changing existing processes and/or creating new ones. An appropriately comprehensive view might suggest that existing components, software, and/or hardware could be reused or modified to support the new requirements or roles. Alternatively, the new requirements or roles might suggest the need for broadening the global view, requiring the addition of lower-level capabilities. This should be done with a view toward making them suitable for use in satisfying further requirements that might be expected to emerge.

The transition from the use of the *International Statistical Classification of Diseases and Related Health Problems, 9th Revision* (ICD-9) to the use of ICD-10 might be an example of such a requirement—and indeed is illustrative of the challenges facing CMS that are described throughout this report (see Box 1.3). First, this transition is an example of a very pervasive set of application and data changes that traverse a wide range of systems within the agency. Second, this transition will occur at the same time that many other changes (such as the certification and implementation/disbursement of financial incentives for the meaningful use of electronic health records technology) take place, illustrating the increase in the pace of change confronting CMS. Third, it is one more example of the shift taking place as CMS moves toward being a data-centric organization (discussed further in Chapter 5). An even more transformative example would be the new role of CMS in managing the insurance exchanges—the collection of state-regulated, standardized health care plans, from which eligible individuals may purchase federally subsidized health insurance. Whereas the transition to ICD-10 is crosscutting, it is, at root, an update to existing functionality. By contrast, management of the insurance exchanges will demand entirely new functionality (and correspondingly new data and information). Each of these challenges can be addressed within the proposed methodology.

Or, imagine a comparatively simple case in which the target CMS global business ecosystem is known to require one CMS role, that of beneficiary registration, whose business requirements are partially known. The context for this case should include the beneficiary registration role characterized by all known and anticipated details. In addition, there would be an abstract target role for each source CMS role. Modernization

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Press; F.P. Brooks, Jr., 1987, "No Silver Bullet—Essence and Accidents of Software Engineering," *IEEE Computer* 20(4):10-19; and, recently, NRC, 2010, *Critical Code: Software Producibility for Defense*, Washington, D.C.: The National Academies Press.

and transformation activities related to the beneficiary registration role would proceed by mapping source to target roles in terms of the component services. This activity may identify services or resources that might be shared by one or more of the abstract roles—for example, security and registry services. Opportunities identified during this initial activity may be confirmed by subsequent incremental activities in which details emerge.

Not all iterations through this process of modernization or transformation will be undertaken in response to changes in higher-level layers. An iteration might instead be aimed at modernization at a lower layer, such as the hardware layer or a well-contained application layer. One example of this sort of transition is the replacement by CMS of a large number of accounting and ledger systems with a modern commercial, off-the-shelf integrated general ledger: the Health Care Integrated General Ledger Accounting System (HIGLAS). These sorts of modernization iterations might result in a marked improvement in performance that is noticeable to key stakeholders. Subsequently, stakeholders' realization of the possibility of an expedited response to their needs might encourage them to change the roles that they would like to play or indeed to expand their business requirements to include capabilities previously thought to be unrealistic or unachievable.

CMS's iterative modernization and transformation activities should be approached comprehensively in the most global context, but with the recognition that the fifth task listed above is the crucial implementation step at the appropriate level of abstraction, where the transitions take place. Each CMS modernization or transformation activity should identify its most global context and initiate the design of that activity within that context. Representatives of the relevant business roles and functions, as well as those with relevant technical specializations, should be involved in the process. (See Chapter 4 for more on organizational aspects of modernization and transformation.) To the extent that the components of that context can be identified, those components should be part of the design. To the extent that details of those components are known, they should be included in the characterization of that component. If a component is anticipated but few details are known, the component should be identified as part of the context and characterized in terms of those aspects that are known or anticipated. In some cases a component may be anticipated, but little may be known of its details. Most aspects of business ecosystems and information ecosystems can be expected to evolve over time, emphasizing the importance of being sure to consider all phases of the life cycle of a business ecosystem or information ecosystem incrementally.

A significant number of source and target business ecosystems are encompassed within the scope of the CMS modernization and transfor-

mation activity. It is feasible to carry out a complete analysis and mapping from sources to targets only as an incremental activity over a period of approximately 5 to 10 years.[11] Hence, business system analysis and mapping should be conducted opportunistically to meet business priorities, allowing activities in Phase 2 to begin as quickly as possible for the given task of interest. For example, if fee for service is the most urgent business ecosystem to transition, the mapping should focus on the relevant source and target business ecosystems, taking into consideration as many global aspects as are known. Subsequent incremental mappings will focus on the relevant source and target business ecosystems as well as on those business system mappings that already exist. The global CMS ecosystem at any point in time consists of all of the individual ecosystems. When transitioning any one ecosystem, the target global ecosystem is identical to the source global ecosystem except for the one being transitioned.

Appendix E offers an elaboration of the steps in Phase 1 and in Phase 2 and includes a discussion of information strategy and the CMS enterprise data environment.

PREPARING FOR INEVITABLE TRANSFORMATIONS

Owing to the continuous evolution of methods and technologies in business and information technology, those communities have been in a period of continuous change for decades. In 2011, business and IT are not just changing but are being continuously transformed through the development of methods and technologies that are usually significantly more efficient and flexible than their predecessors were. Efficiency and flexibility distinguish those methods and technologies that not only will succeed but also are inevitable. In 2011, in the committee's view, there are several inevitable business and IT transformations, or revolutions, underway, each at a different level of maturity and with its own momentum. These are in addition to changes taking place in the health care and health IT communities with which CMS must engage.

Taking advantage of or accommodating any one such transformation to gain the benefits that it will provide poses significant challenges. Moving from the current or source state to the transitioned or target state involves the following: developing a model and reasonably robust methods and technologies for the target state, demonstrating that the target methods and technologies will fully meet the target requirements, planning and executing the migration from the source to the target state, and

[11]CMS, 2010, *Modernizing CMS Computer and Data Systems to Support Improvements in Care Delivery*, Version 1, IT Modernization Program, December 23, available at http://www.cms.gov/InfoTechGenInfo/downloads/CMSSection10330Plan.pdf, last accessed July 27, 2011.

accommodating the cost, schedule, and procedural impact of the migration. Each impact factor must be considered at the scale of the source and target environments. The complexity of these considerations has often prevented large organizations such as CMS from launching transformative efforts, leaving the source or legacy environment in place and thus missing an opportunity to reduce long-term costs and increase flexibility. Over time, the cost of not taking advantage of those opportunities is an unsustainable legacy ecosystem characterized by legacy or uncompetitive costs and inflexible processes, resources, organizational structures, and information ecosystems.

This chapter urges incremental transformation to a global ecosystem environment in which business and IT cooperate to ensure that business requirements drive IT solutions and vice versa. CMS's OIS has already taken significant steps in this direction. Expanding those steps to be CMS-wide and enhancing the business-IT partnership while doing so will be important. The target global ecosystem should be developed incrementally based on well-defined requirements, a migration that the meta-methodology offered here can contribute to planning. This transformation, already underway at CMS, is inevitable and necessary.

CMS should focus on the transformation to a global ecosystem environment in order to be prepared to take advantage of and to accommodate other revolutions currently underway in the broader IT industry, such as service orientation, cloud computing, and Enterprise 2.0 (i.e., the use of social networking, collaborative spaces, and other Web 2.0 technologies to streamline business processes). The transformation to service-oriented business operations and service-oriented computing has been underway since the early 2000s. While some industry leaders have established best practices, the business practices and supporting technologies are maturing. Although OIS is on that path as well, as evidenced by its 18-month plan for enterprise and shared services, the transformation is a long-term project. It involves reformulating both business and IT, as well as significant implementation involving reorganizing the business and re-architecting the information ecosystems.

The transformation to cloud computing is compelling and is a federal strategic direction. However, in the committee's view, despite the fact that industrial practice has succeeded in achieving significant benefits through server virtualization and for small and green-field applications, the movement of existing applications to "the cloud" is not yet mature and should be deployed only on the basis of solid evidence that the target requirements are met within reasonable costs and with appropriate attention to risk assessment and risk tolerance. Careful analysis is also needed regarding the costs and benefits not only of degrees of virtualization but also of private (in this case, agency-managed) versus public (third-

party-managed) cloud services. Additionally, in the committee's view, the inevitable transformation from so-called Enterprise 1.0 to Enterprise 2.0 is just getting started. CMS would benefit significantly from the appropriate and efficient interaction among all of its stakeholders to achieve CMS objectives.

In summary, to take advantage of current and future business and technical advances, CMS should consider the relevant opportunities, such as those described above, and plan prudently to make transformations on the basis of its capacity to do so and using the proposed meta-methodology to manage the iterative process that will be needed.

4

Achieving Cultural and Organizational Transformation

In any large-scale organization, major changes in the roles, uses, and architectural assumptions of information technology (IT) systems and processes may be seen as disruptive, or onerous, or be poorly appreciated—even when the drivers for change are well understood by the organization, and even when modernizing or transforming business and information ecosystems is done in a structured, incremental, and iterative fashion, as this report recommends. If the need for modernization or outright transformation is poorly understood, especially by organizational leaders as well as by the users and stakeholders who will be most affected, even the best-intended and well-designed projects can be unsuccessful.

Achieving the kinds of changes in CMS's business and information ecosystems outlined in previous chapters will require both internal CMS organizational adaptations and a cultural adaptation embracing the notion that CMS's business functions are intrinsically tied to IT. Rather than being seen simply as a support service and mechanism for implementing programs, IT must be recognized as integral to CMS's strategic directions. In the business community, which has increasingly accepted IT as fundamental to its mission, IT leaders play strategic roles in addition to their traditional operational ones. CMS, too, can benefit from evolving structurally and transforming its internal culture to effect an improved understanding of IT's role in and contributions to realization of CMS's mission and goals. Although the choice to modernize or transform a business or information ecosystem has to be evaluated in terms of what

type of transition is needed for that ecosystem, in the committee's view the culture and organization of CMS have to be transformed—not merely modernized—in order to meet its current and future challenges.

CMS faces special challenges in this regard, given that its agenda and priorities are often defined by external forces such as new legislation or other congressional directives, as described in Chapters 1 and 2. But much of how CMS does what it does is determined internally, based on organizational structures, planning and decision-making conventions, the availability of resources, and relationships (defined by informal culture as well as formal reporting relationships). Considering the centrality of IT as an element in, and enhancement to, a transformation in CMS's organization and culture, the committee in this chapter summarizes CMS's current organization and relationships and describes what an IT-enhanced enterprise within CMS might look like, offers suggestions for aligning overall strategic goals and resources to achieve the needed organizational transformation, discusses the importance of leadership and innovation, and outlines some guiding principles along with a roadmap for cultural and organizational transformation at CMS.

In summary, the committee believes that in order to meet emerging and future needs, CMS should undergo an organizational and cultural transformation, actively integrating IT as a strategic partner in its business and deepening in several areas its critical internal IT core competency.

BASIC ELEMENTS OF THE CULTURAL AND ORGANIZATIONAL TRANSFORMATION NEEDED AT CMS

In any organizational transformation, several key elements contribute to a successful transition: a clear and well-articulated mission; an effective organizational structure; firm commitment on the part of leadership to lead change; effective communication across the board; buy-in and support from key players, engaged staff, and employees; and perseverance.[1] A frequently cited example of successful organizational transformation in the federal government is the IT transformation of the Internal Revenue Service. Achieving large-scale change in a complex government service operation,[2] that effort has been applauded for demonstrating the key roles of leadership, vision, and cultural change. Similarly, a generation of physicians and other health professionals has seen the transformation in

[1]Mark A. Abramson and Paul R. Lawrence, 2002, *Transforming Organizations: IBM Endowment Series for Business of Government*, Lanham, Md.: Rowman & Littlefield Publishers.

[2]Amy C. Edmondson, Frances X. Frei, and Corey B. Hajim, 2002, "Transformation at the IRS," Harvard Business School Case 603-010, available at http://cb.hbsp.harvard.edu/cb/product/603010-PDF-ENG, last accessed July 20, 2011.

BOX 4.1
CMS Achievements in Information Technology

CMS has achieved several noteworthy achievements in IT. Among them are the following:

- Consolidated and standardized Medicare fee-for-service claims processing by eliminating numerous claims-processing systems and transitioning all Medicare contractors to three standard claims-processing systems;
- Consolidated 22 independent data centers housing the processing of fee-for-service claims into two CMS-controlled enterprise data centers;
- Implemented the Medicare Part D Prescription Drug Program, a more than $300 million effort over 2 years;
- Implemented the Healthcare Integrated General Ledger Accounting System, providing a single integrated general ledger accounting system for all financial transactions and modernizing Medicare accounting;
- Implemented the CMS Integrated Data Repository—a warehouse envisioned to eventually contain all CMS program data—and business intelligence tools, enabling delivery of the CMS Dashboard (a tool to make CMS data more accessible and transparent) in just over 6 weeks;
- Implemented the Health Insurance Portability and Accountability Act-compliant eligibility transaction system, which processes and responds to more than 300 million eligibility requests annually;
- Implemented the CMS Virtual Call Center strategy in support of users of the toll-free number 1-800-Medicare; and
- Developed and implemented numerous "compare" tools for the Medicare websites.

the Department of Veterans Affairs' clinical services at all its hospitals and clinics as a result of the federal program's effective design, development, and deployment of its transformational electronic health record system known as VISTA.[3] The past 10 years have also seen a number of important CMS achievements in the IT arena, several of which are listed in Box 4.1.

As in other federal agencies, the context within which cultural (attitudes, experiences, beliefs, and values of an organization[4]) and organizational (structures and processes) transformation will occur at CMS is complex. The agency will have to address the core components of business transformation—people (including external stakeholders and Con-

[3]U.S. Department of Veterans Affairs, "Veterans Health Information Systems and Technology Architecture (VISTA)," website, available at http://www.va.gov/vista_monograph/, last accessed July 20, 2011.

[4]E.H. Schein, 2005, *Organizational Culture and Leadership*, 3rd Ed., Jossey-Bass.

gress), processes (including those that involve a complex array of external contractors at state and regional levels), and technology—all while under intense public scrutiny, and coping with federal funding idiosyncrasies and frequent transitions in leadership.

In the committee's view, five related cultural and organizational transitions at CMS would have positive repercussions for nearly all of CMS's activities, given the centrality of data, IT, information, and information management to the agency's mission:

- A cultural shift from viewing IT as simply an operational necessity to embracing IT as a critical strategic element;
- A cultural shift away from viewing IT leadership as overseeing a support group, complementing but not an integral part of the leadership mainstream, and toward viewing IT leadership as playing a key role in planning, designing solutions, and advising CMS business leaders regarding suitable approaches to their own responsibilities;
- An organizational shift from a mission centered on transaction processing to a mission centered on data, information, and information management;
- An organizational shift from a focus on paying claims to a focus on driving a combination of payment with improvements in quality, safety, and equity of health care and outcomes for individuals and populations; and
- An organizational shift from relying on heroics from IT staff to securing a sustained investment in and commitment to infrastructure, resources, and staff.

These transitions must occur in the context of shifts in the CMS customer base, with a Patient Protection and Affordable Care Act (PPACA)-mandated emphasis on clinical care quality, equity, and safety as well as the promotion of health and increased efficiencies and cost savings. The demand for CMS-managed data to support research and other external analytic efforts continues to grow and may change in both character and volume as CMS is perceived as providing information that is more clinical in nature. Furthermore, the creation of accountable care organizations, the development of episode-of-care and bundled payment mechanisms, the relationship with the Office of the National Coordinator for Health IT concerning meaningful use of health IT, and growing interactions with other federal IT organizations (in HHS and beyond) highlight the growing need for cultural transformation within CMS.

CURRENT CMS ORGANIZATION AND RELATIONSHIPS TO INFORMATION TECHNOLOGY FUNCTIONS

One of the largest agencies within the Department of Health and Human Services, CMS has more than 4,000 federal employees and approximately 80,000 external contractors organized into 6 major centers, 18 operating offices and consortia, and 10 regional offices across the country (Box 4.2).

The most recent enterprise-wide organizational restructuring of the agency occurred in 2001, when the agency changed its name from the Health Care Financing Administration to the current Centers for Medicare and Medicaid Services and reorganized into three centers reflecting the agency's major lines of business: Medicare Management, Beneficiary Choices, and Medicaid and State Operations.[5] In 2003, the most significant legislative change to Medicare (the Medicare Modernization Act, or MMA)[6] was signed into law, adding a new outpatient prescription drug benefit and making many other important changes to the program. Figure 4.1 shows the CMS organizational chart at the time of this writing, including the three additional centers introduced since 2001.

Information Services and Information Technology in CMS

Although CMS has experienced significant organizational change over the years, information services and information technology have not been fully consolidated into an enterprise-wide operation. The lead office for IT is the Office of Information Services (OIS), headed by a director who also serves as the agency's chief information officer. The OIS is organized into several units, including enterprise data, business applications management, information services design and development, an enterprise data center, an enterprise architecture and strategy group, consumer information and insurance systems, and resource and acquisition management. The Office of the Chief Information Security Officer is also part of the Office of Information Services. OIS's main responsibility is to serve as the focal point for planning, organizing, and coordinating all aspects of the agency-wide information resource management program and to ensure the effective management of the agency's IT, including information systems and resources. The office also serves as the lead for developing, maintaining, and enforcing the agency's information architecture, policies, standards, and practices in all areas of IT (Box 4.3). Nevertheless, the

[5]CMS Press Office, 2001, "The New Centers for Medicare & Medicaid Services (CMS)," press release, June 14, available at http://archive.hhs.gov/news/press/2001pres/20010614a.html, last accessed July 20, 2011.

[6]The Medicare Prescription Drug and Modernization Act of 2003 (P.L. 108-173).

BOX 4.2
CMS Regions, Centers, and Offices

Regions

- Region I—Boston (Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont)
- Region II—New York City (New Jersey, New York, U.S. Virgin Islands, Puerto Rico)
- Region III—Philadelphia (Delaware, Maryland, Pennsylvania, Virginia, West Virginia, District of Columbia)
- Region IV—Atlanta (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee)
- Region V—Chicago (Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin)
- Region VI—Dallas (Arkansas, Louisiana, New Mexico, Oklahoma, Texas)
- Region VII—Kansas City (Iowa, Kansas, Missouri, Nebraska)
- Region VIII—Denver (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming)
- Region IX—San Francisco (Arizona, California, Hawaii, Nevada, U.S. Territories)
- Region X—Seattle (Alaska, Idaho, Oregon, Washington)

Centers

- Center for Medicare
- Center for Medicaid, CHIP and Survey & Certification
- Center for Strategic Planning

committee's impression is that there is still significant fragmentation of resources (human, technical, financial), and cross-program coordination and collaboration are less than ideal.

Apart from OIS, IT resources and systems can be found across almost all other offices and centers throughout CMS. Although the operations and indeed the missions, goals, and responsibilities of all the agency's units (whether centers, offices, or consortia) are heavily dependent on IT services and resources, there are in most cases opportunities to integrate these key IT components more fully into each unit's operational leadership and policy directions. Opportunities also exist to increase OIS's oversight and coordination of the IT resources distributed across the agency in order to use them more effectively and at lower cost, for example, by reducing redundancy.

Some offices and centers within the agency play a more significant

- Center for Program Integrity
- Center for Medicare and Medicaid Innovation
- Center for Consumer Information and Insurance Oversight

Offices

- Operations (Chief Operating Officer)
  - —Office of Acquisition and Grant Management
  - —Office of e-Health Standards and Services
  - —Office of Information Services
  - —Offices of Financial Management
  - —Office of Operations Management
  - —Consortium for Medicaid and Children's Health
  - —Consortium for Financial Management and Fee for Service Operations
  - —Consortium for Medicare Health Plan Operations
  - —Consortium for Quality Improvement and Survey and Certification Operations
- Office of the Actuary
- Office of Strategic Operations and Regulatory Affairs
- Office of Clinical Standards and Quality (CMS Chief Medical Officer)
- Office of Legislation
- Office of Communications
- Office of Public Engagement
- Office of Equal Opportunity and Civil Rights
- Office of Federal Coordinated Health Care

NOTE: Information from the CMS website, available at http://www.cms.gov/home/aboutcms.asp.

role than others in shaping and defining the direction of IT at CMS. In addition to the Center for Medicare and the Center for Medicaid, CHIP and Survey & Certification, other centers and offices with a significant role in IT include:[7]

- Center for Strategic Planning, which provides senior leadership across the organization for strategic planning and the development of CMS strategic goals, using metrics to facilitate plans for IT integration of data resources. The center is also responsible for providing leadership in the development of performance dashboards and databases for key agency initiatives; maintaining and ensuring the quality of data resources

[7]CMS, 2011, "Overview: CMS Leadership," website, available at http://www.cms.gov/CMSLeadership/Downloads/CMS_Organizational_Chart.pdf, last accessed August 1, 2011.

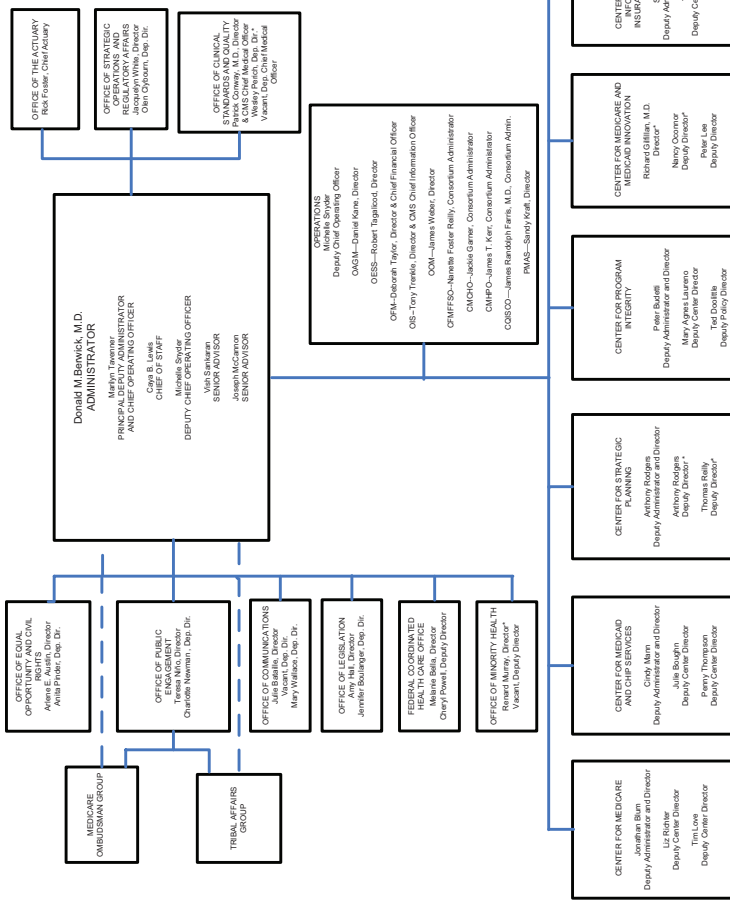

FIGURE 4.1 Centers for Medicare and Medicaid Services organizational chart. *, Acting. For more information regarding CMS's organizational structure, see the CMS organizational chart, "Department of Health and Human Services: Centers for Medicare and Medicaid Services," last updated October 1, 2011, available at http://www.cms.gov/CMSLeadership/Downloads/CMS_Organizational_Chart.pdf, last accessed November 5, 2011.

BOX 4.3
Functional Responsibilities of the CMS Office of Information Services

CMS's Office of Information Services has the following functional responsibilities:

- Serves as the focal point for the responsibilities of the agency's chief information officer in planning, organizing, and coordinating the activities required to maintain the agency-wide Information Resources Management program.
- Ensures the effective management of the agency's information technology and its information systems and resources (for example, implementation and administration of the process of managing change).
- Provides workstation, server, and local area network support for CMS-wide activities. Works with customer components to develop requirements, needs, and cost-benefit analysis in support of the local area network infrastructure, including hardware, software, and office automation services.
- Serves as the lead for developing and enforcing the agency's information architecture, policies, standards, and practices in all areas of information technology.
- Develops and maintains enterprise-wide central databases, statistical files, and general access paths, ensuring the quality of information maintained in these data sources.
- Directs Medicare claims payment systems activities, including common working file operation, as well as systems conversion activities.
- Develops application development platform standards and policies for use by internal CMS staff and contractor agents in such areas as applications development and the use of infrastructure resources.
- Manages and directs the operation of CMS hardware infrastructure, including the agency's data center, data communications networks, enterprise infrastructure, voice/data switch, audio conferencing, and other data centers supporting CMS programs.
- Leads the coordination, development, implementation, and maintenance of health care information standards in the health care industry.
- Provides Medicare and Medicaid information to the public, within the parameters imposed by the Privacy Act.
- Performs information collection analyses as necessary to satisfy the requirements of the Paperwork Reduction Act.
- Directs CMS's application development platform systems security program with respect to data, hardware, and software.
- Directs and advises the administrator, senior staff, and components on the requirements, policies, and administration of the Privacy Act.

SOURCE: CMS, 2011, "CMS Leadership, Office of Information Services," website, available at http://www.cms.gov/CMSLeadership/16_Office_OIS.asp, last accessed August 1, 2011.

needed for testing and evaluating demonstrations and innovations; developing enterprise business plans and process requirements for CMS post-PPACA responsibilities; operationalizing files for Medicare, Medicaid, and CHIP administrative data for use in research; and conducting and managing the Research Data Assistance Center, Research Data Distribution Center, and Chronic Condition Warehouse activities.

- Center for Medicare and Medicaid Innovation, which is responsible for identifying and developing new models for payment approaches, clinical care, integrated care, and community health, and for disseminating information about these new models. This center is discussed in more detail below.
- Center for Program Integrity, which serves as CMS's focal point for all national and state-wide Medicare and Medicaid programs and CHIP integrity fraud and abuse issues.
- Office of e-Health Standards and Services, which, in addition to having primary responsibility for developing regulations and guidance materials related to the administrative simplification provisions of the Health Insurance Portability and Accountability Act (HIPPA; P.L. 104-191) is also responsible for developing and coordinating implementation of a comprehensive e-health strategy for CMS, and for coordinating and supporting internal and external technical activities related to e-health services. This office also ensures that individual initiatives tie to overall CMS and federal e-health goals and strategies, promoting and leveraging innovative component initiatives, and facilitating cross-component awareness of various e-health projects.
- Office of Clinical Standards and Quality, which serves as the focal point for all quality, clinical, and medical science issues and policies for CMS. It also provides leadership and coordination for the development and implementation of a cohesive, agency-wide approach to measuring and promoting quality and leads the agency's priority-setting process for clinical quality improvement.
- Office of Legislation, which provides leadership and executive direction within CMS for legislative planning to address the organization's agenda, and also tracks, evaluates, and develops provisions of annual legislative proposals for Medicare, Medicaid, the Clinical Laboratory Improvement Act (P.L. 90-174), HIPPA, and related statutes affecting health care financing, quality, and access. It does so in concert with other CMS components, the Department of Health and Human Services, and the Office of Management and Budget, advancing the legislative policy process through analysis, review, and development of health care initiatives and issues.
- Office of Federal Coordinated Health Care, which is responsible for managing the implementation and operation of the office as mandated in

section 2602 of the Patient Protection and Affordable Care Act,[8] to ensure more effective integration of benefits under Medicare and Medicaid for individuals eligible for both programs and to improve coordination between the federal government and the states in the delivery of benefits for such individuals. This office is also responsible for facilitating the testing of various delivery system, payment, service, and/or technology models to improve coordination of care, control costs, and improve the experience of beneficiaries eligible for both Medicare and Medicaid, and for performing policy and program analysis of federal and state statutes, policies, rules, and regulations affecting the dual-eligible population.

CMS IT Internal and External Bodies and Oversight Review Groups

As part of the agency's IT operations CMS uses several internal and external bodies and oversight review groups, including the following:[9]

- CIO's Technical Advisory Board (CTAB), comprising technical representatives from the CMS business components who collectively serve as a communication and vetting body for CMS target architecture products and standards, responsible for reviewing technical impact analyses performed by OIS regarding requests to add, change, or delete a product or standard in the Technical Reference Architecture (TRA). The CTAB weighs the overall technical impact of the request against the CMS business need(s) and makes related recommendations to the CIO. The CTAB also recommends to the CIO any changes that are deemed necessary to evolve CMS's enterprise architecture in response to business needs, technology innovations, or industry trends.
- The Information Technology Investment Review Board (ITIRB) provides business-driven leadership to CMS's IT operations and development to ensure that CMS's IT resources are efficiently deployed to meet short-, medium-, and long-term business demand. The board deliberates and provides recommendations to the Office of the Administrator regarding expenditure of appropriated IT capital investment funds.
- Executive steering committees (ESCs) serve as management authorities, providing senior management leadership for the successful and timely completion of IT projects to meet business needs. Each ESC provides management oversight and guidance to project owners/managers and project officers and makes final decisions on the priority, risk,

[8]The Patient Protection and Affordable Care Act of 2010 (P.L. 111-148).

[9]CMS, 2011, "Oversight and Review Groups," document, available at http://www.cms.gov/SystemLifecycleFramework/Downloads/OversightReviewGroups.pdf, last accessed August 1, 2011.

and potential impact of changes to project objectives, operations, quality, schedule, performance, budget, and other resources related to the IT project. The CMS ITIRB has established nine separate ESCs to provide oversight and direction to the IT projects within their designated investment portfolios. The ESCs monitor the progress and status of the IT projects and adjust, if necessary, both project and business needs and priorities to ensure the success of IT projects in achieving CMS's mission.

- The Configuration Control Board (CCB) is responsible for evaluating and approving or disapproving proposed changes and for ensuring implementation of approved changes.
- The Data Integrity Board (DIB) oversees and coordinates CMS's implementation of matching programs, which are computerized comparisons of two or more systems of records, or of a system of records with non-federal records, for the purpose of (1) establishing or verifying eligibility or compliance with law or regulations of applicants or recipients/beneficiaries, or (2) recouping payments or overpayments. The matching programs also encompass matches involving federal personnel or payroll records.

In addition to these groups, CMS has established the Integrated IT Investment & System Life Cycle Framework (ILC), a comprehensive set of policies, processes, procedures, standards, artifacts, reviews, and resources that provide guidance for IT investment and system life-cycle management. The ILC provides a foundation and supporting structure designed to aid in the successful planning, engineering, implementation, maintenance, management, and governance of CMS IT investments and system life-cycle projects.

Other Federal Information Technology Efforts and Initiatives

CMS's work is conducted in the broader context of the Department of Health and Human Services and the federal government as a whole. Accordingly, IT initiatives, guidance, and mandates in those contexts also bear on CMS's IT efforts. For example, the White House's recent *25 Point Implementation Plan to Reform Federal Information Technology Management*[10] from the U.S. chief information officer calls for a series of concrete steps to improve how IT projects are staffed, managed, and completed and urges the elimination of barriers to agencies' ability to leverage IT

[10]Vivek Kundra, 2010, *25 Point Implementation Plan to Reform Federal Information Technology Management*, December 9, Washington, D.C.: White House, Office of the Chief Information Officer, available at http://www.cio.gov/documents/25-Point-Implementation-Plan-to-Reform-Federal%20IT.pdf, last accessed July 28, 2011.

for creating a more efficient and effective government. The plan recommends steps in five major domains: shared solutions, program management, aligned budgeting and acquisition, improved accountability, and increased engagement with industry. The committee believes that embracing the spirit of these steps, in particular in the areas of strengthening program management and streamlining government and improving accountability, may assist CMS in achieving needed cultural and organizational transformation.

A number of the strategic goals and objectives contained in the 2010-2015 HHS Strategic Plan[11] may also assist CMS's cultural and organizational transformation—in particular, strategic goals 4 and 5:

- Strategic Goal 4—Increasing efficiency, transparency, and accountability of HHS programs, including ensuring program integrity and responsible stewardship of resources, fighting fraud and working to eliminate improper payments, using HHS data to improve the health and well-being of the American people, and improving HHS environmental, energy, and economic performance to promote sustainability.
- Strategic Goal 5—Strengthening the nation's health and human services infrastructure and workforce, through investing in the HHS workforce to meet America's health and human services needs today and tomorrow, ensuring that the nation's health care workforce can meet increased demands, enhancing the ability of the public health workforce to improve public health at home and abroad, strengthening the nation's human services workforce, and improving national, state, local, and tribal surveillance and epidemiology capacity.

The committee believes that the adoption of these strategic goals and objectives within CMS will assist in the agency's cultural and organizational transformation needed to support its expanding roles and responsibilities.

The recent report from the President's Council of Advisors on Science and Technology (PCAST), *Realizing the Full Potential of Health Information Technology to Improve Healthcare for Americans: The Path Forward*,[12] offered another view on how to use IT to improve health care quality and control costs. The Office of the National Coordinator (ONC), under the auspices of both the Health IT Policy Committee and the Health IT Standards Committee, created the PCAST Report Workgroup to study and make

[11]U.S. Department of Health and Human Services, "Strategic Plan and Priorities: Strategic Plan 2010-2015," available at http://www.hhs.gov/secretary/about/priorities/priorities.html, last accessed July 20, 2011.

[12]See http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-health-it-report.pdf.

recommendations regarding the PCAST proposals.[13] Thus far that group has recommended that ONC and CMS move cautiously in addressing the report's proposals.[14] That report was very forward looking in terms of what CMS might do, and addressing its recommendations may not be possible in the short term or in the incremental and iterative fashion espoused in Chapters 2 and 3 of this report.

DEFINING THE INFORMATION TECHNOLOGY-ENHANCED ENTERPRISE AT CMS

In the committee's view, CMS will have to transform itself into an organization where IT represents a core enterprise-wide concern, strategically, organizationally, and operationally. Concrete examples of how such a transition will manifest itself include increased general knowledge across CMS about the types of data that are available, enhanced ability to access the data, and deepened knowledge of how to use CMS IT systems to implement programmatic changes.

As discussed in Chapters 2 and 3, CMS should develop a comprehensive strategic technology plan to help drive its enterprise architecture framework. To succeed in that effort will require that the agency develop and sustain leadership that will motivate the cultural and organizational change needed to maintain and meet the goals of the strategy over time. IT should become an enterprise-wide lead operation with horizontal and vertical integration across programs, processes, and priorities. IT strategic planning accordingly requires ownership and engagement at the highest levels of the organization and at all stages, including creation, communication, and evolution. These efforts cannot be driven effectively by OIS alone.

Aligning Strategic Goals and Resources to Achieve Transformation at CMS

A common challenge in business is overcoming the disassociation of an IT department's goals from the goals of the organization. Whereas other units in an organization are charged with fulfilling various facets of the organization's mission, IT departments are typically expected to carry out disparate, often conflicting tasks handed over from the other units in isolation. Simultaneously, an organization's IT department must

[13]PCAST Report Workgroup, website, available at http://healthit.hhs.gov/portal/server.pt/community/pcast_workgroup/3354/home/21741, last accessed September 10, 2011.

[14]ONC work group, website, available at http://www.modernhealthcare.com/article/20110418/NEWS/304189988, last accessed September 10, 2011.

maintain an infrastructure—including implementing network and other hardware upgrades and updating or modifying existing software—necessary to produce reliable and secure IT services. That ongoing maintenance is often costly and can conflict with the IT tasks coming from the other units, competing for both fiscal and human resources. If all such tasks cannot be accomplished in the desired time frames, an IT department may be viewed by business units as unresponsive, failing to serve its "customers," and obstructing progress.

Unlike the case in industry, many of CMS's most important strategic goals are set legislatively, with mission and timeline mandated across all CMS units, including IT. These external mandates (a notable recent example being implementation of Medicare Part D) often require enormous projects that stretch all units within CMS to their limits. CMS IT has done a commendable job of meeting these challenges over the years, delivering entirely new IT systems within legislative deadlines despite often formidable demands. Despite successes in meeting these large challenges, CMS has typically done so by tackling them as fairly independent efforts (such as developing de novo the systems necessary to effect Medicare Part D). Unfortunately, the agency has often been trapped in operational fire fighting. The committee's impression is that even though CMS might want to operate more strategically, time, resources, or structural support have been insufficient for CMS to expand its scope much beyond day-to-day operations.

The committee believes that, going forward, the approach of meeting each new demand independently falls short in two important areas. First, new legislative mandates such as HITECH and PPACA are requiring more integrated solutions—not the least because they will require pulling data from many sources, sharing common customers (such as health care providers), and minimizing redundancy and variances in data collection (for example, the quality measures in independent programs should be aligned). Because of the complexity of such undertakings and the intra-agency coordination and integration required, strategic alignment is needed not just between the responsible CMS unit and IT, but also across many CMS units. Second, many needs are not mandated explicitly yet remain critical. These include the ongoing needs of CMS business units and also CMS's IT infrastructural and maintenance needs, including modernization and transformation (as discussed in Chapter 3). OIS is responsible for the detailed tasks required to maintain a reliable and secure set of services—a responsibility that requires alignment between IT and the other units because the choice of future infrastructure depends not just on the current infrastructure, but also on the available resources and the requirements of the entire organization.

Chapter 2 describes the need for CMS to have a comprehensive strate-

gic technology plan to help mitigate these issues. From an organizational and cultural perspective, an important part of the solution will be clear, continuing, and effective communication, not only at an operational level but also at a strategic level, between IT, senior leadership, and the other CMS units. A first step is making IT leaders members of the relevant internal committees—including those that oversee and set directions for CMS at the highest levels. To be clear, the committee believes that the CIO, with that label or another suitable senior title, needs to be part of the top management team for the agency, at the table when major operational and strategic decisions are made and contributing fully to the broad management of CMS. Both planning meetings about long-term strategic goals and day-to-day planning meetings regarding business requirements and the feasibility of particular IT solutions should involve and expect the contributions of IT leadership. As with development of the strategic technology plan as a whole, these processes must be iterative as experience is gained and as new requirements arise. Otherwise, in the absence of IT leadership, major strategic decisions could be made without recognizing the IT roles or challenges involved, leading either to missed opportunities or to poorly informed plans that reflect unrealistic expectations on the IT staff or infrastructure.

Enhancing the Strategic Role of Informatics and Innovation at CMS

The Role of Biomedical and Health Informatics at CMS

The field of biomedical informatics (the scientific discipline[15]) and its application in clinical and public health settings (health informatics[16]) are highly relevant to the current and future needs of CMS and its IT planning, design, and implementations.[17] This is particularly true as CMS transitions from its traditional role as a massive insurance payer to an organization that is also heavily involved with clinical data, their capture and integration, quality, safety, and EHR incentive payments. Although on occasion individuals with informatics backgrounds have worked at CMS, adequately defined mechanisms have not been available for bringing their expertise to bear in the design, planning, or implementation

[15]Biomedical informatics is the interdisciplinary field that studies and pursues the effective uses of biomedical data, information, and knowledge for scientific inquiry, problem solving, and decision making, motivated by efforts to improve human health. See also Edward H. Shortliffe and James J. Cimino (eds.), 2006, *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, New York: Springer.

[16]Health informatics is applied research and practice in the implementation of systems to support clinical care or public health, applying the principles of biomedical informatics.

[17]Hereafter the committee refers to the underlying science and its application in clinical care and public health simply as informatics.

processes for IT systems, and they have had little impact on the internal culture of the organization with regard to IT and its strategic role. It is time for CMS to build up a dedicated capacity in the informatics field, with clear roles in IT design and strategic planning.

An informatics organization within CMS would play a variety of key roles, both organizationally and culturally, if properly staffed and engaged in the work of the agency. Although the precise organizational model is best determined by the agency, the committee believes that it needs to be an explicit, identified entity rather than represented abstractly across the CMS centers and offices. Informatics experts bring both technical knowledge of computing and communications and a health professional orientation (many are also trained in one of the health professions, and all have substantial exposure to the processes, workflow, sources of error, and culture of health care). Owing to the nature of their training, informatics experts typically bring significantly more expertise for coping with issues of quality enhancement and patient safety than do those with more traditional IT expertise. Informaticians are a new breed of health professionals imbued with the culture of health care who understand the decision-making processes in health care environments and the subtleties of real-world applications, culture, workflow, and ultimately quality and safety issues, and their understanding is enhanced by a technology perspective that a quality-focused group alone might not bring.

As is the case in academic health centers and large health systems that have invested heavily in the development of informatics expertise, the informatics group should interact closely with the IT organization, but it should serve a design, planning, and cultural function, helping to define, maintain, and execute an enterprise-wide informatics agenda that is closely coupled with the organization's overall mission and goals.[18]

Synergies between informatics experts and the IT organization have been broadly recognized, leading, for example, to the creation of the chief medical information officer (CMIO) role (optimally an informatics function) to complement the IT operation (and the CIO) at hospitals and in health systems.[19] Informatics organizations generally exist separately

[18]M.E. Frisse, 1992, "Medical Informatics in Academic Health Centers," *Academic Medicine* 67(4):238-241; F.B. Cerra, C.W. Delaney, and L.A. Watson, 2011, "Academic Medicine Is Doing More in Health Information Technology Than Meets the Eye," *Academic Medicine* 86(4):407; J. Ash, 1997, "Organizational Factors That Influence Information Technology Diffusion in Academic Health Sciences Centers," *Journal of the American Medical Informatics Association* 4(2):102-111.

[19]The Informatics Review, Chief Medical Information Officer, available at http://www.informatics-review.com/jobdesc/sample3.html, last accessed September 10, 2011; Modern Healthcare: What Does a Chief Medical Information Officer Do?, available at http://www.informatics-review.com/jobdesc/sample3.html, last accessed September 10, 2011.

from the related IT organization and typically provide internal support in the form of analytical capabilities, taking into account the broad mandates and functions of an organization and tying them together both tactically and strategically. Informatics experts often play a central role in educating other staff about technical and information-management issues, and they help to bridge the technical and business functions of the enterprise.

Informatics expertise will be valuable across a range of current and potential activities at CMS such as data standardization efforts, the development of means for analyzing comparative effectiveness, the evaluation of accountable care organizations, the usability of systems by stakeholders and others, the support of national-scale initiatives for clinical data (and perhaps other health data) liquidity (for example, interoperability of electronic health records), and so on. More generally, informatics experts at CMS should be able to contribute to the development of strategy and should staff several strategic initiatives. It would be appropriate for an informatics organization within CMS to have relationships with both OIS and the Center for Medicare and Medicaid Innovation (see below) since it serves an innovation role and supports operations, while also focusing on strategic planning and evaluation.

Chapter 3 presents a meta-methodology for CMS's modernization or transformation of its business and information ecosystems over the coming years. As noted there, one element in that process, which extends beyond current work on data modeling, will be a consistent health information model that can guide all work and ensure uniform conventions to support system integration and standardization, such as the Veterans Health Administration health information model that underlies a broad array of health-related applications and services.[20] The development and maintenance of a health information model that meets the needs of CMS and its stakeholders is a complex informatics task that highlights the need for informatics expertise within CMS. Despite the many other roles for informatics experts at CMS, the committee sees the development and maintenance of a consistent health information model as a particularly important one. It implies a coherent approach to terminology, semantic relationships, and both abstract and specific vocabulary for a large number of content matters that lie at the heart of CMS's current and future work as a data-driven organization.

[20]U.S. Department of Veterans Affairs, "The VHA Health Information Model," website, available at http://www.va.gov/vhim/, last accessed July 20, 2011.

The Role of the CMS Innovation Center

The creation of the CMS Innovation Center has provided an excellent opportunity for CMS to propose, test, and evaluate new concepts that may influence the directions of the organization for years to come. Congress created the Innovation Center under the PPACA, giving the center the authority and direction to "test innovative payment and service delivery models to reduce program expenditures, while preserving or enhancing the quality of care" for those who receive Medicare, Medicaid, or CHIP benefits. Although the emphasis has been on new payment models that could enhance quality while reducing costs, the center's authorization, which is supported by a total of $10 billion through FY2019, includes investigation of new models of service delivery.

Given the role of IT and specifically of health care informatics in enabling new and more effective service delivery models, the committee observes that the Innovation Center, while studying the payment process and incentives, could also be investigating innovative IT to support the organization's mission. This prospect becomes particularly intriguing in light of the new PPACA mandates that CMS move into areas related to quality, equity, safety, and maintaining the public's health. Acquiring clinical data in addition to claims data, either detailed data or aggregated data, creates tremendous challenges that are increasingly well understood by those involved in the development of regional health information organizations (RHIOs) or health information exchange (HIE) organizations. Such entities are addressing data exchange for purposes of direct patient care, not just secondary uses. Although CMS does not necessarily have to duplicate their broad efforts on a national scale, there is much to be learned from the RHIO and HIE experiences to date. At the same time, CMS has to decide how best to respond to the new mandates for gathering clinical indicators, and the Innovation Center could play a key role in exploring those options.

Decisions regarding what data to collect, in what form, and with what implications for interfacing and integration (for example, with electronic health records or regional repositories) require not only policy makers but also experts on clinical data management, the advent of genomic medicine, electronic health records, standards, integration, data protection and security, privacy, and models for secondary data use and stewardship. This is the purview of the field of informatics, and the Innovation Center would benefit greatly from enhancing its portfolio of projects and available expertise in this area, ideally through relationships with a new CMS informatics unit as suggested above.

The committee recognizes that the Innovation Center is a new entity and still developing its agenda and organizational relationships. Although it is important to avoid overburdening this important group with dif-

fusely broad demands or expectations, the inclusion of some elements of the suggestions offered here may be important to specify early on, before the Innovation Center's culture, personnel, and budget are focused solely on innovative payment models.

STRATEGY, GUIDING PRINCIPLES, AND ROADMAP FOR CULTURAL AND ORGANIZATIONAL TRANSFORMATION AT CMS

CMS is in the information business; its changing roles and mission make this ever more true. The successful transformation of CMS toward an IT-enhanced enterprise requires that the CMS leadership manage the following organizational and cultural elements in such a way that they are aligned and carefully optimized to work together. Comparatively frequent changes in leadership make it difficult to build and execute a strategic IT plan. This is particularly challenging when there is no strong backbone of enterprise strategic planning that tightly integrates IT strategic planning with business needs. For IT to be deployed strategically, particularly given the frequent changes at the top level, CMS business-led IT governance is needed whereby the OIS guides the agenda but the CMS business leaders are also responsible for the actions and outcomes. Ensuring that CMS business leaders are directly involved in sorting out IT priorities for CMS contributes to their understanding of what business and IT alignment means to them as well as the consequences of action or inaction and funding constraints.

- *Active engagement of leadership.* CMS IT transformation is not solely a technical issue but is also a critical business issue and thus must be owned by CMS top management. Emphasized above in this chapter are the roles of CMS leadership in the modernization and transformation of CMS business and information ecosystems.
- *Business-driven IT governance.* IT governance should include not only the current focus of technical review but also IT investment prioritization and funding and should aim to take advantage of the benefits of shared services and enterprise architecture. Business-driven IT governance for CMS is discussed in more detail below.
- *Strategic technology plan*. CMS's organization and culture must be aligned to support the execution and evolution of the strategic technology plan in an incremental manner as recommended in Chapters 2 and 3.
- *Skill sets*. Some of the in-house skill sets that need to be strengthened or newly acquired for the successful modernization and transformation are discussed below.
- *Management of change*. The meta-methodology described in

Chapter 3 implies changes not only in the way CMS manages IT but also in the way CMS interacts with its stakeholders. Suggestions for effective management of change are discussed below.

Information Technology Governance

Given the strategic and operational importance of IT modernization and CMS transformation, the highest levels of the organization must be involved in the governance of the transition, actively guiding and managing it using a meta-methodology as described in Chapter 3. Governance refers to the principles, processes, and organization that direct and manage IT resources.[21] At its core, governance involves determining the distribution of the responsibility for making decisions, the scope of the decisions that can be made by different organizational functions, and the processes to be used for making decisions. Internal and external stakeholders should be engaged in defining governance structures.

CMS can strengthen its IT governance efforts by addressing (and regularly reconsidering) the following general IT-governance related questions:[22]

- Who sets priorities for IT and how are those priorities set?
- Who is responsible for implementing information systems plans, and what principles will guide the implementation process?
- What organizational structures are needed to support the linkage between IT and the rest of the organization? [In particular, how is management authority assigned regarding data, projects, budgets, strategies, and so on?]
- How are IT responsibilities distributed between IT and the rest of the organization and between central and "local" IT groups?
- How is the IT budget developed?
- What principles will govern [data, applications, and core technologies]?

High-level governance should ensure that the efforts toward business and information ecosystems modernization and transformation achieve CMS's goals. In addition governance should provide direction with respect to major changes to core processes, resolve policy issues raised by the implementation, address problems encountered during the transition, and approve, if necessary, the commitment of additional resources. IT governance must be developed to oversee the full set of CMS IT strategies, policies, and operations. The governing body that serves this function

[21]Erica Drazen and D. Staisor, 1995, "Information Support in an Integrated Care Delivery System," *Healthcare Information and Management Systems Society Proceedings* 2:191-199.

[22]John P. Glaser, 2002, *The Strategic Application of Information Technology in Health Care Organizations*, 2nd Ed., San Francisco, Calif.: Jossey-Bass.

should be led by senior business leadership at the agency, and members of the body should be drawn from the senior leadership team.[23]

CMS currently has several IT governance bodies such as the Executive Steering Committee, Information Technology Investment Review Board, and Configuration Control Board. These bodies are important. However, they focus largely on technical, tactical, and operational issues. Because modernization and transformation efforts are critically important to the agency, IT governance bodies should be structured so that senior leadership, including the CMS administrator, are well aware of the needs and efforts underway, are willing and able to integrate the planning into their business thinking, and are well-informed so as to take advantages of the opportunities that such planning provides.[24]

In addition, subordinate governance bodies (reporting to the overall governance body) should be established to strategically direct and manage critical components of the IT strategy. On the basis of the discussion in Chapters 2 and 3 and related recommendations, component-specific bodies should be established for the following:

- Shared services,
- An enterprise architecture framework, and
- A health information model.

Shared service governance determines which services should be shared among whom to achieve which benefits, defines the services, and ensures that services evolve appropriately. Enterprise architecture and health information model governance defines the architecture and model, monitors conformance, and evolves the architecture and model as appropriate. The enterprise architecture governance defines the enterprise architecture framework, including all relevant standards, monitors conformance to standards, and evolves the framework.

Each of these component bodies will need means and authority (including budgets, authority in personnel actions, and exercise of management decision-making authority) to enforce governance decisions.

Effective IT governance requires a tight linkage with the overall organizational strategy. The agency's Center for Strategic Planning and its Office of Research Development and Information will play important roles. The implementation of a major IT application invariably occurs as

[23]Peter Weill and Jeanne W. Ross, 2004, *IT Governance*, Harvard Business School Press, available at http://hbswk.hbs.edu/archive/4241.html.

[24]For more on characteristics and behaviors of senior leaders who are actively engaged and successful in the strategic use of IT, see M. Earl and D. Freeney, 2000, "How to Be a CEO for the Information Age," *MIT Sloan Management Review* 41(2):11-23.

a component of a larger process in the management of change. Hence IT governance is inextricably linked to the strategies and operations of the organization, and governance should be responsible for making such IT-centric decisions as the following:[25]

- How do we link our IT strategy to our overall strategy?
- How much should we spend on IT?
- Which business processes should receive our IT dollars?
- Which IT capabilities need to be organization-wide?
- How good do our IT services really need to be?
- What security and privacy risks will we accept?
- Who do we hold accountable for the success of an IT project?

The specific relationships between IT and the business side have to be worked out through this governance process. In general, CMS's business side would lead process transformation and establish what it needs from IT (including service-level agreements), and indeed this is what the process outlined in Chapter 3 affords. From time to time IT might be asked to lead a specific initiative within the overall agenda for transformation. A key component of establishing governance is determining which individuals and functions will make which decisions and the mechanics of the governance process. The governance function for each of these efforts could be structured as a CMS IT governance committee or could become a responsibility of an existing CMS senior leadership forum. Regardless, given the importance of the transformation, the CMS business leadership should be an integral part of the IT governance function.

Organizations cannot accomplish the large-scale modernization or transformation of core business and information ecosystems without the effective utilization of outside expertise. This expertise takes several forms:

- Expertise in the management of change that can assist the organization in preparing its members for changes in roles, processes, working relationships, and goals;
- Process redesign experience that can help the organization think through how to design its new processes and how to determine what data it needs;
- Project management experience with projects of comparable, scope, size, and complexity;

[25]Jeanne W. Ross and Peter Weill, 2002, "Six IT Decisions Your IT People Shouldn't Make," *Harvard Business Review* 80(11):84-91.

- Technical assistance to enable the organization's information technology staff to master the new technology being introduced; and
- Staff augmentation management to provide the person-power necessary to do a sizeable portion of the work that accompanies the implementation of a large system; existing organizational staff rarely have large amounts of "free time" to devote to such an initiative.

In particular, CMS would benefit from the counsel of leaders from organizations in the public and private sectors that have effected significant IT-enabled organizational transformations. CMS will encounter issues and challenges for which the advice of others would be very important. An advisory panel of these leaders or similar entity should be developed and structured so that they can develop a deep understanding of CMS and its challenges as well as its broader stakeholder communities. Building in the ability to foster informed and frank exchanges of ideas should be emphasized.

CMS should not underestimate the difficulty of the transformation and the value of learning from the experiences of others.

Critical Skill Sets

The implementation of the recommendations stemming from the discussion in Chapters 2 and 3 will require introducing new skills into CMS and strengthening existing skills. In addition to reflecting the importance of informatics skills and the value of the CMS Innovation Center, the IT organization should be augmented and changed in some key areas.

CMS's existing IT staff are talented and skilled, and they have demonstrated an impressive ability to implement complex systems under significant time pressures. Moreover they continue to manage well a massive IT operation. To enable an effective response to the near and intermediate demands of payment reform and other responsibilities placed on CMS, these competencies must be strengthened. Central to the CMS agenda is the application of IT and data to help improve the delivery of care. Enhancing staff expertise in data management practices and the application of those practices to health care, as well as in health services research and the performance of that research in an electronic health record environment, will be important.

Recognizing the critical role played by having a well-conceived, well-executed, and well-supported global information ecosystem and design is a critical competency of CMS. The roles of the technology strategy function and chief information officer should be strengthened, and they should be responsible for guiding and managing the enterprise technical architecture and contributing to the strategic and tactical decisions

basic to the approach outlined in Chapter 3, including shared services and process and information model strategies and plans. These efforts should be aligned with the agency's strategic planning office as part of the strengthened interactions between business and operation needs and IT. Architectural, engineering, project management, security, and support staff will all have critical roles to play.

Information technology continues to undergo extraordinary innovation. This innovation occurs not only in the technology but also in the uses of the technologies and surrounding business models that enable rapid technology adoption. CMS would benefit from having a stronger technology scanning and surveillance function to regularly assess the potential applicability of new information technologies to CMS requirements.

In the committee's view CMS IT currently excels at managing its huge portfolio of subcontracts, which provide the bulk of CMS's IT services. The recruitment, retention, and training of IT professionals within CMS must reflect not only technical skill requirements but also organizational, management, and planning capabilities. In addition to its internal staff, CMS has a large contracting contingent that performs the bulk of the day-to-day work in systems development, operations, maintenance, claims processing, and so on. Of course the cultural shifts the committee is urging here will have to occur in the contracting community as well. Appropriate leadership and strategic guidance from within the agency are critical to ensuring that the needed cultural changes propagate through CMS's contractor community as well.

The ability to manage subcontractors is critical, but so is the ability to manage and respond to internal CMS organizational and cultural issues. Although soliciting and receiving advice from contractors about technology can be useful, the ultimate decisions about which technologies should be explored, evaluated, and deployed must reside with CMS and should be based on the judgments of people whose principal obligations are to CMS and the success of its missions and who can draw on deep insights and expertise in IT. Key decisions need to be made by the agency itself. Contractors may have their own institutional agendas, which may or may not always align with CMS's agenda, or they may simply have an understandably narrower view than in-house staff. In order for CMS to make decisions that are as sound as possible, the decisions must be rooted in a strong grasp of CMS issues and considerations, and also in a strong grasp of technology.

A number of positive factors should be preserved during the transformation. IT personnel's current commitment to the CMS mission and the welfare of the public is notable. In the committee's view, the group has a commitment to getting the job done, having succeeded on a number of difficult projects like Medicare Part D. The group has shown unusual

resourcefulness and inventiveness in executing such projects, overcoming the challenges of outdated software and enormous complexity and largely recognizing the need for positive organizational and cultural changes such as those outlined in this report.

IT skills and knowledge will also be needed by non-technical managers in an IT-enhanced enterprise. IT is at the heart of virtually every CMS business interaction, process, and decision. Managers can thus no longer afford the luxury of relinquishing participation in IT decisions. CMS managers must become knowledgeable participants in IT decisions, understanding the interdependency between its business strategy, organizational strategy, and IT strategy. In addition, managers have to understand the basics of how IT is managed in CMS, in particular, enterprise architecture, IT governance, IT funding and value management, and the moral and ethical implications of using information and information systems.

Management of Change

Effective management of change requires attention not only to the formal design of the organization (business processes, roles, and incentives) but also to the political (power bases) and cultural (shared values and beliefs and traditions) aspects of the organization. These three areas—formal design, political considerations, and culture—need to change in concert for significant organizational change to be effective. Organizational change need not be precipitated by the implementation of an information ecosystem, but invariably new information ecosystems are required to enable the change.[26]

Managing significant change has several necessary aspects:[27]

- *Leadership*. Change must be led. Leadership, often in the form of a group of leaders, will be necessary to:
  - —Define the nature of the change;
  - —Communicate the rationale for and approach to the change;
  - —Identify, procure, and deploy necessary resources;
  - —Resolve issues and alter direction as needed;
  - —Monitor the progress of the change initiative; and
  - —Lead by example.

Given the magnitude of the changes proposed for CMS, the process

[26]S.L. Woerner and J.W. Ross, 2007, "Tackling the Organizational Change Issues in IT Projects," research briefing, Volume VII, Number 3D, Center for Information Systems Research, Massachusetts Institute of Technology, December.

[27]Peter G.W. Keen, 1997, *The Process Edge*, Boston: Harvard University Press.

of change should be led by senior business leadership at the agency, and all members of the CMS leadership and management structure should be engaged as leaders of change.

- *Language and vision.* The staff who are experiencing a change must understand the nature of the change. They must know what the world will look like (to the degree that this is clear) when the change has been completed, how their roles and work life will be different, and why making this change is important. A failure to communicate the importance of a chosen vision elevates the risk that staff will resist the change needed to realize that vision and through subtle and not-so-subtle means cause the change to grind to a halt, or worse, negatively affect current operations. For example, CMS can establish a vision of being at the forefront of the country's efforts to transform health care delivery.
- *Connection and trust.* Achieving connection means that leadership takes every opportunity to present the guiding vision throughout the organization. Leaders may use department head meetings, all-staff meetings, one-on-one conversations in the hallway, internal publications, and e-mail to communicate and to keep communicating the vision. These communications need to invite feedback, criticism, and challenges. The members of the organization need to trust the integrity, intelligence, compassion, and skill of the leadership. Trust is earned or lost by everything that leaders do or do not do. The members must also trust that leaders have thoughtfully come to the conclusion that a difficult change has excellent reasons behind it and represents the best option for the organization. An organization's members are willing to rise to a challenge, often to heroic levels, if they trust their leadership. Trust requires that leaders act in the best interests of the staff and the organization and that leaders listen and respond to the organization's concerns.
- *Motivating factors.* An organization's members must be motivated to support significant change. At times, excitement about the vision will be a sufficient incentive. Alternatively, fear of what will happen if the organization fails to move toward the vision may serve as an incentive. Although important, neither fear nor enthusiasm is necessarily sufficient. If an organization's members will lose their jobs or have their roles changed significantly, education that prepares them for new roles and or new jobs must be offered.
- *Planning, implementing, and iterating*. Change should be planned. Plans describe the tasks and task sequences necessary to effect a change. Tasks, which can range from redesigning forms to managing the staged implementation of information ecosystems to retraining staff, must be allotted resources, and staff accountable for the performance of the tasks must be designated. Because few organizational changes of any magnitude are fully understood beforehand, problems will be encountered during

implementation in addition to the problems that occur, for example, when task timetables slip and task sequences are interrupted or tasks themselves disrupted. Iteration and adjustment will be necessary as an organization handles problems and learns about glitches in new processes and workflows.

These basic steps in managing large-scale change will require the focused attention of the CMS leadership and the involvement of all CMS staff and its contractors.

Factors That Contribute to Successful Organizational Transformations

Transformation of the role and contribution of IT at CMS requires that the leadership skillfully manage the necessary changes in processes, culture, and technology. In addition to this overall effort CMS should establish management practices that will enable it to more effectively guide the changes and manage the new organization throughout its transformation. Moving an organization from the systems that currently support core operations to a new system is a difficult, expensive, and risky undertaking. The organization must make this transition in a way that does not jeopardize its ability to function from day to day.

Several factors come into play and are discussed below along with specific management practices that contribute to successful transformations.

Leadership Conviction and Sustained Commitment

The leadership of the organization must be convinced that a transition is necessary. This conviction can result from the creation of a new strategy that clearly highlights the need for new organizational activities, processes, and data needs—needs that can be addressed only by an extensive replacement or modernization of an information ecosystem. Such a conviction can also result from a fear by leadership that the current systems will be unable to support the future demands made of the organization, raising the specter that the organization will be unable to fulfill its mission because of its information systems' inability to keep up.

Conviction on the part of leaders is necessary because these transitions invariably take years to accomplish, involve a significant investment, subject the organization to extensive change, and place the organization at risk that the transition will not go well. These transitions inevitably involve some disruption to the organization and the transition will encounter problems, some of them serious problems, several times during the transition; leadership conviction will be needed to ensure that the organization stays the course during rough periods. Frequent leader-

ship changes over the course of a transformation, such as those experienced by CMS, are an impediment to success.

Resources Sufficient for the Task

The transition of major application systems and infrastructure has costs that include the new system infrastructure, external implementation assistance, and the time and management attention of organization members who have been assigned the tasks of guiding and designing the new system. The investment will be non-trivial. But if some of the funds are obtained by taxing current initiatives, demand for new funds may be modest. In addition, in CMS's case, the committee's suggested incremental approach means that the funds would not all be required up front. Experience and the literature show that the initial estimates of resources needed are almost always low because organizations usually fail to accurately estimate the magnitude of the necessary resources and do not anticipate the problems that will be encountered.

Even if internal taxes on programmatic initiatives can be used to help fund larger transition efforts, resources for the transition should be managed separately from routine operating and capital budgets lest line managers be faced with the temptation to borrow funds from the transition effort to address shortfalls in operations budgets. Funding for any piece of these efforts should cover not only the initial capital and operating costs of the implementation but also ongoing operations and maintenance of the new IT applications and infrastructure. Too often in the past the allotted funding has failed to take into account the life-cycle costs of a system once implementation has been completed. Successful transitions can lead to reduced expenses in ongoing operations, but such expenses still need to be accounted for.

Obtaining and protecting resources in an ongoing manner for transition as the incremental work is done is challenging for any large organization, but particularly so for a government agency. If the commitment of resources is anemic, too myopic, unnecessarily stove-piped, or unpredictable, the transformation will not succeed.

Management of Risk

Large-scale transitions are fraught with risk. Invariably, mistakes will be made in the design of new processes. The information systems may not scale or may demonstrate unexpected instability. Project budget and time estimates may be grossly understated. Changes in the organization's external environment may challenge the value or importance of some of the changes particular to a transition.

An analysis of the risks associated with an initiative should be conducted and frequently updated. Such an analysis would identify the more significant risks, develop plans to mitigate risk should it occur, and devise means to track whether a risk is materializing.

5

Anticipating a Data-Centric Future

CMS's role in the U.S. health care mosaic will be pivotal as the nation shifts to improved approaches for organization, payment, consumer engagement, understanding of the bioscience foundations of health, and data management for the provision of quality, equitable health care. This transition will take place over many years, but some key shifts are already underway, with some dimensions being planned while others evolve on their own. At every stage, the capacity to improve decision making throughout the entire system will depend not only on having timely access to data but also on the capacity to transform the raw data first into information and ultimately into intelligence to support future planning and action.

Data warehouses, business intelligence, and data analysis have existed for more than 30 years and have a long history of use in the sciences. The explosive growth of data in all areas of business, science, medicine, and life in general has opened ever greater potential for discovery and understanding through analysis of data. Over the past 20 years the advent of virtual or data-driven science has meant that in some areas it is possible to experiment or discover for the cost of database searches and analysis. Data-driven techniques can have application in medicine and health care in addition to sciences such as astrophysics. For example, if data from longitudinal studies, clinical observations, and other health care activities were made available to researchers, studies of the comparative effectiveness of alternative medicines could be conducted in a fraction of the time and cost required for clinical trials, which are often extremely

limited in terms of the population studied, are expensive, and can incorporate biases.[1]

Another health care trend that has implications for CMS's data-related efforts is the ongoing shift of individual practitioners from solo and/or small group practices into care systems and networks. This realignment of providers and institutions could result in far more payments for bundled services intended to achieve defined outcomes. The efficiency and effectiveness of such an approach will depend on the collection and transfer of a great deal of data.

CMS is in the process of transforming itself to enable a focus on information collection and data management while still fulfilling its traditional mandates, including retrospective payment for health services for segments of the population. Several trends in health care illustrate the broad need for a more data-centric approach, including the diffusion of electronic health records (EHRs), practitioner positioning into care networks, and increased consumer access to and demand for health and medical information.

In aggregate, these trends in health care regarding data will interact in ways to produce both additional work and new requirements for CMS. Although the ultimate result is currently unknowable, the drive to achieve great value for health care for both individuals and populations is not likely to abate anytime soon, especially in light of the demographic pressures and the size of the financial investment the nation is making in health care services.

Data are essential to and underpin nearly all of the efforts CMS is undertaking—and data are an essential driver for the strategic technology plan advocated in Chapter 2, motivate the meta-methodology outlined in Chapter 3, and are a key impetus for the organizational changes discussed in Chapter 4. Gathering these data and sorting out how to make data available and to whom cannot be envisaged adequately until all stakeholders have been engaged and are contributing to an ongoing discussion. Doing that incremental engagement is part of the committee's recommended approach and is essential to the development of mechanisms for future data management as an aspect of CMS's new and changing relationship to data and information. In addition, CMS has to grapple with ensuring that only authorized users have access to data such as personal health information or other individual-level information.[2]

[1]Sharon Begley, 2011, "The Best Medicine: A Quiet Revolution in Comparative Effectiveness Research Just Might Save Us from Soaring Medical Costs," *Scientific American* 305(July):50-55.

[2]While posing technical challenges, the question of who is authorized to access what sorts of data is a policy matter distinct from the technical challenges.

This chapter discusses several ways in which the data and information collected by CMS are used extensively within the agency for purposes such as quality-related efforts, policy analysis, and combating fraud, as well as for informing consumers and managing payments. It also addresses recent legislative mandates for CMS—such as use of CMS information to analyze racial and ethnic disparities so as to contribute to their reduction.

IMPROVING QUALITY

Heightened since the publication of a 2000 Institute of Medicine report,[3] the effort to improve the quality and safety of health care has been fostered by CMS and many other key actors in health care, including insurers, professional associations, accreditation and review groups such as the Joint Commission,[4] the National Committee for Quality Assurance (NCQA),[5] and the National Quality Forum (NQF),[6] and care providers such as physicians and hospitals. Although this effort has been uneven and at a slower pace than hoped for by safety champions,[7] the cumulative effect of several factors—policy maker and academic attention to quality and safety improvement,[8] Medicare payment and reporting incentives such as pay for performance[9] and value-based purchasing, and the proliferation of EHRs, aided by the financial incentives in HITECH—have

[3]Institute of Medicine, 2000, *To Err Is Human: Building a Safer Health System*, Washington, D.C.: National Academy Press.

[4]Joint Commission Center for Transforming Healthcare, 2011, "About the Center," website, available at http://www.centerfortransforminghealthcare.org/about/about.aspx, last accessed August 8, 2011.

[5]National Committee for Quality Assurance, 2011, "State of Health Care Quality Reports," website, available at http://www.ncqa.org/tabid/836/Default.aspx, last accessed August 8, 2011.

[6]National Quality Forum, 2011, "ABC's of Measurement," website, available at http://www.qualityforum.org/Measuring_Performance/ABCs_of_Measurement.aspx, last accessed August 8, 2011.

[7]Mark R. Chassin, Robert W. Galvin, and the National Roundtable on Healthcare Quality, 1998, "The Urgent Need to Improve Health Care Quality," *Journal of the American Medical Association* 280(11):1000-1005.

[8]The Dartmouth Institute for Health Policy and Clinical Practice, 2011, "Dartmouth Atlas of Health Care," website, available at http://www.dartmouthatlas.org/, last accessed August 8, 2011.

[9]CMS, 2011, "IPPS Regulations and Notices," website, available at http://www.cms.gov/acuteinpatientpps/ipps/itemdetail.asp?filterType=none&filterByDID=-99&sortByDID=4&sortOrder=ascending&itemID=CMS1229138&intNumPerPage=10, last accessed August 8, 2011.

created an environment in which the measurement and improvement of health care[10] are better understood now than 10 years ago.

The budgetary imperatives to "bend the cost curve"[11] and the movement for improved quality come together in the Patient Protection and Affordable Care Act (PPACA), which contains numerous initiatives (for example, the promotion of accountable care organizations and the creation of the CMS Innovation Center) intended to result in better, more cost-effective care for Medicare beneficiaries. CMS has substantial responsibility in implementing parts of the PPACA and therefore in creating the standards, reporting mechanisms, payment processes, and data and measurement requirements that will foster these hoped-for improvements in health care for beneficiaries and more broadly for the U.S. population.

Nationwide investment in EHRs and EHR systems—enabled through HITECH—is occurring on such a broad scale that it has the potential to accomplish some sea changes in the information infrastructure of health care delivery across the country and to generate the fine-grain data needed for improved health care delivery. For example, although the focus today is heavily on clinical transactions and data capture, insurance recipients will increasingly have the ability to access information about their health directly through secure patient portals. The day is coming when evidence-based care protocols will support not only decision making by clinicians and patients but also direct enhancements of health care quality and safety for diverse populations and subpopulations through IT-based applications that help ensure quality as care is being delivered rather than focusing on measurement after the fact. The HITECH approach to meaningful use of health information technology also has the potential to allow measurement of the quality of performance without engaging data abstractors, thereby making such assessment much less expensive. However, there are also some limitations that will have to be overcome—including those related to the connectivity of interoperable systems, to systems themselves, to users, and to potential barriers resulting from public policy and regulation. The shift will have clear implications for CMS.

The data provided by the expansion of EHRs deserves special notice. Although policy analysts (in, for example, the Medicare Payment Advisory Commission (MedPAC), the Congressional Budget Office, the Office for Management and Budget, and research-oriented "think tanks") have used Medicare claims data for decades in proposals for improving the

[10]Atul Gawande, 2007, *Better: A Surgeon's Notes on Performance*, New York: Metropolitan Books.

[11]"Obama Talks Health Care with Fred Hiatt," 2009, *Washington Post*, July 22, available at http://www.washingtonpost.com/wp-dyn/content/article/2009/07/22/AR2009072202522.html, last accessed August 1, 2011.

health care system, the more robust data contained in EHRs now allow for richer analyses of the health care provided to populations than those analyses based on data previously available. Because the results of medical procedures, medications, and treatments can be measured and analyzed by using the information contained in EHRs, providers such as integrated medical groups and major hospital systems, which have led the way in implementing EHRs, are now better able to improve care processes by, for example, introducing evidence-based "alerts" and guidance for physicians and nurses during the actual provision of medical care. In addition, having electronic access to real-time health and medical data can advance people's capacity to manage health care.

CMS's role in the context of today's data explosion is multifaceted. CMS has responsibility for establishing and evaluating the meaningful-use standards and incentive payments legislated in HITECH. It establishes standards for quality reporting, such as the "core measures" required in the value-based purchasing mandated by the PPACA. Through accreditation processes, CMS can measure how well providers meet the "conditions of participation" in Medicare. It can set the criteria by which quality improvement efforts (such as "medical homes") are evaluated by patient-specific clinical data. The possible ways that such data in electronic records can be used to improve measurement and payment processes are numerous, and CMS will have to determine the preferred options within its broader implementation of PPACA.

This transition will induce heavy demands for the capture of accurate, meaningful data that account fully for the health status of those served by health care delivery organizations. To manage this accounting, CMS is likely to focus increasingly on the full range of social determinants of health status, moving beyond those that relate solely to health care technology and medical interventions. An example of the complexity of this effort can be seen with respect to the use of billing data for quality measurement; although some relevant information can be extracted, that data alone is not enough. Future efforts are likely to require ongoing attention to high-resolution information in the form of natural language or formalized data flows realized through an evolution of ontologies, terminologies, and, ultimately, relevant standards that can help to ensure that meaning is not lost in the translation of data to understanding.

Clinical outcomes data are currently used throughout the health care system to monitor, improve, and report on the quality of care in a wide variety of settings. Increasing use of EHRs, and the potential associated increase in available clinical data, offer both great potential benefits in terms of measuring and monitoring quality—and potential risks in terms of cost, acceptability, and protection of patient privacy. CMS will be tasked not only with using outcomes data to evaluate the care of its own benefi-

ciaries but also with building links to information systems with data on the care given to others so that comprehensive evaluations of the quality of care provided for individuals and groups can be developed, both inside and outside government programs.

There are a number of measures of basic quality for which data could be collected on all providers. Additional information from certain geographic regions or practice settings might then be collected, if problems arise, to help illuminate the source of a problem. The committee is aware of the assumption of some that CMS should plan to collect information on patients following what Diamond and colleagues call the "dominant paradigm" for handling population health data: "gather copies of all the detailed information one needs, normalize the information once one has it, and then run queries against that data storehouse."[12] Such an approach—if applied to CMS's role in analyzing and monitoring health care quality, equity, and safety—has drawbacks in terms of cost and the potential for violations of privacy, and may reduce the acceptability of EHRs for many practitioners. In addition, such an approach is relatively rigid, requiring advance knowledge of what data are needed and implying a single national approach to improvement of quality.

Others argue for a distributed analytic system that, once in place, could be used to increase monitoring in settings where problems have been identified while maintaining only minimum information on practice groups that are functioning well. A distributed system could be deployed rapidly in support of local efforts at containment of public health emergencies such as the Severe Acute Respiratory Syndrome epidemic. Such an approach, in which information remains at the source where it was collected, is being used increasingly for purposes as disparate as public health surveillance and cancer research. Of particular interest for CMS's purposes is the Distributed Research Network (DRN) supported by the Agency for Health Care Research and Quality (AHRQ), which is designed to support composite data analysis on the safety and effectiveness of health care.[13] Distributed approaches have disadvantages as well, such as decreased access to data for some stakeholders and potentially less comprehensive analytic capabilities.

Separate from how data are collected and stored are the many opportunities clearly afforded in the area of quality and safety by the development of effective analytics. Information from payers other than Medicare

[12]Carol C. Diamond, Farzad Mostashari, and Clay Shirky, 2009, "Collecting and Sharing Data for Population Health: A New Paradigm," *Health Affairs* 28(2):454-466.

[13]Andrew J. McMurry, Clint A. Gilbert, Ben Y. Reis, Henry C. Chueh, Isaac S. Kohane, and Kenneth D. Mandl, 2007, "A Self Scaling, Distributed Architecture for Public Health, Research and Clinical Care," *Journal of the American Medical Informatics Association* 14(4):527-533.

and Medicaid could be analyzed in combination with CMS information to provide a much more comprehensive view of the performance of a practitioner, group, or system. Information from sources other than individual clinical records (such as registries with data on the incidence of exposure to disease) can, when appropriate, be included in the analysis to give a clearer picture of trends in uses of medical care. In planning its future quality management strategies, CMS will have to resolve for itself and in collaboration with its stakeholders what strategies for handling such data it will adopt.

Outside researchers, many of whom are investigating quality-related research questions, currently make extensive use of the data sets generated by CMS. Although in comments received by the committee the cost of obtaining CMS data was raised as a concern, the chief complaint was that currently almost 2 years elapse before the data can be accessed. For example, the most current data available on the frequently used MEDpar file (hospital discharges) is from 2009, with the release of data from 2010 expected in October 2011 as of this writing. Data in the "access to care" section of the Medicare Current Beneficiary Survey, another area of particular interest to many, is also available only through 2009, with the 2010 update scheduled for the summer of 2012.[14]

Among the reasons for these delays are that claims data from any insurance program are not complete until sometime after the date of service. In Medicare's case this "claims lag" is fairly short, with 98 percent of claims submitted within 3 months,[15] although even so, a data set for any given year still lacks some claims at the end of the first quarter of the following year. To permit earlier release of claims, CMS could use a variety of strategies, such as providing an interim data set of the most-used information on a quarterly basis with the limitations clearly spelled out. Many of the modernization steps discussed throughout this report will make data integration easier (for example, integrating the reports from Medicare Managed Care with those from fee for service), leading toward earlier release. Much earlier release of survey data, which should be technically possible even now, will support the best use of this important information.

[14]See http://www.resdac.org/Tools/TBs/TN_015_CMS%20Data%20Availability_508%20.pdf, last accessed June 14, 2011.

[15]Department of Health and Human Services, CMS, 2011, "Medicare Program; Medicare Shared Saving Program: Accountable Care Organizations," Proposed Rule, *Federal Register* 76(67; April 7):19554.

CONSUMER ACCESS TO CMS INFORMATION

CMS's first effort at consumer-oriented, public reports on the quality of care first began approximately 15 years ago with dialysis units. Those results are available at "Dialysis Compare"[16] (with individual data sets available on data.gov), and the effort is widely regarded as successful. It is not clear that consumers have used the information extensively—but providers pay attention and work to meet the standards. Dialysis, however, has two characteristics that make it unique: (1) Medicare is, for all practical purposes, the only payer, and so data on Medicare beneficiaries reflect the full experience of dialysis centers, and (2) dialysis has a limited number of easily measurable objective outcomes.

CMS's efforts have expanded to other consumer-oriented "report cards," and the CMS website now also has sections, known as "Hospital Compare"[17] and "Nursing Home Compare,"[18] that make use of information collected in surveys as well as reporting of quality measures and "never events" (adverse outcomes that ought not to have happened, such as wrong-site surgery). There are limitations to the information's utility, because hospitals and nursing homes serve many non-Medicare beneficiaries, and so even the most precise analysis of care received under Medicare may not reflect overall performance. However, as CMS's ability to use more granular data from sources outside the organization becomes more robust, these reports have the potential to become more accurate and, consequently, more useful.

Although the mechanisms for consumer engagement are somewhat unclear, more groups and individuals will seek greater access to CMS data and information. It is reasonable to assume that the equivalent of citizen engagement in health services and health policy research will increase, analogous to social networking in other domains, as will online dialogue relating to the output of such efforts.[19]

POLICY ANALYSIS

One of the most important secondary uses of CMS data on health care encounters is the analysis of current spending patterns and projections of future spending. The number of reports that make use of CMS encounter data is vast; two of the most important are the annual trustees' report

[16]See http://www.medicare.gov/Dialysis/.

[17]See http://www.hospitalcompare.hhs.gov.

[18]See http://www.medicare.gov/NHCompare/.

[19]Schumpeter, 2011, "Saving Britain's Health Service: The NHS Needs to Learn from Innovations in the Rest of the World," *The Economist*, June 16.

(which evaluates the current status of the trust funds[20]) and the "data book" (published at least annually by the MedPAC[21]). The trustees' report focuses on projections of future costs of the Medicare program, and the data book is a more detailed analysis of changes in patterns of use and spending over time.

These documents use information from a variety of sources; the most significant of these are (1) the Medicare Current Beneficiary Survey, which is a continuous, multipurpose survey of a nationally representative sample of aged, disabled, and institutionalized Medicare beneficiaries, and (2) the various "market baskets" developed by an economic forecasting firm[22] to serve as the basis for the annual updates of payments to hospitals and other providers.

CMS and MedPAC are not the only government and quasi-government agencies using encounter data—other groups, such as the Congressional Budget Office, the Government Accountability Office, and HHS's Office of the Inspector General, also depend on encounter data for their analyses and predictions. The Independent Payment Advisory Board, established by the PPACA, will also require Medicare data in order to fulfill its mission to help reduce the rate of growth in Medicare costs without affecting coverage or quality.

As the Medicare actuaries note in their discussion of the data in the trustees' report, there are elements in the information, such as delayed decisions on the exact amounts paid to specific hospitals, which lead to small error rates, which are multiplied when extended projections are developed.[23] It is therefore particularly important that the same sources of information be available to independent researchers in order to facilitate well-informed debate regarding the future of the Medicare and Medicaid programs.

[20]The Boards of Trustees of the Federal Hospital Insurance and Federal Supplementary Medical Insurance Trust Funds, 2011, *2011 Annual Report of the Boards of Trustees of the Federal Hospital Insurance and Federal Supplementary Medical Insurance Trust Funds*, available at https://www.cms.gov/ReportsTrustFunds/downloads/tr2011.pdf, last accessed July 21, 2011.

[21]Medicare Payment Advisory Commission (MedPac), 2010, *A Data Book: Health Care Spending and the Medicare Program*, June, available at http://www.medpac.gov/documents/Jun10DataBookEntireReport.pdf, last accessed July 21, 2011.

[22]Currently Global Insights, headquartered in Lexington, Massachusetts.

[23]Boards of Trustees, 2011, "Actuarial Methodology," *2011 Annual Report*, p. 150.

REDUCING HEALTH DISPARITIES

Evidence confirms the reality of health disparities experienced by minority Medicare, Medicaid, and other beneficiaries served by CMS.[24] These individuals constitute an ever-increasing percentage of the total—for example, nearly 20 percent of Medicare beneficiaries and 60 percent of all individuals receiving assistance through Medicaid.[25] Persistent health inequities[26] among population groups in the United States are not only unacceptable as characterized by the Institute of Medicine in its landmark 2003 report,[27] but also costly,[28] contributing substantially to the nation's spiraling health care costs.

CMS's key role in the transformation of the nation's health care system has been noted throughout this report. The significance of that role in addressing health disparities is also critical. It will not be possible for CMS, and the nation as a whole, to cross the "quality chasm"[29] and achieve the transformation of the nation's health system if the needs of all populations are not addressed in an equitable manner.

The committee is aware that strategies to reduce health disparities are receiving high-priority attention by CMS, HHS, and the U.S. Congress.[30]

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[24]See, for example, David C. Goodman, Dhannon Brownlee, Chaing-Hua Chang, and Elliott S. Fischer, 2010, "Regional and Racial Variation in Primary Care and the Quality of Care Among Medicare Beneficiaries," from the Dartmouth Atlas Project, available at http://www.dartmouthatlas.org/downloads/reports/Primary_care_report_090910.pdf, last accessed August 1, 2011; and Tracy Onega, Eric J. Duell, Xun Shi, et al., 2010, "Race Versus Place of Service in Mortality Among Medicare Beneficiaries with Cancer," *Cancer* 116(11):2698-2706.

[25]Kaiser Family Foundation, "Distribution of Medicare Enrollees by Race/Ethnicity, States (2008-2009), U.S. (2009)," available at http://www.statehealthfacts.org/comparebar.jsp?ind=297&cat=6, accessed August 1, 2011; and Kaiser Family Foundation, "Distribution of the Nonelderly with Medicaid by Race/Ethnicity, States (2008-2009), U.S. (2009)," available at http://www.statehealthfacts.org/comparebar.jsp?ind=158&cat=3&sub=42, last accessed August 1, 2011.

[26]Agency for Healthcare Research and Quality, 2010, "Disparities in Healthcare Quality Among Racial and Ethnic Minority Groups: Selected Findings from the 2010 National Healthcare Quality and Disparities Reports," available at http://www.ahrq.gov/qual/nhqrdr10/nhqrdrminority10.pdf, last accessed August 1, 2011.

[27]Institute of Medicine, 2003, *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care,* Washington, D.C.: The National Academies Press.

[28]Thomas A. LaVeist, Darrell J. Gaskin, and Patrick Richard, 2009, *The Economic Burden of Health Inequalities in the United States,* Report by the Joint Center for Political and Economic Studies, available at http://www.jointcenter.org/sites/default/files/upload/research/files/The%20Economic%20Burden%20of%20Health%20Inequalities%20in%20the%20United%20States.pdf, last accessed August 1, 2011.

[29]Institute of Medicine, 2001, *Crossing the Quality Chasm: A New Health System for the 21st Century,* Washington, D.C.: National Academy Press.

[30]U.S. Congress, 2009, "Addressing Health Care Disparities," *Congressional Record,* Sec. 1946, November 19, S11734.

It has also noted the findings of agencies and other observers, both within and outside government, that the availability of data, disaggregated by race, ethnicity, primary language, and other factors, is essential for the accomplishment of this goal. Available evidence indicates, however, that adequately categorized, complete, and comprehensive data, collected by systematic and effective means, currently are not readily available at CMS.

CMS race/ethnicity data are of uneven quality with respect to accuracy and completeness, as documented by reports produced by HHS, IOM, and other agencies, as well as testimony received by the committee. For example, although the Social Security Administration (SSA) modified its data collection practices in 2008 to follow the categorization standards promulgated by the Office of Management and Budget (OMB), the updated procedures apply only to new Social Security and Supplemental Security Income claims and replacement number and lost card applications. These revised OMB standards, which provide for detailed race/ethnicity categories, do not apply to applications filed before 2008 or to applications received under SSA's Enumeration at Birth process, which precludes the collection of race and ethnicity data because of states' restrictions.

Recent developments, however, are encouraging. Although CMS's report to Congress as required under the Medicare Improvements for Patients and Providers Act (MIPPA) of 2008 was not available for the committee's review, it is expected to reflect new and innovative "approaches . . . for identifying and collecting and evaluating data on health care disparities on the basis of race, ethnicity, and gender" as mandated by the MIPPA.[31] CMS's requirement of those receiving EHR meaningful-use incentives to collect data on race, ethnicity, primary language, and other factors is an opportunity to "connect the dots," revealing and tracking health care patterns and trends by population and subpopulation in relation to the quality of services received—not just for CMS beneficiaries but also for a much wider population of health care consumers.

CMS leadership also gave presentations to the committee on the primacy of equity in advancing a health quality agenda.[32] And indeed, the value of these data has been succinctly described by HHS Secretary Kathleen Sebelius, who stated in her March report to Congress: "Improvements in the way data is collected help to pinpoint and address where

[31]Medicare Improvements for Patients and Providers Act of 2008, HR 6331, 110th Congress, 2nd session.

[32]Terris King, CMS Office of Minority Health, 2011, "Health Disparities," presentation to the committee, April 18, Baltimore, Md.

health disparities exist."[33] CMS's role in collecting and reporting race/ethnicity, gender, and other disaggregated health data is critical to the equitable delivery of quality health services to all CMS beneficiaries. Thus CMS's vision, strategies, and priorities for the use of information technology as well as its organizational and strategic technology plans will have to take this role and its requirements into account.

FIGHTING FRAUD

CMS's Center for Program Integrity faces a formidable challenge in dealing with fraud, waste, and abuse within the Medicare and Medicaid programs. The following major elements of criminal fraud were identified for the committee:

- Registration of fraudulent providers and/or suppliers, most commonly involving providers of durable medical equipment;
- Fraudulent use of an existing provider number;[34]
- Fraudulent, duplicative, or excessive billings by an existing provider who is also delivering legitimate services;[35]
- Theft of beneficiary identification; and
- Fraud in which the beneficiary participates (for example, billings for expensive services not rendered, with profits split with the beneficiary).

At present, only a tiny minority of claims are reviewed prior to payment. But as has been noted by both the current administrator of CMS and the secretary of HHS,[36] and as industry experience demonstrates,[37] it is materially more productive and efficient to identify questionable billings in advance of payment. An ability to analyze all claims prior to payment as a basic element in CMS's fraud detection would enable unusual patterns to be identified and holds to be placed on those that are most

[33]Department of Health and Human Services, Office of the Secretary, Office of the Assistant Secretary of Health, Office of Minority Health, 2011, *Report on Minority Health Activities as Required by the Patient Protection and Affordable Care Act, P.L. 111-148,* available at http://www.healthcare.gov/center/reports/minorities03252011a.pdf, last accessed August 1, 2011.

[34]For example, use of a retired physician's identity.

[35]See, for example, Mark Schoofs and Maurice Tamman, 2010, "In Medicare's Data Trove, Clues to Curing Cost Crisis," *Wall Street Journal,* October 25, available at http://online.wsj.com/article/SB10001424052748704696304575538112856615900.html, last accessed August 1, 2011.

[36]See Healthcare Fraud Prevention Summit video, December 16, 2010, available at http://www.stopmedicarefraud.gov/videos/fraudprevention_boston.html, last accessed August 1, 2011.

[37]Bob Shiflet, 2011, "Fraud Detection and Prevention in Large Scale Systems," presentation to the committee, February 17, Irvine, Calif.

suspicious. This identification necessarily depends on techniques of pattern recognition across multiple data sets, including data sets related to claims, providers, patients, and third parties and including government and private data sources. CMS's current information infrastructure was not designed to provide the ability to mine data in a timely fashion, even within a single system, much less across all of them.

Moreover, as certain patterns of fraud or abuse become identifiable and bad actors modify their strategies, CMS will need to continuously modify its approach and responses. As it is notoriously complex to retrofit legacy systems to deliver the agility and flexibility to meet these challenges, new information management and analysis solutions will have to be designed to provide this agility.

To prevent the registration of false providers and suppliers, CMS will have to develop strategies to deal with the 18,000 Part A and B provider enrollment applications and 900 curable medical equipment supplier applications received each month.[38] At present the steps taken to ensure that only genuine providers and suppliers are enrolled include surprise site visits as well as a focus on high fraud areas. External data such as data on location are available on new business concerns. Using a modernized claims payment system, however, it would also be possible to conduct intensely focused pattern analysis of claims submitted by newly enrolled providers to detect outliers with high billing rates that can in turn be subject to on-site inspection. Similarly, pattern analysis of claims submitted by all providers for beneficiaries who have reached retirement age is likely to be productive in terms of identifying unusual and suspicious changes in billing behavior.

The current separation of the Medicare and Medicaid programs allows duplicate billings by the same provider for the same service. Merging that information in ways that allow detection of this sort of duplication would be useful. Using insurance exchanges to correlate data across all plans can also yield information about patterns of fraudulent activity that should make fraud detection more rapid and efficient. The committee heard arguments that reduction of fraud in the Medicare and Medicaid systems might be more easily accomplished through a preventive stance rather than an emphasis on detection and enforcement after fraudulent claims have been submitted.[39] For example, with the increasing adoption of electronic health records, there are improved opportunities for detecting fraud when a patient is being scheduled or seen, or as a fee-for-service

[38]CMS, 2010, "Partner with CMS," website, available at https://www.cms.gov/Partnerships/Downloads/72010NMEPFraudandAbuse508.pdf, last accessed August 8, 2011.

[39]Donald W. Simborg, 2011, "CMS IT and Fraud," presentation to the committee, February 17, Irvine, Calif.

bill is being generated.[40] Similarly, some of the metadata in EHRs could serve to identify patterns that suggest improper billings, such as notes written before the official date of service.

Although it is CMS that faces the onus of dealing with fraudulent claims when they are submitted, and the cost to the nation is generally judged to be enormous, partnerships with other agencies, and particularly the Office of the National Coordinator, may be required to effect some of the needed innovation. Some have argued that EHR vendors should be required to address these issues in their products, which raises the possibility of anti-fraud capabilities being incorporated into future criteria for meaningful-use payments. The Small Business Jobs Act of 2010, passed in September 2010,[41] directs CMS to use predictive modeling and other techniques to identify improper claims and prevent the payment of such claims.[42] CMS began using a new fraud management platform in July 2011.[43] At present, however, the primary focus on fraud and abuse at CMS continues to be in the post-billing payment arena, where CMS has greater control but still faces significant challenges in recognizing fraud before bills are paid, after which funds can be recovered only with great difficulty.

In addition to criminal fraud, The CMS Center for Program Integrity must also monitor a number of complex rules about physician behavior. The anti-kickback statute[44] and the physician self-referral statute[45] forbid activities that may appear innocent to a new provider, such as the offer of a "medical directorship" or other position that involves generous pay-

[40]D.W. Simborg, 2008, "Healthcare Fraud: Whose Problem Is It Anyway?" *Journal of the American Medical Informatics Association* 15(3):278-280; D.W. Simborg, 2011, "There Is No Neutral Position on Fraud!" *Journal of the American Medical Informatics Association* 18(5):675-677.

[41]Public Law 111-240, Small Business Jobs Act of 2010, 124 Stat. 2504, September 27, 2010.

[42]As stated by CMS,

"The Small Business Lending Act, which was signed into law on September 27, 2010, included an anti-fraud provision requiring that CMS implement new software with "predictive modeling," a type of analytical technology that already has been adopted in the credit card industry to identify potentially fraudulent bills. The provision requires CMS to launch a competitive bidding process by January 2011 for predictive modeling software contractors and to begin implementing the technology by July in the ten states with the highest Medicare fraud rates. A key driver to the success of Program Integrity (PI) at CMS is data integration—across programs and across patient, provider, and plan domains." See CMS, 2010, "Modernizing CMS Computer and Data Systems to Support Improvements in Care Delivery," December 23, available at https://www.cms.gov/InfoTechGenInfo/Downloads/CMSSection10330Plan.pdf, last accessed October 21, 2011.

[43]CMS, 2011, "New Technology to Help Fight Medicare Fraud," press release, June 17, available at http://www.cms.gov/apps/media/press/release.asp?Counter=3983, last accessed September 12, 2011.

[44]Within the Medicare and Medicaid Patient Protection Act of 1987, 42 U.S.C. §1320a-7b.

[45]Section 1877 of the Social Security Act, enacted in 1989, also referred to as the Stark law.

ment for little work. There is every reason to believe that good pattern analysis will be productive here as well.

DATA GOVERNANCE

Chapter 4 discusses issues related to internal data governance in CMS, and previous sections of this chapter discuss the potential utility that comes with the enormous amount of data that CMS already has, as well as data that will be generated in the future and will involve specific governance issues. As CMS prepares for a data-centric future, a number of questions will merit careful consideration. This section describes some of them, but the list not intended to be exhaustive.

- *What is the scope of the data that will be available?* The scope can range from national-level summary data to data with granularity at the level of states, counties, cities, individual institutions, specific providers, or even individual patients.
- *What is the nature of the data to be provided?* The data could be billing codes or could include overview-level clinical summaries. There might even be such specificity as clinical details and short-term outcomes. Even more specific would be data on long-term outcomes and the follow-up regarding patient status in the months or years after care, or long-range data on lifetime cumulative health status.
- *Who will have access to the data?* Although CMS itself and other payers or their proxies (for example, insurance companies, state Medicaid agencies, and so on) are among those that are likely to have first-order access, there will also be interest on the part of the providers and others from whom the data on quality and cost-effectiveness data are collected. In addition, as discussed in Chapter 1, an even broader range of potential data users includes academic researchers, public interest groups, certification bodies, and disease-focused societies that have an interest in CMS data. CMS might even choose to post some data sets (with suitable privacy protections) on data.gov and make them accessible to anyone.
- Different access and use models will have very different governance models. Access to the data of CMS and other payers would require relatively simple agreements and access authorization and authentication. Opening up data to broader groups such as researchers might require institutional review board approval to examine limited data sets. Wide public access has the potential to be exciting—opening up the possibility of a health information economy by allowing anyone to develop innovative analytic measures from the data—but would also raise concerns about such things as the residual identifiability of individual-level data, biased competitive use of the data, and so on. Such broad disclosure

would also allow CMS to share the responsibility to define the "right" derived data with other analysts. This could reduce CMS's own administrative costs, reduce the cost of data to potential users, and permit the growth of profitable businesses to do useful analyses.

- *How are the data organized?* Data could be stored centrally within a CMS repository or distributed in some federated manner that keeps the data closer to their source. There are of course tradeoffs involved in whether and how CMS collects and stores detailed clinical data. An in-depth discussion of this question is beyond the scope of this report—but such choices have clear implications for CMS's business and information ecosystems, and so the committee outlines some of these issues briefly.

Benefits to a centralized approach could include:

—The comprehensive ability to measure detailed outcomes;

—Support of large-scale research on comparative effectiveness;

—Public and institutional access to unbiased summary data; and

—Potential for consumers to have direct access to their own integrated data, experience with cases similar to their own, alternative treatments, and so on.

Offsetting these benefits are:

—Technical challenges of operating a national data warehouse for all clinical data;

—Creation of a prime target for security threats; and

—Political challenges related to the role of government with regard to such data.

There are more issues to be sorted out than these, but such tradeoffs will have to be considered carefully.

Other organizational issues include whether the data are left in heterogeneous forms or transformed into a common form on the basis of a consensus set of standards or ontologies, and whether any standards or ontologies extend to the representation of metadata.[46] Finally, the desired timeliness of data releases may have to be balanced against the desire for increased utility that will come with transformation into a common format.

- *Who is in charge of providing the data?* This responsibility could be located within CMS or organized along the lines of a consortium. The responsibility for privacy protections—which may be the largest public

[46]An example of the rationale for the use of metadata would be what was recommended by the President's Council of Advisors on Science and Technology in its December 2010 report to the President, *Realizing the Full Potential of Health Information Technology to Improve Healthcare for Americans: The Path Forward,* available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-health-it-report.pdf, last accessed August 8, 2011.

concern—also bears consideration. Another option is a repository, structured similarly to the National Center for Biotechnology Information.[47]

- *What does CMS expect to gain from providing the data?* In the short term, CMS's provision of data may lead to faster, more efficient versions of today's payment systems, the opportunity for increased scrutiny of the data, and the possibility of innovative analyses by allowing many stakeholders to analyze both their own and others' experiences as reflected in the data. In the longer term, broader access to data may lead to the construction of better models of clinical outcomes and subsequent improved guidelines for the delivery of high-quality and cost-effective care. It could also foster greater competition among providers and provider organizations on price and quality, by making measures available and by allowing organizations to manage care processes to improve their performance in relation to accepted measures.[48]

The increasing use of partnerships may allow CMS to see progress in these various arenas of change without being directly and primarily engaged in them. For example, CMS could engage through contracts with consortia of medical and surgical specialty societies that have valuable registries of data and that can, working with CMS, reduce the direct burden on CMS of doing such work alone. These collaborations will also put a premium on data security.

CONCLUSION

Recent pieces of legislation—including the Medicare Improvements for Patients and Providers Act of 2008, the HITECH provision of the American Reinvestment and Recovery Act, and the Patient Protection and Affordable Care Act—have the potential to improve health care in the United States, and much of that change is data-dependent.

The effective analysis and management of data have the potential to reduce costs, by giving providers the information necessary to choose effective treatments and also by allowing CMS to identify improper payments and prevent fraud; improve overall public health by reducing disparities in treatment and also by rewarding effective outcomes; and empower consumers by providing them with information to manage their own health and also by providing them with information on the quality

[47]This model would have an effect on the organization of the data and involve direct interaction with those that fund these capabilities.

[48]Other possible transformations are outlined in previous sections of this chapter as well as in Institute of Medicine, 2001, *Digital Infrastructure for a Learning Health System: The Foundation for Continuous Improvement in Health and Health Care,* Washington, D.C.: National Academy Press.

of providers. A learning health care system should emerge over time, improving the quality, equity, and safety of care for both individuals and populations.

Achieving these goals will be neither easy nor automatic, but with careful attention to the development of a robust, data-driven environment and culture as described in the previous chapters, it is possible.

Appendixes

A

Statement of Task

The Centers for Medicare and Medicaid Services (CMS) face enormous challenges related to their information systems. They must meet challenging day-to-day operational requirements and make frequent adjustments to their business processes, code, databases, and systems in response to changing statutory, regulatory, and policy requirements. Increasingly, their core mission is expanding from one focused on prompt claims payment to one that is more broadly involved in improving health care quality and efficiency. And all of this is being done with old, and arguably antiquated, information technology even as CMS is increasingly engaged in efforts to modernize the nation's health care information technology.

An ad hoc committee will conduct a study that will, in the foregoing context, lay out a forward-looking vision for the Centers for Medicare and Medicaid Services, taking account of CMS's mission, business processes, and information technology requirements. It will review the current state of CMS's technical infrastructure and systems architecture and current plans for its evolution, and make recommendations to CMS on modernizing its business processes, practices, and information systems to meet today's and tomorrow's demands, including how to build in the flexibility to cope with changing requirements. The study will anticipate ever-broadening mandates for CMS to deal with data on outcomes, performance, and clinical procedures—perhaps even extending to electronic health records themselves—and requirements for interacting directly with beneficiaries, both to manage claims and to manage health. It will also

consider the financial and human resources necessary to implement this modernization.

The study will take place in 2 phases. The first phase, drawing largely on a workshop (centered on the current CMS landscape and emerging strategy to match its information technology to changing mission requirements), will result in an interim report to be issued 6-9 months after the project start. The second phase, drawing on the workshop and additional briefings, site visits, and committee deliberations, will result in a final report to be issued by the end of the project.

B

Briefers to the Committee

JULY 19, 2010, COMMITTEE MEETING

Julie Boughn, Centers for Medicare and Medicaid Services (CMS), Office of Information Services

JULY 23, 2010, COMMITTEE MEETING

Julie Boughn, CMS, Office of Information Services
Tony Trenkle, CMS, Office of Information Services

SEPTEMBER 27-28, 2010, WORKSHOP AND COMMITTEE MEETING

John Bertko, LMI Consulting
Donald Berwick, CMS, Administrator
Jonathan Blum, CMS, Center for Medicare
Julie Boughn, CMS, Office of Information Services
Peter Budetti, CMS, Center for Program Integrity
Cathy Carter, CMS, Office of Information Services
Henry Chao, CMS, Office of Information Services
Alan Constantian, CMS, Office of Information Services
Kelly Croft, Social Security Administration, Systems
Jack Ebeler, Health Policy Alternatives
Amy Hall, CMS, Office of Legislation
Karen Jackson, CMS, Center for Medicare

Ashish Jha, Harvard School of Public Health
Norman Kahn, Council of Medical Specialty Societies
Cindy Mann, CMS, Center for Medicaid, CHIP and Survey & Certification
Karen Matsuoka, Brookings Institution, Engelberg Center for Health Care Reform
Vincent Mor, Brown University
Farzad Mostashari, Department of Health and Human Services, Office of the National Coordinator for Health Information Technology
Teresa Nino, CMS, Office of External Affairs and Beneficiary Services
Anthony Rodgers, CMS, Center for Strategic Planning
Michelle Snyder, CMS, Operations
Robert Tagalicod, CMS, Office of External Affairs and Beneficiary Services
Marilyn Tavenner, CMS, Office of the Administrator
Penny Thompson, CMS, Center for Medicaid, CHIP and Survey & Certification
Tony Trenkle, CMS, Office of Information Services

NOVEMBER 10-11, 2010, COMMITTEE MEETING

Anthony Rodgers, CMS, Center for Strategic Planning
Michael Shabot, Memorial Hermann Healthcare System

JANUARY 13-14, 2011, SITE VISIT AT CMS BALTIMORE HEADQUARTERS

Cynthia Anderson, CMS, Office of Information Services
C. Ryan Brewer, CMS, Office of Information Services
Frank Cipolloni, CMS, Office of Information Services
Lori Maatta, CMS, Office of Information Services
Ray Pfeiffer, CMS, Office of Information Services
Vish Sankaran, CMS, Office of the Administrator
Penny Thompson, CMS, Center for Medicaid, CHIP and Survey & Certification
Ronald Topper, CMS, Office of Information Services
Janet Vogel, CMS, Office of Financial Management
Carol Young, CMS, Office of Information Services

FEBRUARY 17-18, 2011, COMMITTEE MEETING

Christine Cassel, American Board of Internal Medicine
Chris Cruz, Medi-Cal

Larry Dickey, Medi-Cal
Thomas Donovan, New York State Department of Health, Office of Health Insurance Programs
John Halamka, Caregroup
George Isham, Health Partners Minnesota
James Johnson, The Standish Group
Anthony Rodgers, CMS, Center for Strategic Planning
Vish Sankaran, CMS, Office of the Administrator
Robert Shiflet, Bank of America
Donald W. Simborg, Consultant
Randy Teach, Comprehensive Blood and Cancer Center

APRIL 18-19, 2011, COMMITTEE MEETING

Julie Boughn, CMS, Office of Information Services
Jennifer Boulanger, CMS, Office of Legislation
Cathy Carter, CMS, Office of Information Services
Ashley Corbin, CMS, Office of Information Services
Jane Fountain, CMS, University of Massachusetts, Amherst
Sally Good-Burton, CMS, Office of Information Services
Debbie Hattery, CMS, Office of Clinical Standards and Quality
Mark Hogle, CMS, Office of Information Services
Terris King, CMS, Office of Minority Health
Diane Kovach, CMS, Office of Information Services
Mary Agnes Laureno, CMS, Center for Program Integrity
Peter Lee, CMS, Center for Medicare and Medicaid Innovation
Maria Martino, CMS, Office of Legislation
Paul McGann, CMS, Office of Clinical Standards and Quality
David Nelson, CMS, Center for Program Integrity
Todd Park, Department of Health and Human Services
Michael Reinhold, CMS, Office of Clinical Standards and Quality
Elizabeth Richter, CMS, Center for Medicare
William Saunders, CMS, Office Information Services
Tony Trenkle, CMS, Office of Information Services

C

Biosketches of Committee Members and Staff

Edward H. Shortliffe, *Chair,* is the president and chief executive officer (CEO) of the American Medical Informatics Association (AMIA), the informatics professional association based in Bethesda, Maryland. He is also adjunct professor of biomedical informatics at Columbia University. Previously he was a professor of biomedical informatics at the University of Texas Health Science Center in Houston (2009-2011) and at Arizona State University (2007-2009). From March 2007 to May 2008, Dr. Shortliffe served as the founding dean of the Phoenix campus of the University of Arizona's College of Medicine. Before that he had been the Rolf A. Scholdager Professor and chair of the Department of Biomedical Informatics at Columbia College of Physicians and Surgeons in New York City (2000-2007) and professor of medicine and of computer science at Stanford University (1979-2000). After receiving an A.B. in applied mathematics from Harvard College in 1970, he moved to Stanford University, where he was awarded a Ph.D. in medical information sciences in 1975 and an M.D. in 1976. During the early 1970s, Dr. Shortliffe was the principal developer of the medical expert system known as MYCIN. After internal medicine house-staff training at Massachusetts General Hospital and Stanford Hospital between 1976 and 1979, he joined the Stanford internal medicine faculty, where he served as chief of general internal medicine and associate chair of medicine for primary care and was the director of an active research program in clinical information systems and decision support. Dr. Shortliffe is an elected member of the Institute of Medicine

of the National Academies and the American Society for Clinical Investigation. An elected fellow of the American College of Medical Informatics and the American Association for Artificial Intelligence, he is also a master of the American College of Physicians. He is the editor in chief of the *Journal of Biomedical Informatics* and serves on the editorial boards for several other biomedical informatics publications. In addition, he received the Grace Murray Hopper Award of the Association for Computing Machinery in 1976 and the Morris F. Collen Award of the American College of Medical Informatics in 2006, and he has been a Henry J. Kaiser Family Foundation Faculty Scholar in General Internal Medicine. Dr. Shortliffe has authored more than 300 articles and books in the field of biomedical computing and artificial intelligence.

Michael L. Brodie is chief scientist of Verizon Services Operations at Verizon Communications, one of the world's leading providers of communications services. Dr. Brodie works on strategic information technology opportunities and challenges to deliver business value from emerging technologies and practices in large-scale, distributed operational environments. He is concerned with the "big picture," including business, economic, application, and technical aspects of information ecosystems, core technologies, and integration, with an active involvement in the semantic Web and the holistic view of Web sciences. Dr. Brodie holds a Ph.D. in databases from the University of Toronto; has authored more than 160 books, chapters, and articles; and has presented more than 150 keynotes and invited lectures in more than 30 countries. He is an adjunct professor, National University of Ireland, Galway; an adjunct research fellow, Digital Ecosystems and Business Intelligence Institute at Curtin University of Technology, Perth, Australia; and the chair of advisory boards for three institutions—Semantic Technology Institutes International, Vienna, Austria; Digital Enterprise Research Institute, National University of Ireland; and the Semantic Technology Institute, Innsbrück, Austria. He is also a member of several advisory boards—for the European Research Consortium for Informatics and Mathematics; the School of Computer and Communication Sciences, École Polytechnique Fédérale de Lausanne, Switzerland; Web Science Champion for the Web Science Trust; and the European Union's Information Society Technologies 5th, 6th, and 7th Framework Programmes. Dr. Brodie is a reviewer for the European Research Council and is on the editorial board of several research journals. He has served on the National Research Council's Committee on Technical and Privacy Dimensions of Information for Terrorism Prevention and other National Goals, the VLDB (Very Large Databases) Endowment, and the Client Advisory Board, Forrester Research, Inc.

Don E. Detmer is the medical director for advocacy and health policy for the American College of Surgeons, professor emeritus and professor of medical education in the Department of Public Health Sciences at the University of Virginia School of Medicine, and a visiting professor at the College of Healthcare Information Management Executives, University College of London. He is the chair of the board of MedBiquitous, associate editor of the American Medical Informatics Association's (AMIA's) *Standards Standard,* and a director of the Corporation for National Research Initiatives. He is a member of the Institute of Medicine (IOM), a lifetime Associate of the National Academies, a recipient of the IOM's Walsh McDermott Medal for lifetime contributions, and a fellow of the American Association for the Advancement of Science, American College of Medical Informatics, American College of Surgeons, and American College of Sports Medicine (emeritus). Dr. Detmer is the immediate past president and CEO of AMIA and a past chair of the IOM Membership Committee, the IOM's Board on Health Care Services, the National Library of Medicine's Board of Regents, and the National Committee on Vital and Health Statistics. He is also the founder and a current member of the Blue Ridge Academic Health Group. Dr. Detmer sat on the Strategic Plan Work Group of the Policy Advisory Committee to the Office of the National Coordinator for Health Information Technology. His M.D. is from the University of Kansas, and his M.A. is from Cambridge University, United Kingdom. His education and training include work at the University of Kansas, Johns Hopkins University, the National Institutes of Health, Duke University, IOM, and Harvard Business School. He has held faculty appointments at the University of Wisconsin-Madison, the University of Utah, the University of Virginia, and Cambridge University. He served as vice president for health sciences at the University of Utah and the University of Virginia. He chaired the IOM committee that produced the computer-based patient record reports of 1991 and 1997 and was a member of the committees that produced the IOM reports *To Err Is Human: Building a Safer Health System* and *Crossing the Quality Chasm: A New Health System for the 21st Century.* Dr. Detmer's research interests include national and international health information and communications policy, quality improvement, administrative medicine, vascular surgery, the education of clinician-executives, and leadership of academic health sciences centers.

John R. Dyer is currently dividing his time between health care consulting to information management companies and a family business based in Central America involved in coffee, real estate, and cemetery and investment portfolio management. He is president and a consultant at Jarrett Associates, Inc. From January 2007 to August 2009, Mr. Dyer was the deputy commissioner for operations and chief operating officer (COO)

of the Food and Drug Administration (FDA) in the U.S. Department of Health and Human Services (HHS). Mr. Dyer managed the overall day-to-day operations of the agency. He served as the COO at the Centers for Medicare and Medicaid Services in HHS from 2004 to 2006. He led the implementation of the Medicare Modernization Act, which provided a new Medicare prescription drug benefit to 43 million eligible Medicare beneficiaries. Mr. Dyer held executive positions with the Social Security Administration as the senior advisor to the commissioner (2000), principal deputy commissioner and chief information officer (1995-2001), and chief financial officer (1988-1994). Mr. Dyer is a graduate of the University of Notre Dame and holds a master's degree in public health from the University of Michigan. He is the recipient of four Presidential Rank Awards and numerous other awards both from government and the private sector.

John Glaser is the CEO of Siemens Healthcare. Before joining Siemens he was vice president and chief information officer of Partners HealthCare System, Inc. Previously, he had been vice president for Information Systems at Brigham and Women's Hospital. Prior to serving at Brigham and Women's Hospital, Dr. Glaser managed the Healthcare Information Systems consulting practice at Arthur D. Little, Inc. Dr. Glaser was the founding chair of the College of Healthcare Information Management Executives (CHIME) and is past president of the Healthcare Information and Management Systems Society (HIMSS). He has been a member of the board of the American Medical Informatics Association and is the former president of the eHealth Initiative Board and a fellow of HIMSS, CHIME, and the American College of Medical Informatics. He was awarded the John Gall Award for Healthcare CIO of the Year. CHIME established a scholarship in his name, and he was elected to the Healthcare CIO Hall of Fame. Partners HealthCare has received several industry awards for its effective and innovative use of information technology. Dr. Glaser has published three books on the strategic application of information technology in health care. He holds a Ph.D. in health care information systems from the University of Minnesota.

Laura M. Haas is an IBM fellow and has been the director of computer science at IBM Almaden Research Center since 2005; she also serves as a "catalyst" for ambitious research across IBM's worldwide research laboratories. Previously, Dr. Haas was responsible for Information Integration Solutions (IIS) architecture in IBM's Software Group after leading the IIS development team through its first 2 years. She joined the development team in 2001 as the manager of DB2 UDB Query Compiler development. Before that, Dr. Haas was a research staff member and manager at the Almaden laboratory for nearly 20 years. At IBM Research, she worked on

and managed a number of exploratory projects in distributed database systems. Dr. Haas is best known for her work on the Starburst query processor (from which DB2 UDB was developed); on Garlic, a system that allowed federation of heterogeneous data sources; and on Clio, the first semiautomatic tool for heterogeneous schema mapping. Garlic technology, married with DB2 UDB query processing, is the basis for the IBM WebSphere Information Server's federation capabilities, while Clio capabilities are a core differentiator in IBM's Rational Data Architect. Dr. Haas is an active member of the database community. She served as vice president of the VLDB Endowment Board of Trustees from 2004 to 2009 and was vice chair of the Association for Computing Machinery's (ACM's) Special Interest Group on Management of Data from 1989 to 1997. Dr. Haas has received several IBM awards for Outstanding Technical Achievement and Outstanding Innovation and an IBM Corporate Award for her work on federated database technology. In 2010 she was recognized with the Anita Borg Institute Technical Leadership Award. She is a member of the National Academy of Engineering and the IBM Academy of Technology, an ACM Fellow, and vice chair of the board of the Computing Research Association. Dr. Haas received her Ph.D. from the University of Texas at Austin and her bachelor's degree from Harvard University.

Blaise Heltai is the principal at genus2 Technology and a general partner at NewVantage Partners, LLC. His focus is on the practical applications of technology to business transformation and product innovation. Dr. Heltai was previously an executive at the FleetBoston Financial Group, where, as the managing director for eBusiness and Corporate eCatalyst, he led the company through a fundamental transformation across all lines of business, in the United States and internationally. Dr. Heltai has also been the customer intelligence executive for Bank of America; was the CEO of fileTRUST, which produced secure online document storage and sharing service; and has held multiple positions at Bell Laboratories and AT&T Consumer Products. There he started by using behavioral methods to predict future demand of telecommunications offerings and ended up leading the development and marketing of 1990s' versions of smartphones, intelligent devices, interactive television, and online services. Dr. Heltai has won numerous awards, including Internet Week's Top 100 of 2001, MassEcomm Top 10 Executives, Microsoft Innovation Award, and Best in Show at the Consumer Electronics Show. He has served on the board of directors of MECA Software, Integrion, and several nonprofit oranizations. He has been on the advisory boards of S1 Corporation, PostX, and FTVentures and is past president of the Massachusetts Innovation and Technology Exchange. He has served on the National Research Council's Committee on the Social Security Administration's E-Government Strat-

egy and Planning for the Future and currently serves on the Social Security Administration's Future Systems Technology Advisory Panel and on the Advisory Committee for the University of Massachusetts College of Mathematics and Natural Sciences. He received his Ph.D. in mathematics from the Stony Brook University in 1984.

George Hripcsak is Vivian Beaumont Allen Professor and chair of Columbia University's Department of Biomedical Informatics, director of Medical Informatics Services for New York-Presbyterian Hospital, and senior informatics advisor at the New York City Department of Health and Mental Hygiene. Dr. Hripcsak is a board-certified internist with degrees in chemistry, medicine, and biostatistics. He led the effort to create the Arden Syntax, a language for representing health knowledge that has become a national standard. Dr. Hripcsak's current research focus is on the clinical information stored in electronic health records. Using data-mining techniques such as machine learning and natural language processing, he is developing the methods necessary to support clinical research and patient safety initiatives. As the director of Medical Informatics Services, he oversees a 7,000-user, 2.5-million-patient clinical information system and data repository. He is currently co-chair of the Meaningful Use Workgroup of the Department of Health and Human Services' (HHS's) Office of the National Coordinator of Health Information Technology, which defines the criteria by which health care providers collect incentives for using electronic health records. Dr. Hripcsak was elected a fellow of the American College of Medical Informatics in 1995 and served on the board of directors of the American Medical Informatics Association (AMIA). As chair of the AMIA Standards Committee, he coordinated the response of the medical informatics community to HHS for the health-informatics standards rules under the Health Insurance Portability and Accountability Act of 1996. Dr. Hripcsak chaired the National Library of Medicine's Biomedical Library and Informatics Review Committee, and he is a fellow of the American College of Medical Informatics and the New York Academy of Medicine. He has published more than 200 papers.

Yeona Jang is a professor of practice at the Desautels Faculty of Management Information Systems of McGill University. Prior to joining McGill University in 2008, she worked as a senior executive and decision maker in companies in industries as widely varying as telecommunications, financial services, utility, and high-tech and information technology (IT) services industries. She led various transformational programs and initiatives in IT strategy, IT-enabled business innovation, strategic use of 6 sigma for business transformation, knowledge management and e-learning, enterprise architecture, software product development, large-scale

systems integration, IT productivity transformation, IT governance, and IT outsourcing management. Her current research focus is on advancing the understanding of IT-to-value pathways to help organizations shape the future and drive changes for greater efficiency and innovation in the 21st-century economy: Not "What worked in the past and how do we repeat it?" but "What's necessary for the future and how do we create it?"

Ralph W. Muller is the CEO of the University of Pennsylvania Health System (UPHS), a $3.3 billion enterprise that includes three owned and two joint venture hospitals, a faculty practice plan, a primary-care provider network, multispecialty satellite facilities, home care, hospice care, and long-term care. His 28-year career in health care administration has set the stage for his extensive knowledge of the multiple and complex challenges faced by today's urban-based academic health systems. Prior to joining UPHS, he was, from 1985 to 2001, the president and CEO of the University of Chicago Hospitals and Health System. In 2001 and 2002, he was a visiting fellow at the Kings Fund in London, United Kingdom. In 1985 and 1986, Mr. Muller also served as the deputy dean of the Division of the Biological Sciences at the Pritzker School of Medicine at the University of Chicago. Previously, he had been budget director at the university. Before joining the University of Chicago, Mr. Muller held senior positions with the Commonwealth of Massachusetts. His career with the Commonwealth included serving as deputy commissioner of the Massachusetts Department of Public Welfare, where he was the operating officer responsible for the state's major welfare programs, including Medicaid. Since the 1990s, Mr. Muller's voice has been at the forefront of the national dialogue and debate on such important health policy issues as the social role of teaching hospitals and medical schools, federal and state payments for patient care and care of the uninsured, and the creation of patient-oriented medical care systems. On the national front, Mr. Muller was a commissioner (2001-2007) of the Medicare Payment Advisory Commission (MedPAC), an independent federal body that advises the U.S. Congress on issues affecting the Medicare program. From 1999 to 2000, Mr. Muller served as chair of the Association of American Medical Colleges (AAMC), the umbrella advocacy organization that represents the interests of the 141 accredited medical schools in the United States and Canada and of the nation's 400 major teaching hospitals. In that role Mr. Muller partnered with the AAMC's leadership to advocate for increased research funding and improvements in medical education, as well as the development of a new coalition of health care providers to improve access to care for the underinsured. Currently, Mr. Muller is chair of the University Healthsystem Consortium, a director of the National Committee for Quality Assurance, and a commissioner of the Joint Commission.

A former chair of the board of the National Opinion Research Center at the University of Chicago, he is a member of the Institute of Medicine of the National Academies and a fellow of the American Association for the Advancement of Science. Mr. Muller received his bachelor's degree in economics from Syracuse University and a master's degree in government from Harvard University.

Leon J. Osterweil is a professor in the Department of Computer Science, co-director of the Laboratory for Advanced Software Engineering Research (LASER), and founding co-director of the Electronic Enterprise Institute, all at the University of Massachusetts, Amherst, where he also served as dean of the College of Natural Sciences and Mathematics from 2001 to 2005. Previously he was a professor in and chair of the Computer Science Department at both the University of California, Irvine, and the University of Colorado, Boulder. He was the founding director of the Irvine Research Unit in Software and the Southern California Software Process Improvement Network. Professor Osterweil's research focuses on the definition, analysis, and iterative improvement of processes. He led the project to develop the Little-JIL process definition language. He has also collaborated with colleagues in leading research projects aimed at defining and analyzing processes in domains such as health care, elections, scientific data processing, software development, and negotiation. His work on processes for the delivery of health care services has resulted in numerous papers demonstrating the ability to identify various kinds of defects and inefficiencies. His work on processes for negotiation has led to the development of the STORM 2 system, which supports interest-based bargaining approaches to negotiation. His work has been supported by a variety of sources, most principally by numerous grants from both the National Science Foundation and the Defense Advanced Research Projects Agency. Professor Osterweil was awarded the Association for Computing Machinery's (ACM's) Special Interest Group on Software Engineering (SIGSOFT) Outstanding Research Award for Lifetime Excellence in Research in 2003 and the ACM SIGSOFT Most Influential Educator Award in 2010. His Ninth International Conference on Software Engineering (ICSE 9) paper was awarded a prize as the most influential paper of ICSE 9, awarded as a 10-year retrospective. Professor Osterweil is a fellow of the ACM. He is a member of the editorial boards of *IEEE Transactions on Software Engineering*, *Software Process Improvement and Practice*, *Automated Software Engineering*, and the *International Journal of Software and Informatics*. Previously he was a member of the editorial boards of the *ACM Transactions on Software Engineering Methods*, *IEEE Software*, and *Software Process Improvement and Practice*. He chaired the National Research Council (NRC) committee that studied strategies for improving electronic

services provision for the U.S. Social Security Administration. Professor Osterweil has presented keynote talks at a variety of meetings, including ICSE 9, at which he introduced the concept of process programming. He has been the program committee chair for such conferences as the ISCE 16; the Second International Symposium on Software Testing, Analysis, and Validation; the Fourth International Software Process Workshop; the Second Symposium on Software Development Environments; and both the Second and Fifth International Conferences on the Software Process. He was also the general chair of the Sixth ACM SIGSOFT Conference on the Foundations of Software Engineering, and of the 28th International Conference on Software Engineering (ICSE 2006). He has consulted for such organizations as IBM, Bell Laboratories, SAIC, MCC, and TRW, and for the Software Engineering Institute's Process Program Advisory Board.

Ruth T. Perot is the managing director of the National Health IT Collaborative for the Underserved (NHIT Collaborative), a public-private-community partnership established to help ensure that underserved, vulnerable communities benefit fully from health information technology initiatives and advances. She is also co-founder and executive director and CEO of Summit Health Institute for Research and Education, Inc. (SHIRE). Since 1997, SHIRE has served as a resource for the attainment of health parity and optimal health for all Americans, with emphasis on communities of color and other vulnerable populations. Ms. Perot has championed the collection and reporting of racial, ethnic, and primary language data to monitor progress toward health equity for all Americans. She also has extensive experience in educating and engaging members of vulnerable populations. With respect to health information technology, her relevant assignments include appointments to the National eHealth Collaborative Membership and Communications Committee and its predecessor, AHIC Successor Inc.; appointment to the Health Information Communication and Data Exchange Taskforce of the State Alliance for E-Health, National Governors Association; and service from 2007 to 2010 as a board-appointed member of the HIMSS Public Policy Steering Committee. In 2010, she served as an advisory council member and presenter for the Brookings Institution's conference addressing data-driven strategies for eliminating health disparities. She also reviewed the Institute of Medicine's report, *Future Directions for the National Healthcare Quality and Disparities Reports.* In addition to her appointment to the CMS Systems Modernization expert panel, Ms. Perot currently advises the Office of the National Coordinator and the Health Resources and Services Administration, Department of Health and Human Services, as an expert panelist addressing the impact of health information technology on underserved communities and those with health disparities. Ms. Perot is a graduate of

Oberlin College and received a Master of Arts in Teaching degree from the Harvard Graduate School of Education. Currently a fellow of the National Academy of Social Insurance, she is also a recipient of the Congressional Black Caucus Health Braintrust's Healthcare Hero Award and Families USA's Consumer Advocate of the Year Award.

Helen L. Smits is an independent consultant. She was the deputy administrator and chief medical officer of the Health Care Financing Administration (HCFA, now CMS) during President Clinton's first term. She is a former member of the Board of Regents of the American College of Physicians and the Board of Commissioners of the Joint Commission on Accreditation of Healthcare Organizations, serving as its first woman chair (1991-1993). She has been a member of the faculties of the Yale School of Public Health and the School of Medicine at the University of Connecticut, a visiting professor at the Wagner School in New York, and a member of the faculty of medicine at the Medical School of the Eduardo Mondlane University in Maputo, Mozambique. Dr. Smits was the director of the John Dempsey Hospital at the University of Connecticut for 7 years. She is the author of a number of publications with particular emphasis on the policy issues associated with the quality of health care. Her recent work has been chiefly focused on Africa; she served as a volunteer for the Clinton Foundation HIV/AIDS Initiative in Mozambique and as a senior consultant to the Doris Duke Foundation's African Health Initiative.

Walter Suarez is a physician and a public health and medical information systems specialist and the director of health information technology (IT) Strategy for Kaiser Permanente. Before joining Kaiser, Dr. Suarez was the president and CEO of the Institute for HIPAA/HIT [Health Insurance Portability and Accountability Act/Health Information Technology] Education and Research. Earlier he was the CEO of the Midwest Center for HIPAA Education, and before that he was the executive director and CEO of the Minnesota Health Data Institute. He also worked for the Minnesota Department of Health in various senior policy positions. Dr. Suarez has provided project management, technical and policy consulting services and project and program evaluation services to health care provider organizations, health plans, Medicaid and Medicare programs, public health agencies, and vendors in the areas of health information technology/health information exchange, public health data standards, health disparities, quality measurement, health information privacy and security standards, and HIPAA standards, including Transactions and Code Sets and the National Provider Identifier. More recently, Dr. Suarez was a lead consultant to national and regional projects such as the Health Information Security and Privacy Collaboration (Office of the National Coordina-

tor—Agency for Healthcare Research and Quality), Technical Assistance to Medicaid and CHIP [Children's Health Insurance Program] Agencies on Health IT and HIE (AHRQ), and Development of Statewide Uniform Companion Guides for HIPAA Transactions (Minnesota). Dr. Suarez was appointed in 2008 by the Secretary of Health and Human Services to the National Committee on Vital and Health Statistics (NCVHS), where he now co-chairs the Sub-Committee on Standards. In 2009 the Secretary of Health and Human Services also appointed him to the Health Information Technology Standards Committee of the Office of the National Coordinator for Health Information Technology. He has also served actively in several national organizations, including as a member of the board of directors of the former Health Information Technology Standards Panel (HITSP), where he co-chaired the Security, Privacy and Infrastructure Technical Committee, the Clinical Research Tiger Team, and the HITSP Education, Communications and Outreach Committee; co-chair of the Privacy and Compliance Workgroup of the Certification Commission for Health Information Technology; founding president of the Public Health Data Standards Consortium; member of the executive board of the Joint Public Health Informatics Task Force; and member of the National Uniform Claims Committee.

John Swainson is a senior advisor in the value creation division of Silver Lake Partners and an independent consultant. Formerly he served as CEO and director of CA Inc., a Fortune 500 enterprise software company, from early 2005 to the end of 2009. While at CA, Mr. Swainson led the company through an extensive transformation of its internal processes and corporate image. During his tenure, the company successfully completed the Deferred Prosecution Agreement, raised customer satisfaction by 20 percentage points, doubled operating margins, restored cash flows to a sustainable growing level of more than $1.2 billion, and added almost $1 billion of revenue. In a period of profound economic uncertainty, the company was upgraded to investment grade by all three major debt-rating agencies, and CA's stock was upgraded to a "buy" by the majority of firms providing coverage. Mr. Swainson hired a new management team and with them reengineered the sales, marketing, finance, tax, development, and support processes, successfully installing a single worldwide instance of SAP to support the new business processes. Having repositioned the company with a strategy for growth, he stepped down from CA at the completion of his employment agreement. Prior to working at CA, Mr. Swainson worked for IBM Corporation for more than 26 years; there he held various management positions in the United States and Canada, including, for 7 years, general manager of the Web Sphere Middleware

Division, a business that he founded in 1997 and grew to more than $1 billion. He also ran the IBM worldwide software sales organization and held a number of senior engineering, marketing, and sales management positions. He has attended numerous executive education programs over the past 30 years, including the Wharton International Fellows Programs and various programs at Harvard Business School (New CEO, Building Better Boards, and others). He sits on the boards of Visa, Inc., where he is the lead director, and of Cadence Design Systems. Before he joined IBM, Mr. Swainson worked for the Utah Mines Division of General Electric Corporation, where he was a process metallurgist. He has a bachelor's degree in engineering from the University of British Columbia.

Peter Szolovits is a professor of computer science and engineering in the Massachusetts Institute of Technology (MIT) Department of Electrical Engineering and Computer Science, a professor of health sciences and technology in the Harvard/MIT Division of Health Sciences and Technology, and head of the Clinical Decision-Making Group within the MIT Computer Science and Artificial Intelligence Laboratory. His research centers on the application of artificial intelligence (AI) methods to problems of medical decision making and the design of information systems for health care institutions and patients. He has worked on problems of diagnosis, therapy planning, execution and monitoring for various medical conditions, computational aspects of genetic counseling, controlled sharing of health information, and privacy and confidentiality issues in medical record systems. His interests in AI include knowledge representation, qualitative reasoning, and probabilistic inference. His interests in medical computing include Web-based heterogeneous medical record systems, lifelong personal health information systems, and the design of cryptographic schemes for health identifiers. He teaches classes in AI, programming languages, medical computing, medical decision making, knowledge-based systems, and probabilistic inference. Professor Szolovits has been on the editorial board of several journals, has served as program chair and on the program committees of national conferences, and has been a founder of and consultant for several companies that apply AI to problems of commercial interest. Professor Szolovits was elected to the Institute of Medicine of the National Academies and is a fellow of the American Association for Artificial Intelligence, the American College of Medical Informatics, and the American Institute for Medical and Biological Engineering. He serves as a member of the National Research Council's Computer Science and Telecommunications Board.

Staff

Lynette I. Millett is a senior program officer and study director at the Computer Science and Telecommunications Board (CSTB), National Research Council of the National Academies. She currently directs several CSTB projects, including a comprehensive exploration of sustaining growth in computing performance and an examination of opportunities for computing research to help meet sustainability challenges. She served as the study director for the CSTB report *Social Security Administration Electronic Service Provision: A Strategic Assessment.* Ms. Millett's portfolio includes significant portions of CSTB's recent work on software, identity systems, and privacy. She directed, among other projects, those that produced *Software for Dependable Systems: Sufficient Evidence?,* an exploration of fundamental approaches to developing dependable mission-critical systems; *Biometric Recognition: Challenges and Opportunities,* a comprehensive assessment of biometric technology; *Who Goes There? Authentication Through the Lens of Privacy,* a discussion of authentication technologies and their privacy implications; and *IDs—Not That Easy: Questions About Nationwide Identity Systems,* a post-9/11 analysis of the challenges presented by large-scale identity systems. She has an M.Sc. in computer science from Cornell University, where her work was supported by graduate fellowships from the National Science Foundation and the Intel Corporation; and a B.A. with honors in mathematics and computer science from Colby College, where she was elected to Phi Beta Kappa.

Emily Ann Meyer is a program officer and study director at CSTB. She came to CSTB from the National Research Council's National Materials Advisory Board (NMAB) and Board on Manufacturing and Engineering Design. While at NMAB, she completed two studies on aviation security (*Fusion of Security System Data to Improve Airport Security* and *Assessment of Millimeter-Wave and Terahertz Technology for Detection and Identification of Concealed Explosives and Weapons*), directed the roundtable on biomedical engineering materials and applications, and oversaw a workshop on nondestructive evaluation for materials state awareness, among other activities. She holds a J.D. from Hamline University School of Law and a B.A. (magna cum laude) in political science from Virginia Wesleyan College, where she also minored in German.

Enita A. Williams is an associate program officer with CSTB. She formerly served as a research associate for the National Research Council's (NRC's) Air Force Studies Board, where she supported a number of projects, including those of the standing committee for the U.S. Special Operations Command and the standing committee for the intelligence community. Prior to her work at the NRC, she served as a program assistant with the

Scientific Freedom, Responsibility and Law Program of the American Association for the Advancement of Science, where she drafted the report of the workshop on human enhancement. Ms. Williams graduated from Stanford University with a B.A. in public policy, with a focus on science and technology policy, and an M.A. in communications. She is currently pursuing a law degree at Georgetown University Law Center.

Eric Whitaker is a senior program assistant at CSTB. Prior to joining CSTB, he was a realtor with Long and Foster Real Estate, Inc., in the Washington, D.C., metropolitan area. Before that, he spent several years with the Public Broadcasting Service in Alexandria, Virginia, as an associate in the Corporate Support Department. He has a B.A. in communication and theater arts from Hampton University.

D

Sources and Uses of Data Within the Centers for Medicare and Medicaid Services

Although it is clear that data collection and dissemination within the Centers for Medicare and Medicaid Services (CMS) will accelerate rapidly in the coming years, CMS already holds vast amounts of information, much of which can be accessed by appropriate outside organizations. This appendix briefly reviews some of the current sources of data within CMS and some of the details of data related to improvement of the quality of care, along with discussion of some of the external, secondary uses of these data. The emphasis is largely on the data collected with respect to Medicare.

DATA SOURCES AND STRUCTURE

The data held currently by CMS come from a variety of sources, of which the most important is claims for all types of services provided. All claims contain basic diagnostic information, as well as information on date of service, the type of service provided, and the identity of the prescribing physician. Some types of data, such as hospital discharges, include multiple diagnoses, as well as a record of procedures performed, diagnosis-related group (DRG) assigned, and other information on the hospital stay. Managed-care plans serving Medicare beneficiaries (Part C of Medicare) are required to submit extensive "benefit utilization" reports, which provide encounter data for these beneficiaries very similar to data from claims submitted on behalf of those in fee-for-service Medicare.

This information is merged into the fee-for-service data sets to generate a comprehensive view of facts such as hospital discharges.

Part D of Medicare is administered by pharmacy benefit organizations that pay the claims rather than CMS's doing so directly. Part D providers are required to submit detailed reports of the drugs prescribed as well as identifying the prescriber and the pharmacy where each prescription is filled.

Special supplemental information aimed at both monitoring quality and assigning patients to payment groups is collected on nursing home patients (the Minimum Data Set, or MDS), home health patients (the Outcome and Assessment Information Set, or OASIS), patients in rehabilitation facilities (Inpatient Rehabilitation Facility-Patient Assessment Instrument, or IRF-PAI), and those in psychiatric facilities (Inpatient Psychiatric Facility Prospective Payment System, or IPF PPS).

Quality information is collected from surveys done by the Joint Commission and state agencies and entered into the Online Survey Certification and Reporting (OSCAR) database. Since 2007, hospitals are required to report "never events," adverse outcomes that ought not to have happened (such as wrong-site surgery), as defined by the National Quality Forum. Payment is withheld for the hospital stays during which such events occur. Additional quality reporting is also required. The amount of reporting is expected to increase as electronic medical records (EMRs) come into common use; ease of reporting should improve as well. Physicians are not required to submit quality information but have been encouraged to do so under a voluntary plan that can lead to incentive payments. Physicians' quality reports are based on measures developed by the National Quality Forum. End-stage renal disease facilities report patient outcome measures into a system known as CROWNWeb, for Consolidated Renal Operations in a Web-enabled Network.

CMS also conducts a number of beneficiary surveys. The Medicare Current Beneficiary Survey (MCBS) is a rolling survey of beneficiaries that includes questions on out-of-pocket costs, services used, and the experience of care. The Health Outcomes Survey (HOS) measures outcomes for individuals enrolled in Medicare managed care. A survey specific to patients' experience of hospital care—Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS)—is also conducted.

Demographic information on beneficiaries, including race and ethnicity data, is provided to CMS by the Social Security Administration (SSA). According to recent reports, race and ethnicity information are now being collected using OMB standards when new Social Security and Supplemental Security Income claims are filed, and when applications are made

for Social Security numbers and replacement cards. However, until 1980[1] very limited data on race and ethnicity (white, black, or "other") were collected at the time of enrollment. While the categories have expanded since then, data available for Hispanic/Latino and Asian beneficiaries remain of limited accuracy despite efforts to repopulate SSA data received through focused outreach efforts, arrangements with the Indian Health Service and the collection of self-reported data through the Medicare Current Beneficiary Survey.[2]

As a result, accurate demographic information is often lacking on Medicare beneficiaries, posing a challenge in terms of identifying and reducing racial disparities in health and treatment. Demographic information on Medicaid beneficiaries is collected by states under a variety of rules.

Information on providers and institutions participating in the Medicare program, including information on the ethnicity of providers, is collected at the time of request for a Medicare number.

The new reporting rules for meaningful use of electronic health records (EHRs) should yield substantial new data that can easily be accessed, but the exact specifications for the information to be generated are not yet determined.

CMS also collects and retains extensive cost information based on regular reports submitted by participating facilities.

The Office of Research, Development, and Information (ORDI) in CMS is responsible for coordinating the agency's research. ORDI conducts research projects such as those that have served as the basis for the design of the new accountable care organizations. The data sets collected in the process of research are usually held by ORDI until the demonstration is complete and analysis has been concluded.

CMS also maintains a number of data sets related to Medicaid. The Medicaid Analytic Extract (MAX) files track utilization and enrollment data at the person level on an annual basis. This data set, according to CMS, is used to support research and policy analysis for Medicaid and other low-income populations. The Medicaid Drug Rebate Product Description file is a catalog listing of all pharmaceuticals that qualify for drug manufacturer rebates to states under the Medicaid Drug Rebate Initiative (MDRI) (part of the Omnibus Budget Reconciliation Act of 1990

[1]Joel S. Weissman and Romana Hasnain-Wynia, 2011, "Advancing Health Care Equity Through Improved Data Collection," *New England Journal of Medicine* 364:2276-2277.

[2]RTI International, 2008, "Creation of New Race-Ethnicity Codes and Socioeconomic Status (SES) Indicators for Medicare Beneficiaries" available at http://www.ahrq.gov/qual/medicareindicators/, last accessed October 24, 2011; AHRQ "Race, Ethnicity, and Language Data: Standardization for Health Care Quality Improvement," available at http://www.ahrq.gov/research/iomracereport/reldata3b.htm, last accessed October 25, 2011.

[Public Law 101-508]). This file is updated and maintained by CMS on a quarterly basis. Supplementing the MDRI is the Medicaid Drug Rebate Utilization file, which captures drug utilization and vendor payments data submitted to CMS by the states in order to calculate state reimbursement amounts.

The Payment Error Rate Measurement is an annual compilation of error rates in payments to states for Medicaid and the Children's Health Insurance Program (CHIP) services.

CMS's Central Data Administration team is the primary custodian of most CMS data. Quality reporting and support of the quality databases are the responsibility of the Office of Clinical Standards and Quality. According to CMS, the process of data administration itself consists of the following:

- Guiding the creation and monitoring the usage of data and information as vital agency assets;
- Promulgating agency standards, procedures, and guidelines related to data names and definitions;
- Maintaining the inventory of agency data assets;
- Facilitating understanding of the meaning, accuracy, and timeliness of data assets; and
- Promoting the reuse of standardized data names, definitions, elements, and values.

A few CMS databases are readily available to the public; many are available to researchers, with appropriate restrictions related to the privacy of individuals; and a few, most notably those collected by quality improvement organizations (QIOs) for their improvement work, are never available for secondary use. In order to facilitate effective outside use of CMS data, CMS has contracted with the University of Minnesota to create the Research Data Assistance Center (ResDAC). ResDAC provides free assistance to researchers interested in using Medicare data for their research; it maintains a comprehensive list of the data sets available and when the next update is expected. All requests must be reviewed by ResDAC prior to submission to CMS; this requirement reduces rework by inexperienced researchers and ensures an efficient process for review.

For users who require more consistent access to CMS data, such as government and state agencies and providers, an active CMS Data Use Agreement can be established, stipulating the manner and time frame in which the data are to be used. Interested external data customers and stakeholders that may wish access to data include the following: academic institutions and the private sector, congressional entities, Department of Health and Human Services (HHS) federal agencies and contractors, non-

HHS federal agencies, providers, state government agencies, and state Medicaid agencies.

CMS organizes its data sets with different levels of specificity and beneficiary personal information in order to facilitate research. Data are maintained in identifiable data files, which contain actual beneficiary-specific and physician-specific information, such as per year person-level enrollment and utilization. Accessing this class of data requires authorization from CMS and is subject to Health Insurance Portability and Accountability Act (HIPAA; Public Law 104-191) protections. Limited data files are files that have been stripped of data elements that might permit the identification of beneficiaries but which include beneficiary-level health information. Accessing this class of data also requires authorization from CMS and is also subject to HIPAA protections. Non-identifiable data files and public use files are accessible to the public and are not subject to CMS authorization or HIPAA protections, as they have been stripped of all individual-identifying information. Cost report data coming from all Medicare program providers is provided on an annual basis and contain information on costs, statistics, and facility characteristics. Medical review data refer to a number of quality-of-care assessment reports by facility such as the MDS. This information includes personal-level specific data on facility residents and other topics, and accessing it is subject to CMS authorization and HIPAA protections.

Demonstration data on "the likely impact of new methods of service delivery, coverage of new types of service, and new payment approaches on beneficiaries, providers, health plans, states, and the Medicare Trust Funds,"[3] as well as CMS's evaluation projects data validating research and providing useful information for monitoring CMS's various programs, may contain identifiable, limited-information, and/or non-identifying information. Accessing demonstration data may or may not warrant CMS approval or HIPAA protections, depending on the data collected. Consumer assessment data such as those collected in the MCBS and the HOS are in the form of survey responses from beneficiaries as consumers on the interpersonal aspects of health care. Some are available with CMS approval, and some are fully de-identified and are available without special approval.

DATA-CENTRIC EFFORTS TOWARD QUALITY IMPROVEMENT

A regulatory and payment agency like CMS has two potential approaches to improving the quality of care: (1) it can establish standards aimed at eliminating the worst care, and (2) it can encourage, in some

[3]As described at the CMS website, https://www.cms.gov/DemonstrProjectsEvalRepts/.

manner, overall improvement. If quality is viewed as a normal curve, the first can be seen as limiting the length of the left tail, whereas the second involves shifting the entire curve to the right. Despite a popular focus on "getting the bad guys," overall improvement can have a much greater effect on more individuals.

Conditions of Participation

Since passage in 1965 of the legislation creating Medicare (Public Law 89-97), CMS, or its predecessor agencies, have had responsibility for monitoring the quality of care in part of the health care system. The focus of the original law was exclusively on establishing minimum standards for institutional providers, particularly hospitals and nursing homes. Regulatory standards, known as "Conditions of Participation," were developed, and physical surveys were conducted to ensure that standards were met. These surveys are conducted by state agencies and, in many instances, by private accrediting agencies whose standards are deemed to be equal to or better than those of the Conditions of Participation. The only accrediting agency mentioned in the original law and used in the early years was the Joint Commission on Accreditation of Hospitals (now the Joint Commission on Accreditation of Healthcare Organizations); more recently other agencies have also qualified for "deemed" status.

Whoever conducts the survey, the core question is straightforward: Is care good enough for CMS beneficiaries? In theory, CMS can act to withdraw all payments if care is substandard; in practice, it has proved very difficult to de-certify a whole institution, even one with serious problems. Although the Conditions of Participation have attempted to improve overall care by means such as requiring quality improvement committees, there is little evidence that this approach makes a difference.

In recent years, CMS has moved, even within the context of the Conditions of Participation, to deal with substandard care in a more precise manner on the basis of objective data. Facilities are now required to report to CMS a list of "never events," and payment is denied whenever these occur.

Quality Improvement Organizations and Predecessor Organizations

The first effort to use data sets to improve care came with the creation of professional standards review organizations (PSROs) in 1972; these physician-run organizations, each of which covered a state or smaller area, had access to Medicare claims data and were expected both to reduce overuse of services and to improve quality. Evaluations of the program, and interest from Congress, focused almost exclusively on

whether or not the PSROs were saving money, with little attention to the matter of quality. In the 1980s, the PRSO program was eliminated, and new entities—professional review organizations (PROs)—were created, with more of a focus on quality. The new law allowed more flexibility in terms of what kinds of organizations could qualify to perform reviews and what areas they would cover. Tasks to be carried out included not only data-based efforts to improve care but also a number of less relevant activities such as the investigation of patient complaints. The name PRO was changed to QIO in 2002 to emphasize further the focus on improving population-based measures of health, but the conflicting tasks remain. A study by the Institute of Medicine (IOM) completed in 2006 argued for even more focused tasks for the QIOs. It is not clear how fully those recommendations have been followed. The conclusions of the IOM study were as follows:

- The quality of the health care received by Medicare beneficiaries has improved over time.
- The existing evidence is inadequate to determine the extent to which the QIO program has contributed directly to those improvements.
- The QIO program provides a potentially valuable nationwide infrastructure dedicated to promoting quality health care.
- The value of the program could be enhanced through the use of strategies designed to focus the QIOs' attention on the provision of technical assistance in support of quality improvement, to broaden their governance base and structure, and to improve CMS's management of related data systems and program evaluations.[4]

EXTERNAL SECONDARY USES OF CMS DATA

The various data sets described here, particularly those produced by Medicare, have served as a rich base for health services research in the United States. Among current researchers, the best known is probably the Dartmouth Atlas of Health Care,[5] which began with studies of variation in hospital use and now reports on a wide variety of issues such as the number of individuals who see 10 or more doctors in the last 6 months of life. The Dartmouth files have been maintained continuously for 20 years, and so patterns of use can be traced back over time. The original research that led to the development of DRGs was also conducted by

[4]Institute of Medicine, 2006, *Medicare's Quality Improvement Organization Program: Maximizing Potential*, Washington, D.C.: The National Academies Press, p. 4.

[5]"The Dartmouth Atlas of Health Care," website, available at http://www.dartmouthatlas.org/, last accessed July 21, 2011.

outside researchers using Medicare Provider Analysis and Review (MEDPAR) data. The DRG system, which was originally intended to facilitate utilization reviews by identifying aberrant cases, or outliers, was first reported 35 years ago[6] and first used as a payment mechanism in New Jersey in 1980.

The information available today is much richer than that available when the Dartmouth Atlas first appeared, and research interest continues to grow. The value of CMS data is limited by the fact that they reflect only care delivered to Medicare and to a certain extent Medicaid beneficiaries. The availability of more universal data will serve to enhance greatly the understanding of the functioning of the U.S. health care system.

[6]John D. Thompson, Robert B. Fetter, and Charles D. Mross, 1975, "Case Mix and Resource Use," *Inquiry* 12(4):300-312.

E

A Two-Phase Approach to Modernization and Transformation of Business and Information Ecosystems

Chapter 3 provided an overview of the committee's recommended meta-methodology for the modernization and transformation of CMS systems. The approach described there consists of two phases, the first focusing on the business systems and the second focusing on the information systems. This appendix offers a more detailed elaboration of each of those two phases.

META-METHODOLOGY PHASE 1: MODERNIZATION AND TRANSFORMATION OF CMS BUSINESS ECOSYSTEMS

Phase 1 of the meta-methodology for the modernization and transformation of business and information ecosystems of the Centers for Medicare and Medicaid Services (CMS) relates to business ecosystems. Phase 1 consists of three sequential tasks: the first is to understand the source business ecosystems (existing constructs), the second is to understand the target business ecosystems (desired constructs), and the third is to carry out mapping between them. Each of these tasks involves understanding and documenting the business ecosystems in business terms, which include business and process models for each major distinct CMS role and its information, events, and shared resources, including automated and non-automated aspects. Source business ecosystems encompass both those that support CMS internal roles and those that either depend on or provide roles to external business ecosystems.

Characterization of Source Business Ecosystems

The task of characterizing source business ecosystems consists of two steps, as presented below. The first step develops an understanding of a set of source business ecosystems, and the second step synthesizes a comprehensive view of those source business ecosystems. The initial set of source business ecosystems chosen will depend on the most critical needs; for example, good candidates might be those that are either "in trouble" (burning platforms) today or those for which the requirements are changing dramatically.

- *Step 1: Develop an inventory of source business ecosystems.* The set of internal CMS business ecosystems chosen must be analyzed so that they can be included in the modernization and transformation plan. A proper inventory not only will list the systems but also will document them—including their characteristics and the way in which they interact with other systems. External business ecosystems that interact with internal CMS business ecosystems must also be inventoried and analyzed, at least to an extent, so that the interaction requirements will be understood for modernization and transformation planning.
- *Step 2: Characterize the source global business ecosystem for the set of business ecosystems chosen.* The deep understanding of the existing source business ecosystems developed in Step 1 makes it possible to analyze these ecosystems together for potential shared business services and to determine requirements for the target ecosystem. This approach to comprehensive modeling at the business layer is one of the leading trends for achieving a shared-services organization. From what the committee understands, CMS has developed an analysis along these lines, but only for information ecosystems, not for business ecosystems. The committee argues that a similar analysis of the interactions of the parts of the global business ecosystem is also needed.

CMS requires a comprehensive view of CMS business roles. Decades ago, independent CMS business organizations, each with responsibility for a specific CMS role, developed the business and operational models required for that role. With limited requirements for the roles to interact, each role was developed and operated independently by independent CMS organizations. Over time there were increased requirements for the roles to interact more closely. In 2011, there are significant requirements for a comprehensive view of CMS business roles from both a health care perspective and an operational perspective.

Characterization of Target Business Ecosystems

Once the source global business ecosystem is understood, the target business ecosystems can be addressed, again building toward a global view. Because CMS will likely continue to evolve indefinitely, it will need to plan its target business ecosystems incrementally and to expect ongoing iteration, starting with those functions that are known, and using methodologies to support continuous, incremental evolution, following the principles outlined in Chapter 2 of this report. The target global business ecosystem at any time will comprise those target business ecosystems whose requirements are then known and the source business ecosystems that have not yet changed.

This second task—characterization of target business ecosystems—consists of two steps, analogous to those for source business ecosystems given above.

- *Step 1: Identify and characterize target business ecosystems.* Target business ecosystems are identified in various ways. Some existing (source) business ecosystems may be mandated to continue as currently constituted. In other cases, new roles may be mandated by new requirements from the Department of Health and Human Services or Congress. In still other cases, the earlier analysis of source business ecosystems may suggest the need for refactoring of these ecosystems into different roles. Factors that may affect the prioritization of target ecosystem development include the importance of the business processes and associated use cases to the agency's mission and priorities. Once target business ecosystems have been identified, they must be defined and documented.
- *Step 2: Characterize the target global business ecosystem for the chosen roles.* The target global business ecosystem—the integration of the individual target business ecosystems chosen, plus the source business ecosystems that have not changed—will be the target of the mappings described below. The target global business ecosystem combines the characterizations from Step 1 of the target business ecosystems, additionally indicating the relationships among them, and identifying all commonalities such as potentially shared roles, services, and resources.

A key element of this global business ecosystem will be the *business glossary*—the standardization of the various data to be shared across all the target business ecosystems. As discussed elsewhere in this report, CMS needs to become a data-driven, information-centric organization. CMS daily creates, collects, maintains, uses, and exchanges vast amounts of data electronically. These data become a mission-critical component for CMS and a key element of the manner in which the agency achieves its core strategic goals and objectives. At the heart of this data-driven

ecosystem is the need to establish an enterprise-wide, standard reference health terminology and value set structure that lists, defines, and maps each data concept being represented in any part of the agency's data infrastructure. This reference health terminology and value set structure should be mapped back to the Federal Health Terminology component of the Federal Health Interoperability Modeling and Standards Initiative being developed by the ONC. The health terminology and value set structure require that a core set of semantic and syntactic interoperable standards be identified, selected, adopted, implemented, and governed across the enterprise. These standards will then become the foundational principles and practices governing information technology (IT) initiatives (see below).

Although CMS has established internal standards for IT systems acquisition and development, there is a lack of an authoritative, enterprise-wide health information model (HIM) by which the data for all roles and projects are governed. Without such a model, each project, unit, program, and office is able to define its own data and, as a result, at the IT level, expensive and complex data interfaces must be developed to integrate data systems and allow for cross-program analysis.

An HIM is an authoritative set of policies and practices that define the health data objects within an enterprise that will be commonly used by business services (and their underlying software services), including the relationship between information elements. Large health care organizations (such as the Department of Veterans Affairs,[1] the Mayo Clinic,[2] Kaiser Permanente, Intermountain Healthcare,[3] and others[4]) are adopting such enterprise-wide HIMs. The HIM determines the standard terminology regarding health data objects that are defined in the business glossary.

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[1]Department of Veterans Affairs, VHA Health Information Model, available at http://www.va.gov/VHIM, last accessed July 27, 2011.

[2]Christopher Chute, Scott Beck, Thomas Fisk, and David Mohr, 2010, "The Enterprise Data Trust at Mayo Clinic: A Semantically Integrated Warehouse of Biomedical Data," *Journal of the American Medical Informatics Association* 17(2):131-135, available at http://jamia.bmj.com/content/17/2/131.full.pdf, last accessed July 27, 2011.

[3]P.D. Clayton, S.P. Narus, S.M. Huff, T.A. Pryor, P.J. Haug, T. Larkin, S. Matney, R.S. Evans, B.H. Rocha, W.A. Bowes III, F.T. Holston, and M.L. Gundersen, 2003, "Building a Comprehensive Clinical Information System from Components: The Approach at Intermountain Health Care," *Methods of Information in Medicine* 42(1):1-7.

[4]Richard Lenz and Klaus A. Kuhn, 2003, "A Strategic Approach for Business-IT Alignment in Health Information Systems," in *On the Move to Meaningful Internet Systems 2003: CoopIS, DOA, and ODBASE, Lecture Notes in Computer Science* 2888:178-195; S.M. Huff, R.A. Rocha, J.F. Coyle, et al., 2004, "Integrating Detailed Clinical Models into Application Development Tools," *Studies in Health Technology and Informatics* 107(2):1058-1062; and C.G. Parker, R.A. Rocha, J.R. Campbell, et al., 2004, "Detailed Clinical Models for Sharable, Executable Guidelines," *Studies in Health Technology and Informatics* 107(1):145-148.

With such a model in place—albeit a model that will be evolving over time—the expensive task of creating customized, one-of-a-kind interfaces between disparate systems is greatly simplified and may be eliminated altogether. Data would be integrated and could be shared internally and, when necessary, externally. The time to create and the cost to build new systems, integrate legacy systems, or extract data from any system are improved. Aiming toward an HIM for all health care data in the organization will also ensure that any future system being developed will follow strict semantic and syntactic interoperable guidelines and standards, which themselves may be modified and adjusted over time as needed. Such an approach will allow the agency to take data from any one of its systems and represent them all in a consistent, comprehensible manner.

In order to best meet CMS goals and congressionally mandated requirements, CMS should accelerate the implementation of its health information model under the Federal Health Interoperability Modeling and Standards Initiative, part of the Federal Health Architecture Project.[5] Similarly, CMS should work within this initiative to implement its reference health terminology and value set standard. CMS should leverage the experience that the Veterans Health Administration has had in implementing its VHA Health Information Model (VHIM).[6] Furthermore, CMS should consider engaging in and participating with other national and international organizations, such as the Mayo Clinic, Kaiser Permanente, Intermountain Health, HL7 International, and others, in developing a cross-organizational HIM that can ensure interoperability across enterprise models.

Mapping of Business Ecosystems

The task of mapping business ecosystems develops a plan for modernization and transformation by creating a mapping between the source and target business ecosystems. The mapping will describe, still at the business level, how the source and target business ecosystems are related. This mapping process requires a multidisciplinary, incremental approach driven tactically by the most urgent target business ecosystems. Maps between source and target business ecosystems will be complex. For

[5]All federal agencies (including CMS) are expected to follow the Federal Health Information Model (FHIM). The FHIM is a critical component of the Federal Health Interoperability Modeling and Standards initiative, part of the overall Federal Health Architecture Program (see http://www.fhims.org/). The emphasis in this report is to note that CMS needs to take the FHIM and apply/adopt it to its enterprise-wide data structures.

[6]For more information, see Department of Veterans Affairs, VHA Health Information Model, available at http://www.va.gov/VHIM, last accessed July 27, 2011.

example, multiple source business ecosystems may map to individual or multiple target business ecosystems.

The source and target global business ecosystems provide a context in which to identify and address strategic or global issues that apply at the global business ecosystem level. One example of such issues is information strategy, which is concerned with what the business requirements and guidelines are for the collection, analysis, management, access, and dissemination of information across the global business ecosystems. The information strategy should be expressed in the terminology defined in the business glossary and health information model. The business ecosystem mapping will provide guidance for the mapping of the corresponding information ecosystems.

Three steps are needed to perform this task. In the first step, how to derive each target business ecosystem is considered. In the second step, given what is now known about the targets, it is decided how to deal with the sources. The third step documents the relationships between the sources and targets, and it leverages earlier work on potentially shared services, documenting which sources will contribute to new shared services and how the targets will use them.

- *Step 1: Determine how each target business ecosystem will be derived.* Some target business ecosystems will be driven by new requirements without a corresponding source business ecosystem and will therefore be designed without historical constraints; such an ecosystem is sometimes referred to as a green field. Many target business ecosystems, however, will have antecedents, such as fee for services. Nevertheless, designing a target business ecosystem conceptually freed from details of the antecedent (which is addressed in the mapping step, below) can bring fresh insights, leading to improved performance and efficiencies.

More specifically, in this step, target business ecosystems will be evaluated to determine how each should be formed. Dispositions may include the following:

—*Green field:* These business ecosystems will be developed from new requirements and have no corresponding source business ecosystem.

—*Unchanged (simple):* These business ecosystems correspond to one or more source business ecosystems with minimal changes.

—*Modernized (simple):* These business ecosystems correspond to one or more source business ecosystems after modest changes.

—*Transformed:* These business ecosystems correspond to one or more source business ecosystems after substantial or fundamental change.

—*Unchanged (complex but refactored):* These business ecosystems incorporate components from one or more source business ecosystems with minimal changes to the resulting functionalities, but with substantial

refactoring (including the removal of redundancy and the elimination of unnecessary components).

- *Step 2: Determine whether to discard, modernize, or transform each source business ecosystem chosen.* This determination will be based on the expected need for a particular role, in its current form, in the future. This decision in turn will be based on the work done in Step 1, above. In particular, each source business ecosystem might be:
  - —*Retired:* Put out of service by a defined date.
  - —*Unchanged:* Able to be operated as a target business ecosystem more or less unchanged.
  - —*Modernized:* Operated as a target business ecosystem after modest enhancements or changes.
  - —*Transformed:* Used as a target business ecosystem after substantial or fundamental change.

- *Step 3: Map source to target business ecosystems.* This step starts by determining the services, if any, to be shared across the target business ecosystems chosen for instantiation. The relevant source services must be mapped to these new shared services so that the target can rely directly on these shared services (rather than on the sources). Because the global context (the global business ecosystem) is built incrementally, the initial mapping increment may or may not identify some shared services. Subsequent increments may identify additional shared services and confirm or question the previously identified shared services.

In general, this step determines in detail how each target business ecosystem is formed, using the source and target global business ecosystems as a guide, as well as the dispositions of source and target business ecosystems decided as described above. The mapping is done at the business level in terms of the roles that the business ecosystem implements. Mappings involve all aspects of a business ecosystem, including stakeholders, processes, events, information, and shared resources.

When undertaking this step, the ecosystem requirements developed in the above analysis and mapping steps should be used to justify the ecosystem mapping and thus provide the essential ecosystem or business details for the relevant business case. Indeed, the development of models and methods to be used and governed across CMS is a central feature of the overall approach. The meta-methodology should be tailored to CMS's requirements and published and taught across CMS. Similarly, the HIM and other models that are to become standard should be documented, published, and evolved.

META-METHODOLOGY PHASE 2: MODERNIZATION AND TRANSFORMATION OF CMS INFORMATION ECOSYSTEMS

Modernization and transformation planning at the information ecosystem level is guided by planning corresponding to that described for business ecosystems, in the same sequence as in Phase 1: characterize the existing source information ecosystems, then the targets, and then decide which to modernize and which to transform, and create the mappings between them. Decisions on how to treat each information ecosystem should be guided by corresponding decisions for the corresponding business ecosystems. An incremental approach should be followed, guided by the decisions from Phase 1 on which of the business ecosystems should be tackled first. Again, planning starts by understanding individual information ecosystems and builds to a global view. As with the business ecosystems discussed above, the information ecosystems analyzed include both internal CMS information ecosystems and those external to, but interoperating with, CMS.

Phase 2 consists of five tasks. The first task is to develop frameworks to guide the design of the common components of the global information ecosystem (those common to multiple information ecosystems) and its life-cycle management. Again, this is an incremental process. The first time through this task establishes the first increment of the required frameworks. Subsequent increments expand the frameworks as needed. The next three tasks are analogous to those of Phase 1: understanding the source information ecosystems, understanding the target information ecosystems, and mapping between them. Finally, the fifth task is to actually implement the required transformations in order to create the new information ecosystems and move them to production.

Development of the Necessary Frameworks

A framework is a set of rules, guidelines, and standards for development and life-cycle management. An enterprise architecture (EA) framework defines the standards and guidance for the enterprise architecture of all the target information ecosystems. A framework also provides a context within which to identify components that will be shared by two or more target information ecosystems.

The CMS Office of Information Services (OIS) has defined architectural policies and guidance for OIS systems, such as its CMS Technical Reference Architecture (TRA).[7] The CMS OIS documentation that the

[7]See CMS, Technical Reference Architecture (TRA) Standards, 2011, available at http://www.cms.gov/SystemLifecycleFramework/TRAS/list.asp, last accessed July 27, 2011.

committee has seen is not, however, inclusive of all global information ecosystem requirements, nor is it developed for or applied to a CMS global information ecosystem. It is noted above that the enterprise architecture encompasses several architectural components, including the process, applications, information, and infrastructure architectures. An EA framework defines the necessary standards for the design, development, and deployment of information ecosystems, to facilitate interoperation and other properties among new and existing information ecosystems. A key piece of this framework should be the information architecture framework. This latter framework and the corresponding information architectures require more focus from CMS. This section briefly explores the information architecture component of the enterprise architecture as an example of how the EA framework would be applied. The business requirements that drive the development of the information architecture comprise an information strategy.

Information Strategy and the CMS Enterprise Data Environment

Data-driven health care[8] must have an "information strategy"—a basis in business requirements at the global ecosystem level. This strategy addresses questions such as the following: What is the scope of health care data that CMS will manage and/or access? What is the nature of health care data? How should health care data be organized? What are appropriate uses of health care data? Who owns health care data? Where can health care data reside? Who has access to health care data? Under what conditions can health care data be disseminated? And how should health care data be governed? An information strategy that answers these and other questions guides the information management solutions developed

[8]CMS and its predecessor organizations began with a business model similar to that of a large insurance company and focused their business processes on those activities necessary to keep track of patients, providers, and organizations and to pay for medical services rendered to the covered patients. With time, health care financing has become more sophisticated and more analytical, so that CMS has been tasked with the responsibility for gathering many new forms of data in addition to claims. These data include quality metrics, aggregate utilization data, and even individual abstracted clinical records to support specific studies on effectiveness and costs of various approaches to treating patients. CMS's responsibilities under the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 (Public Law 110-185) also require it to collect and analyze data on the meaningful use of health information technologies, and under the Patient Protection and Affordable Care Act (Public Law 111-148), it must collect additional data that are not yet well specified that will help to analyze the costs and effectiveness of future ways to organize patient care. An important part of CMS's business strategies will be to decide the degree to which such analyses can be done by aggregate reporting and attestation by its client organizations and to what extent CMS will need the ability to handle additional patient-specific data.

for the global information ecosystem. Those guidelines are part of an information architecture framework that defines standards and guidelines for the information architecture components of the global information ecosystem.

CMS has correctly recognized the need for an information architecture component for the global information ecosystem: CMS's proposed enterprise data environment (EDE). As with all large-scale, complex components, the EDE will need to be developed incrementally to meet known requirements, using technical solutions that have been proven to meet the specific requirements of CMS. The meta-methodology outlined here is intended to support such an incremental development of an EDE and other global information ecosystem components. All information ecosystem solutions and components should be designed, developed, tested, and deployed incrementally relative to specific requirements that are known at the time of the current increment. Although it is impossible to predict future requirements accurately, good engineering practices and judicious architecture, technology, and product choices can contribute to meeting some anticipated but not precisely defined requirements, such as future reuse and interoperability.

At the time that the committee examined it, the EDE was just a part of what is needed. In addition to the EDE, which requires solutions for business intelligence, enterprise content management, advanced analytics, master data management, and other information management solutions that can be shared across the global information ecosystem, there will be a need for shared, enterprise-wide solutions to identify and access management; enterprise governance, risk, and compliance; security; fraud prevention and detection; and business process management.

Components of the Enterprise Architecture Framework

Enterprise architectures and standards for them have been industry best practices for several decades. U.S. federal government policies and guidelines recommend them. Reports of the National Research Council (NRC)[9,10] have recommended them for some time. For example, the 2004 NRC report on the Federal Bureau of Investigation's (FBI's) Trilogy system recommended an enterprise architecture as both critical and urgent,

[9]NRC, 2004, *A Review of the FBI's Trilogy Information Technology Modernization Program*, Washington, D.C.: The National Academies Press.

[10]NRC, 2010, *Critical Code: Software Producibility for Defense*, Washington, D.C.: The National Academies Press.

as does the committee here. CMS has already created a Technical Reference Architecture[11] that includes some aspects of an EA framework.

In terms of the meta-methodology proposed here, CMS's EA framework would leverage a comprehensive understanding of target information ecosystems and their requirements. However, since the modernization and transformation effort will of necessity take several years, an incremental approach must be adopted. The initial EA framework should meet all of the requirements for the initial target information ecosystem. It should also include requirements that are known or anticipated.

The CMS EA framework should include the following:

- Requirements for the standard EA components;
- Guidance for product selection, configuration, certification, optimization, operation, and maintenance for EA components; and
- Guidance on EA life cycle: design, development, construction, deployment, operation, management, and evolution.

Care should be taken to ensure that the standards are as generic as possible and not specific to a model or technology. The purpose of high-level standards is to ensure flexibility, efficiency, interoperability, and so forth, and not to choose a specific implementation model (such as Software-as-a-Service) or a specific technology (such as Java or .Net). Such standards should permit evolution in order to accommodate inevitable future target information ecosystems requirements and EA solutions. The initial framework should be based on the most advanced technologies and products that are proven to meet the requirements of the known enterprise architectures.

All selections of technologies, models, and methods must be proven at scale to meet CMS requirements for the target information ecosystem, which in turn must meet the business requirements of the target CMS business ecosystem that it supports. As the target information ecosystems are designed and as source information ecosystems are mapped to these, detailed models and technology designs will need to be created, consistent with the EA framework.

Frameworks also provide guidance for the design and development of services that are shared across information ecosystems. These shared resources include those core functions required for any and all information ecosystems. For example, the shared business services defined by CMS in its enterprise and shared services plan,[12] as well as its modern-

[11]See CMS, Technical Reference Architecture (TRA) Standards, 2011, available at http://www.cms.gov/SystemLifecycleFramework/TRAS/list.asp, last accessed July 27, 2011.

[12]CMS, 2011, *18-Month Plan for Enterprise and Shared Services,* Baltimore, Md., July 7.

ization report,[13] would be part of this framework, including an EDE-like component to provide information management services across the global information ecosystem. There could also be global functional components, for example for beneficiary registration and for various health care delivery quality metrics. Hence, the framework is an extension of the work that CMS is already doing.

Characterization of Source Information Ecosystems

At this stage the enterprise architecture of each information ecosystem needs to be understood and documented. This understanding includes the interrelationships between ecosystems, including their interoperation by means of processes (i.e., their process architectures) and by means of information exchange (i.e., their information architectures). This task consists of two steps. The first step develops an inventory of the source information ecosystems, and the second advances that understanding toward a global view of the source information ecosystems.

- *Step 1: Inventory source information ecosystems*. This step starts by identifying and documenting the source information ecosystems that are relevant to the business ecosystems identified in Phase 1. For each of these, it characterizes the enterprise architecture for each source information ecosystem in terms of the process architecture, applications architecture, information architecture, infrastructure architecture, and so on.

Then analysis methods similar to those for source business ecosystems are applied. The characterization of related business ecosystems should be used to guide that of the corresponding information ecosystem. Information ecosystem analysis must be done for each layer, listed above, of the enterprise architecture.

- *Step 2: Develop a characterization of the comprehensive CMS source global information ecosystem.* The source global information ecosystem will provide a context within which the modernization and transformation of CMS information ecosystems will be planned. The CMS plan for the future of CMS is focused primarily on the enterprise data environment.[14] This component is missing from the source CMS information ecosystem. As described earlier, the EDE is a critical component; however, its requirements and function can be understood only in terms of the requirements

[13]CMS, 2010, *Modernizing CMS Computer and Data Systems to Support Improvements in Care Delivery*, Version 1, IT Modernization Program, December 23, available at http://www.cms.gov/InfoTechGenInfo/downloads/CMSSection10330Plan.pdf, last accessed July 27, 2011.

[14]CMS, 2010, *Modernizing CMS Computer and Data Systems to Support Improvements in Care Delivery*, Version 1, IT Modernization Program, December 23, available at http://www.cms.gov/InfoTechGenInfo/downloads/CMSSection10330Plan.pdf, last accessed July 27, 2011.

that it must meet to support all target information ecosystems. Hence, CMS must develop, incrementally, as comprehensive a view as possible. This view, imposed on the source systems, aids in analyzing the source and the potential for shared services in the targets.

The global information ecosystem is created by combining the characterizations of the identified source information ecosystems indicating the relationships among them, including all commonalities, with a specific focus on actual and potential overlapping or redundant artifacts.

Characterization of Target Information Ecosystems

The task of characterizing target information ecosystems applies to those target information ecosystems for which a target business ecosystem has been identified and characterized in the business ecosystem plan. A comprehensive view of the target information ecosystems assists design not only of those information ecosystems but also of the target global information ecosystem. As usual, this task proceeds incrementally, starting with those functions that are known, and using methodologies to support continuous, incremental evolution. Again, there are two steps: the first is to understand the target information ecosystems, and the second is to understand the relevant portion of the target global information ecosystem.

- *Step 1: Inventory target information ecosystems.* This step is analogous to Step 1 for the target business ecosystems. It starts by identifying and documenting the target information ecosystems that are relevant to the target business ecosystems identified in Phase 1. For each of these, it characterizes the enterprise architecture layer by layer. The functional and nonfunctional requirements of each architectural layer are defined following the guidance and standards defined by the EA framework and guided by the business requirements expressed in the characterization of the corresponding business ecosystem.
- *Step 2: Develop a characterization of the CMS target global information ecosystem.* As with the corresponding business ecosystem step, this step will be accomplished by combining the characterizations of the target information ecosystems identified above and indicating the relationships among them. This global context is required for the analysis of potential and actual commonalities such as shared software, components, and resources. However, these cannot be determined a priori because the target systems do not yet exist. These shared facilities may be hypothesized, but they must be designed, developed, and tested with respect to concrete requirements. Further shared services and components will be discovered incrementally as the global information ecosystem evolves.

Mapping and Disposition of Information Ecosystems

Mapping source information ecosystems to target information ecosystems means mapping between their corresponding enterprise architectures layer by layer— that is, understanding and defining how to move from the existing "artifacts" (functional or architectural components or services) in the source information ecosystem to the desired, target artifacts. The term "artifact" is used to suggest that these methods are applicable to all aspects of information ecosystems. Mappings are needed for software artifacts (processes and applications), information artifacts (e.g., databases and files), and infrastructure artifacts (other components, especially the operating systems, database management systems, web servers, and application servers). The goal is to create a plan that can be sequenced so that individual technical transitions can be conducted one at a time.

The source and target global information ecosystems provide a context within which to address strategic issues that arise for the source and target global information ecosystems, including shared services and information sharing. Factors that affect prioritization choices, in addition to decisions made during the global business ecosystem analysis phase, may include implementation difficulty, and the potential for the early retirement of legacy systems, freeing up resources from legacy sustainment to be applied to modernization. Mapping is also guided by the source to target business ecosystem mappings created in Phase 1. If a target business ecosystem has one or more source business ecosystems, there will be source to target business ecosystem mappings that define the business requirements for the source to target information ecosystem mapping process. And, of course, the components of the target enterprise architecture must comply with the standards defined by the EA framework.

As at the business ecosystem level, there are three steps to mapping information ecosystems: decide how to create each target artifact, decide how to leverage each source artifact, and then document the relationships between sources and targets, determining shared services. Each of these steps is done EA layer by EA layer.

- *Step 1: Determine how best to create each target information ecosystem and its artifacts.* Target information ecosystems and their artifacts—that is, enterprise architecture components—should be analyzed to determine a disposition for the modernization and transformation process, including the following:

  —*Green field:* The target artifact will be developed from original requirements with no mapping from a source artifact.

  —*Unchanged:* The target artifact will map unchanged from a source artifact; no substantial modernization and transformation are required.

Minor changes, such as moving to a new platform and recompiling, may be required.

—*Changed:* The target artifact requires modification for modernization and/or transformation from one or more source artifacts.

—*Candidate shared service:* The target artifact is a candidate for being a target shared service.

Note that layers are somewhat independent. For instance, a new application or process could be identified at one layer of the architecture, and yet, lower down, artifacts from the infrastructure or information layers could be preserved or modernized and transformed.

- *Step 2: Determine how to leverage each source information ecosystem and its artifacts.* Source information ecosystems and their artifacts—for example, enterprise architecture components, should be analyzed to determine a disposition for the modernization and transformation process, including the following dispositions:

—*Unchanged:* The source artifact will map unchanged to a target artifact; no substantial modernization and transformation are required. Minor changes, such as moving to a new platform and recompiling, may be required.

—*Changed:* The source artifact requires modification for modernization and/or transformation to one or more target artifacts.

—*Retired:* The source artifact will be retired at some future defined date in the source information ecosystem and will not map to any target artifact.

—*Candidate shared service:* The source artifact is a candidate for mapping to a target shared service.

Here, too, layers are to a certain extent independent. For example, an information ecosystem may be unnecessary going forward. However, a database from that ecosystem's information architecture layer might be reused in a new service, even though the applications that were originally built on it are no longer necessary.

- *Step 3: Create the mapping between source and target information ecosystems and their artifacts.* Using as a guide the corresponding source and target global information ecosystems and the results of the above analysis, the source information ecosystems are mapped to the target information ecosystems. The mappings will provide guidance for the ultimate modernization and transformation activities that will achieve the planned result. Mapping from source to target information ecosystems requires mapping from the source to the target enterprise architectures layer by layer, as for the analysis in Steps 1 and 2 above.

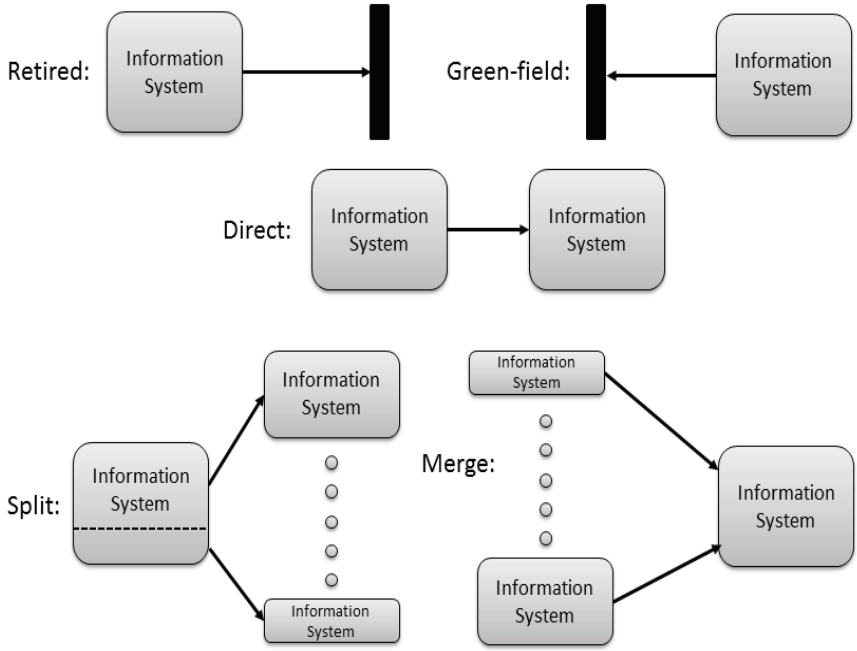

FIGURE E.1 A simplified representation of the several types of mappings are possible. Systems can be retired, newly created (green field), split into one or more systems (parts of which may be retired), or merged out of one or more existing systems (some of which may be new).

In general, mappings can be arbitrarily complex. Examples of types of mappings (Figure E.1) include the following:

—*Null mapping:* Retired source artifacts and green-field target artifacts map to or from "null."

—*Direct mapping:* A source artifact may map directly to a target artifact.

—*Split mapping:* A source artifact may map to multiple target artifacts.

—*Join mapping:* Multiple source artifacts may map to a single target artifact.

The simplest mappings are direct mappings, especially those that hold at all levels of architecture. For example, CMS may plan to use a source information ecosystem unchanged in any way to be the target information ecosystem. The most complex mappings involve mapping multiple source artifacts from potentially several source information ecosystems to one or more target artifacts, perhaps in several target ecosystems, when

artifacts from different layers of the architecture may be mapped differently (Figure E.2). For example, there is a null mapping for green-field information ecosystems; however, at the information architecture level in the enterprise architecture, a new information service might be based on an existing database, from some source information ecosystem. As another example, a green-field payment process may leverage payment and registration services that do have source mappings.

One of the most important aspects of information ecosystems analysis and mapping is the identification of potential services to be shared across two or more target information ecosystems. There is substantial input into this already, from Phase 1's analysis of shared business services, to the layer-by-layer analysis of potential shared services in Steps 1 and 2 of Phase 2. In the mapping process, the plan for creating the target artifacts will depend on these decisions. The design of target artifacts and mappings from source to target artifacts should attempt to leverage as many shared artifacts as possible. Since modernization and transformation planning occurs incrementally, a comprehensive analysis of what ser-

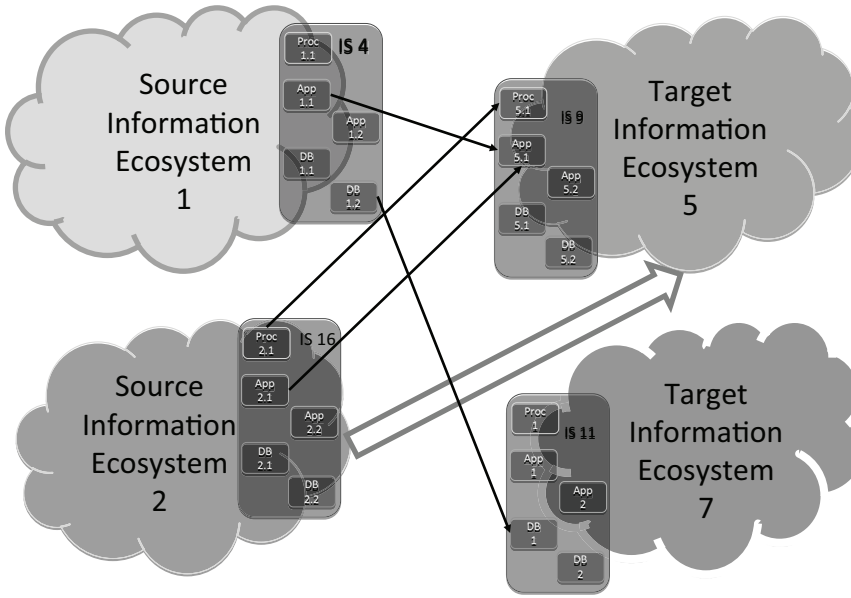

FIGURE E.2 A complex mapping. Target information ecosystem (IE) 5 is derived from source IE 2, but one application is a merge of an application from source IE 1 with one from IE 2. Target IE 7 is new but uses a database from IE 1.

vices could be shared is not possible. Hence, the identification of shared services will be incremental, like all other aspects of CMS modernization and transformation.

Implementation of the Mappings

A considerable amount of the meta-methodology described above is intended to ensure appropriate context and identification of affected source and target components. The actual transitions—modernizations or transformations—that result from the planned mappings, however, take place on individual components and/or the lowest-level elements of the architecture. The final task in the modernization and transformation of a chosen component is to plan for the implementation of the mappings defined in the fourth task above and then to implement them. For each of these mappings, the implementation plan will include (1) creating a development version of the newly envisioned technical ecosystem, (2) testing and evaluating this version against requirements, and (3) moving this ecosystem to production once the requirements are satisfied, replacing the source ecosystem. Implementing a single source to target information system mapping often requires a significant project and considerable resources.[15,16] Implementing a source to target information ecosystem mapping that involves multiple information systems is correspondingly larger and more complex, requiring an incremental approach.

The information ecosystems requirements developed in the above analysis and mapping steps should be used to justify the information ecosystem mapping and thus provide the information systems details for the relevant business case.

[15]For example, see Michael L. Brodie and Michael R. Stonebraker, 1995, *Legacy Information Systems Migration: The Incremental Strategy*, San Francisco, Calif.: Morgan Kaufmann Publishers.

[16]For example, see Willem-Jan van den Heuvel, 2007, *Aligning Modern Business Processes and Legacy Systems: A Component-Based Perspective*, Cambridge, Mass.: MIT Press.

F

Glossary

Accountable care organization—A recognized legal entity under state law, composed of a group of participants (providers of services and suppliers) that have established a mechanism for shared governance and work together to coordinate care for Medicare fee-for-service beneficiaries.

applications architecture—Descriptive term encompassing the structure (e.g., logical organization), properties, and behavior (e.g., interactions) of the applications (e.g., functionality) needed to support a business process.

business ecosystem—The people, processes, services, and information required to operate and meet all business requirements of a specific business role that is independent of other business roles.

business glossary—A compendium of standard definitions, terminology, and representations regarding data to be shared across all the target business systems.

enterprise architecture—Descriptive term encompassing the structure, properties, and behavior of the components of an information system, including architectural layers such as process architecture, applications architecture, information architecture, and infrastructure architecture.

global business ecosystem—The union of all of the business ecosystems bearing on the business.

global information ecosystem—The union of all of the information ecosystems in the enterprise.

health information model—An authoritative set of policies and practices that define the health data objects within an enterprise that will be commonly used by business services; it determines a standard terminology regarding health data objects that is defined in the business glossary.

informatics—Used in the present report as a generic term to refer to both biomedical informatics (the core discipline) and health informatics (its application in clinical care and public health). The field deals with data, information, and knowledge for scientific inquiry, problem solving, and decision making—motivated by efforts to improve human health.

information architecture—Descriptive term encompassing the structure, properties (e.g., formats), and behavior (e.g., flows) of the storage and management of information within a specific information system, with emphasis on information exchange among applications and processes.

information ecosystem—The information technology components and their interactions, automated and manual, required to build, develop, operate, and evolve one or perhaps multiple business functions; the term includes the people who design, build, maintain, and operate the systems.

information system families—Term used internally by the Centers for Medicare and Medicaid Services for groupings of information systems used to accomplish a specific business role; essentially synonymous with the present report's use of "information ecosystem," absent the focus on the humans who design, build, maintain, and operate the systems.

infrastructure architecture—Descriptive term encompassing the structure, properties, and behavior of the technology infrastructure (i.e., hardware and software) components of an information system; does not include information or applications in the information or applications architectures.

modernization, systems modernization—Refers to modest or evolutionary transitions of components and subcomponents of an information system.

process architecture—Descriptive term encompassing the structure, properties, and behavior of the processes in an information system.

software service—An abstraction that represents the execution of some set of actions as part of a process in an information ecosystem. Such services are implemented in modern enterprise architectures by means of remotely invoked procedures and service-level agreements with business units.

transformation, systems transformation—Refers to significant or revolutionary transitions of components and subcomponents of an information technology system.

G

Acronyms

ACO	accountable care organization
AHRQ	Agency for Healthcare Research and Quality
ARRA	American Recovery and Reinvestment Act of 2009
CBO	Congressional Budget Office
CCB	Configuration Control Board
CCW	Chronic Condition Warehouse (CMS)
CHIP	Children's Health Insurance Program
CIO	chief information officer
CLIA	Clinical Laboratory Improvement Amendments of 1988
CMS	Centers for Medicare and Medicaid Services
CTAB	Chief Information Officer's Technical Advisory Board (CMS)
DIB	Data Integrity Board
DME	durable medical equipment
DRG	diagnosis-related group
DRN	distributed research network
EA	enterprise architecture
EDE	enterprise data environment
EHR	electronic health record
EMR	electronic medical record
ESC	executive steering committee

FBI	Federal Bureau of Investigation
FDA	U.S. Food and Drug Administration
FFS	fee for service
GAO	U.S. Government Accountability Office
GBE	global business ecosystem
GDP	gross domestic product
GIE	global information ecosystem
GME	graduate medical education
HCAHPS	Hospital Consumer Assessment of Healthcare Providers and Systems
HCERA	Health Care and Education Reconciliation Act of 2010
HCFA	Health Care Financing Administration (CMS predecessor)
HHS	Health and Human Services, U.S. Department of
HIE	health information exchange
HIGLAS	Health Care Integrated General Ledger Accounting System
HIM	health information model
HIPAA	Health Insurance Portability and Accountability Act of 1996
HITECH	Health Information Technology for Economic and Clinical Health
HOS	Health Outcomes Survey
ICD-9	International Statistical Classification of Diseases and Related Health Problems, 9th Revision
ICD-10	International Statistical Classification of Diseases and Related Health Problems, 10th Revision
ILC	Integrated IT Investment & System Life Cycle Framework
IOM	Institute of Medicine
IPERA	Improper Payments Elimination and Recovery Act of 2009
IRF-PAI	Inpatient Rehabilitation Facility-Patient Assessment Instrument
IPF PPS	Inpatient Psychiatric Facility Prospective Payment System
IRM	information resource management
IT	information technology
ITIRB	Information Technology Investment Review Board (CMS)
MAC	Medicare administrative contractor
MAX	Medicaid Analytic Extract
MCBS	Medicare Current Beneficiary Survey
MDRI	Medicaid Drug Rebate Initiative

MDS	Minimum Data Set
MedPAC	Medicare Payment Advisory Commission
MEDPAR	Medicare Provider Analysis and Review
MIPPA	Medicare Improvements for Patients and Providers Act of 2008
MMA	Medicare Prescription Drug, Improvement, and Modernization Act of 2003
MSP	Medicare as a Secondary Payer
NCQA	National Committee for Quality Assurance
NQF	National Quality Forum
OASIS	Outcome and Assessment Information Set
OESS	Offices of E-Standards and Services (CMS)
OIS	Office of Information Services (CMS)
OMB	Office of Management and Budget
ONC	Office of the National Coordinator for Health Information Technology
ORDI	Office of Research, Development, and Information
OSCAR	Online Survey Certification and Reporting
PPACA	Patient Protection and Affordable Care Act
PRO	professional review organization
PSRO	professional standards review organization
QIO	quality improvement organization
ResDAC	Research Data Assistance Center (CMS)
RHIO	regional health information organization
SSA	U.S. Social Security Administration
SSI	Supplemental Security Income (from SSA)
TRA	Technical Reference Architecture (CMS)
VHA	Veterans Health Administration
VHIM	VHA Health Information Model
VISTA	Veterans Health Information Systems and Technology Architecture