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INFORMATION TECHNOLOGY

HUD Needs to Address Significant Weaknesses in Its Cost Estimating Practices

Accessible Version

GAO Highlights

Highlights of [GAO-17-281](#), a report to congressional committees

Why GAO Did This Study

HUD relies extensively on IT to deliver services and manage programs in support of its mission. For fiscal year 2017, HUD requested \$36 million for IT investments intended to deliver modernized enterprise-level capabilities that better support the department's mission. Critical to the success of such efforts is the department's ability to develop reliable cost estimates that project life-cycle costs and provide the basis for, among other things, informed decision making and realistic budget formulation.

The joint explanatory statement that accompanied the Consolidated and Further Continuing Appropriations Act, 2015, included a provision for GAO to evaluate HUD's cost estimating practices. This review determined the extent to which HUD implemented cost estimating best practices for selected IT investments. GAO selected four IT modernization investments with the largest portion of requested funding for fiscal year 2017, interviewed relevant agency officials, and analyzed and compared each investment's cost estimate to best practices in the *Cost Guide*. This guide states that, when most or all of the practices are "fully" or "substantially" met, an estimate is considered reliable.

What GAO Recommends To improve cost estimating practices, GAO recommends that HUD finalize and implement guidance that incorporates best practices called for in the *Cost Guide*. HUD concurred with this recommendation.

View [GAO-17-281](#). For more information, contact Valerie Melvin at (202) 512-6304 or melvinv@gao.gov.

February 2017

Information Technology

HUD Needs to Address Significant Weaknesses in Its Cost Estimating Practices

What GAO Found

The cost estimates that the Department of Housing and Urban Development (HUD) developed for the four selected information technology (IT) investments were unreliable and, thus, lacked a sound basis for informing the department's investment and budgetary decisions. GAO's *Cost Estimating and Assessment Guide (Cost Guide)* defines best practices that are associated with four characteristics of a reliable estimate—comprehensive, well documented, accurate, and credible. However, none of the cost estimates for the selected investments exhibited all of these characteristics. Only one estimate—for the Customer Relationship Management investment—more than minimally met best practices associated with any of the four characteristics because it partially met the practices for a comprehensive and accurate estimate. The remaining three investments minimally or did not meet the best practices associated with the four characteristics. For example, the Enterprise Data Warehouse estimate minimally met all four characteristics; the Enterprise Voucher Management System estimate did not meet the characteristic for being accurate and minimally met the other three characteristics; and the Federal Housing Administration Automation and Modernization estimate did not meet the characteristic for being credible, while minimally meeting the remaining characteristics (see table).

GAO's Assessment of Cost Estimates for Selected Information Technology (IT) Investments at the Department of Housing and Urban Development (HUD)

Characteristic	Customer Relationship Management	Enterprise Data Warehouse	Enterprise Voucher Management System	Federal Housing Administration Automation and Modernization
Comprehensive	Partially met	Minimally met	Minimally met	Minimally met
Well-documented	Minimally met	Minimally met	Minimally met	Minimally met
Accurate	Partially met	Minimally met	Not met	Minimally met
Credible	Minimally met	Minimally met	Minimally met	Not met

Source: GAO analysis of data provided by HUD officials. | GAO-17-281

The significant weaknesses in the cost estimates for the selected investments can largely be attributed to the department's lack of guidance for developing reliable cost estimates. HUD officials responsible for the selected investments stated that the department had not required the development of estimates that exhibit the four characteristics of a reliable estimate. As a result, according to these officials, cost estimating practices have been decentralized and inconsistent across the department. While HUD drafted guidance in June 2015 that was intended to conform to the best practices in GAO's *Cost Guide*, the department has not yet finalized the guidance because it has focused on establishing the infrastructure needed to support improved cost estimation practices. Until HUD finalizes and ensures the implementation of guidance to improve its cost estimating practices, the department is at risk of continuing to make investment decisions based on unreliable information.

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Abbreviations

HUD	Department of Housing and Urban Development
IT	information technology
OMB	Office of Management and Budget

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February 7, 2017

The Honorable Susan M. Collins
Chairman
The Honorable Jack Reed
Ranking Member
Subcommittee on Transportation, Housing and Urban Development, and
Related Agencies
Committee on Appropriations
United States Senate

The Honorable Mario Diaz-Balart
Chairman
The Honorable David Price
Ranking Member
Subcommittee on Transportation, Housing and Urban Development, and
Related Agencies
Committee on Appropriations
House of Representatives

The Department of Housing and Urban Development (HUD) relies extensively on information technology (IT) to deliver services and manage programs that support its mission of creating strong, sustainable, inclusive communities and quality, affordable homes for all. Among other purposes, HUD relies on IT to support programs that manage approximately \$1 trillion portfolio of insured mortgages, provide roughly \$35 billion in rental housing assistance to needy families, and administer community development grant programs with a combined value of about \$6.6 billion.

However, HUD has long experienced limitations in the systems supporting its mission. Specifically, the department has reported since 2008 that its systems are overlapping, duplicative, and not integrated; necessitate manual workarounds; and employ antiquated, costly-to-maintain technologies. For fiscal year 2017, HUD requested \$36 million for IT investments intended to deliver modernized enterprise-level capabilities that better support the department's mission.

Critical to the success of its modernization efforts is HUD's ability to effectively manage and apply disciplined processes for its IT investments, including developing cost estimates that project realistic life-cycle costs.

Such estimates can provide the basis for informed decision making, realistic budget formulation, and meaningful progress measurement.

The joint explanatory statement accompanying the Consolidated and Further Continuing Appropriations Act, 2015, incorporated language from Senate and House reports that included a provision for GAO to evaluate HUD's cost estimating practices.¹ This review determined the extent to which HUD implemented cost estimating best practices for selected IT investments.

To address the objective, we obtained and analyzed available documentation supporting HUD's cost estimating practices for selected IT investments. This documentation included projected cost estimates, business cases, budget data, and management briefings and reports.

To select the specific investments for our review, we identified the investments in HUD's fiscal year 2017 IT budget request that had not been fully implemented or recently approved for termination, and that were intended to support the different lines of business at HUD.² This resulted in a list of nine potential modernization investments. From this list, we then chose the four modernization investments that comprised the largest portion of the funding requested, 81 percent, for fiscal year 2017.³

For each of the four selections, we assessed the reliability of the investments' cost estimates by comparing the estimates and supporting documentation to the best practices discussed in the GAO Cost

¹Senate Appropriations Committee report, S. Rep. No. 113-182, at 143 (2014), and House Appropriations Committee report, H. Rep. No. 113-464, at 96-97 (2014) (where not changed by the Senate report), as incorporated by the joint explanatory statement of the conference, 160 Cong. Rec. H9307, H9975 and H9983 (daily ed. Dec. 11, 2014) (statement of Chairman Rogers) specifically referenced in section 4 of the Consolidated and Further Continuing Appropriations Act, 2015, Pub. L. No. 113-235, § 4, 128 Stat. 2130, 2132 (Dec. 16, 2014).

²According to HUD's 2015 Enterprise Roadmap, there are 18 different business segments across the department, with each representing an individual line of business (e.g., homeownership) or cross-cutting service (e.g., grants management).

³The four selected investments were (1) Customer Relationship Management, (2) Enterprise Data Warehouse, (3) Enterprise Voucher Management System, and (4) Federal Housing Administration Automation and Modernization. The total amount requested by these four IT investments was approximately 81 percent of the fiscal year 2017 budget request for modernization investments.

Estimating and Assessment Guide (Cost Guide).⁴ These practices have been found to be the basis for reliable cost estimates.

Specifically, we assessed each investment against the four characteristics of a reliable estimate—comprehensive, well-documented, accurate, and credible. Each characteristic was defined by multiple practices, which we assessed as being

- not met—the investment did not provide evidence that it implemented the practices;
- minimally met—the investment provided evidence that it implemented a small portion (less than half) of the practices;
- partially met—the investment provided evidence that it implemented about half of the practices;
- substantially met—the investment provided evidence that it implemented a large portion (more than half) of the practices; or
- fully met—the investment provided evidence that it implemented all of the practices.

We then summarized our assessments of the practices for each characteristic. We considered a cost estimate to be reliable if each of the four characteristics were substantially or fully met. If any of the characteristics were not met, minimally met, or partially met, then we determined that the cost estimate did not reflect the characteristics of a reliable estimate.

We supplemented our analysis with interviews of cognizant HUD officials. These officials included program and other officials responsible for each of the four investments, as well as the Deputy Chief Information Officer, the Director of the Office of the Strategic Planning and Management, and the Assistant Chief Financial Officer for Budget. From these officials, we sought additional information on each investment's approach to developing cost estimates and the steps taken to establish department guidance related to cost estimation.

We conducted this performance audit from July 2016 to February 2017 in accordance with generally accepted government auditing standards.

⁴GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs* (Supersedes [GAO-07-1134SP](#)), [GAO-09-3SP](#) (Washington, D.C.: Mar. 2, 2009).

Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objective. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective.

Background

HUD's mission is to create strong, sustainable, inclusive communities and quality, affordable homes for all. To carry out this mission, the department administers community and housing programs that affect millions of households each year. These programs provide affordable rental housing opportunities and help homeless families and chronically homeless individuals and veterans. The department also administers mortgage insurance programs for single-family housing, multifamily housing, and health care facilities.

IT plays a critical role in HUD's ability to perform its business functions, which involve the management of billions of dollars to carry out its mission. For example, the department's IT environment consists of multiple systems that, among other things, are intended to help coordinate interactions with lending institutions to insure mortgages, collect and manage state and local housing data, process applications for community development, and process vouchers for different rental assistance programs. Its systems also support the processing of applications for, and the management of, more than 50 grant programs administered by the department.

However, according to HUD, its IT environment has not been sufficient to effectively support business functions because its systems are overlapping and duplicative, not integrated, necessitate manual workloads, and employ antiquated technologies that are costly to maintain. The department has reported⁵ that its environment consists of:

⁵Department of Housing and Urban Development, *Strategic Portfolio Review FY 2009* (Washington, D.C.: June 2008); *U.S. Department of Housing and Urban Development: IT Current State Assessment* (Washington, D.C.: January 2011); *FY2012 Information Technology Strategic Portfolio Review, Version 1.1* (Washington, D.C.: May 2012); *Fiscal Year 2013 Target Enterprise Architecture Version 7.0* (Washington, D.C.: November 2012); *Fiscal Year 2013 IT Strategic Portfolio Review* (Washington, D.C.: January 2013); and *HUD Enterprise Roadmap, Version 5.0* (Washington, D.C.: Feb. 14, 2014).

-
- over 200 information systems, many of which perform the same function and, thus, are overlapping and duplicative;
 - stove-piped, nonintegrated systems that result in identical data existing in multiple systems;
 - manual processing for business functions due to a lack of systems to support these processes; and
 - antiquated technology (15 to 30 years old) and complex systems that are costly to maintain.

To address challenges with its IT environment, HUD has developed a number of plans in recent years to guide its modernization efforts. These include plans that outline how it intends to spend IT funds, an information resource management strategic plan, and an enterprise architecture roadmap. These plans contain information related to the department's modernization efforts and actions aimed at improving its capacity to manage IT. Nevertheless, even with these plans and ongoing modernization efforts, the department reported in November 2016 that limited progress had been made in replacing legacy systems and manual processes with modern applications and enhanced capabilities.⁶

HUD's Information Technology Budget and Fiscal Year 2017 Investments

HUD's IT budget covers two categories of spending: (1) operations and maintenance of existing systems and (2) new investments for modernization (often referred to as development, modernization, and enhancement). Operations and maintenance funds refer to the expenses required for general upkeep of the department's existing systems. Funds for modernization support projects and activities that lead to new systems, or changes and modifications to existing systems that substantively improve capability or performance to better support HUD's mission and business functions.

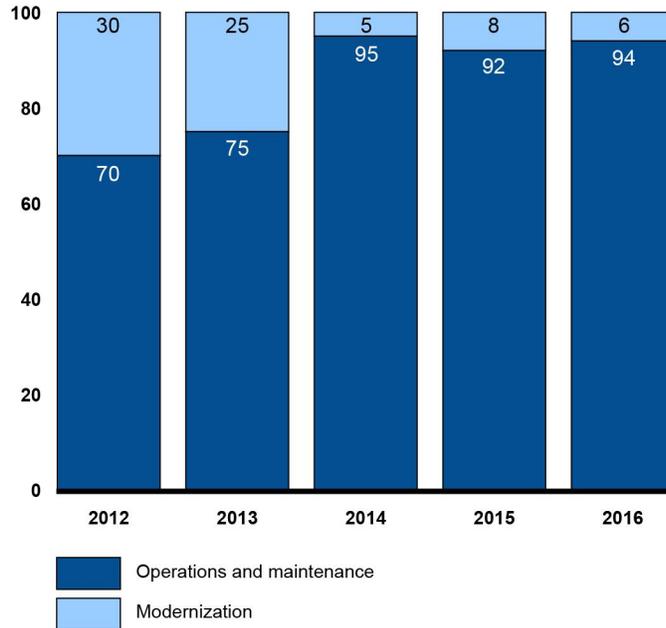
⁶Department of Housing and Urban Development, *Agency Financial Report Fiscal Year 2016* (Washington, D.C.: November 2016).

According to the Office of Management and Budget's (OMB) IT Dashboard,⁷ over the past 5 years, the department spent between approximately 70 and 95 percent of its total IT budget on operations and maintenance; it dedicated a smaller portion—ranging from approximately 5 to 30 percent—to modernization efforts. Figure 1 illustrates the percentage of HUD's IT spending during fiscal years 2012 through 2016,⁸ dedicated to operating and maintaining existing IT versus modernization efforts, as reported on the IT Dashboard.

⁷To provide visibility into the performance of federal agencies' IT investments, OMB deployed the IT Dashboard in 2009, which displays federal agencies' cost, schedule, and performance data. According to OMB, these data are intended to provide a near-real-time perspective on the performance of these investments, as well as a historical perspective. The Dashboard's data are based, in part, on agency assessments of individual investment performance and each agency's budget request to OMB. Further, the public display of these data is intended to allow OMB; other oversight bodies, including Congress; and the general public to hold government agencies accountable for progress and results.

⁸The data represent HUD's actual IT spending during fiscal years 2012 through 2015 and planned spending during fiscal year 2016. As of December 2016, data on actual spending for fiscal year 2016 had yet to be provided on the IT Dashboard.

Figure 1: Department of Housing and Urban Development Percentage of Information Technology (IT) Spending on Operations and Maintenance of Existing IT Versus Modernization Efforts for Fiscal Years 2012-2015, 2016 Planned



Source: GAO analysis of Department of Housing and Urban Development data as reported on the IT Dashboard. | GAO-17-281

Consistent with prior years, a majority of HUD’s fiscal year 2017 IT budget request is intended to support existing systems. Specifically, the department requested \$286 million, of which approximately 87 percent (\$250 million) is planned for operations and maintenance. According to the budget request, the department anticipates using operations and maintenance funds to support business administrative functions as well as its IT infrastructure, which includes servers, communications, equipment and support, desktops, mobile devices, and security.

Of the fiscal year 2017 IT budget request, approximately 13 percent (\$36 million) is intended to support modernization investments aimed at improving the department’s IT environment. According to HUD’s budget request, these funds are to support new investments intended to deliver modernized enterprise capabilities that better support the department’s mission. Specifically, these investments are expected to, among other things, leverage enterprise-level technology, reduce the number of stand-

alone systems, deliver cloud-based technologies,⁹ automate manual processes, and consolidate data.

Of the \$36 million requested for modernization, approximately 81 percent (\$29 million) was identified to support four modernization efforts, which were in various phases of planning and development.¹⁰ Table 1 provides a description of these investments and the amounts of their associated fiscal year 2017 budget requests.

Table 1: Descriptions of Four Information Technology (IT) Investments Identified to Receive 81 Percent of the Department of Housing and Urban Development’s (HUD) Requested Fiscal Year 2017 Modernization Budget

Investment	Description	Fiscal year 2017 budget request
Customer Relationship Management	Intended to replace legacy systems with a modern and unified solution that is expected to integrate multiple call centers, over 40 help desks, and 90 toll-free telephone numbers to allow for more consistent responses and improved service to HUD’s customers.	\$4 million
Enterprise Data Warehouse	Expected to result in the development of a large-scale data warehouse with integrated and standardized data that reduces duplicative systems across the department, improves data analysis and reporting capabilities, and addresses requirements of the Digital Accountability and Transparency Act of 2014. ^a	\$4 million
Enterprise Voucher Management System	Aims to provide automated cash management functions such as performing and validating calculations of monthly disbursements to Public Housing Authorities with greater transparency to external stakeholders and enable the department to begin the decommissioning of legacy systems that support financial management. ^b	\$8 million
Federal Housing Administration Automation and Modernization	Envisioned to modernize obsolete applications, reduce infrastructure costs, and leverage shared components and data to improve the department’s understanding of risks and improve its adaptability to adjust with changes in the housing industry, economic trends, and new legislation, among other things.	\$13 million

Source: GAO analysis of data provided by HUD officials. | GAO-17-281

^aThe Digital Accountability and Transparency Act of 2014 directed the Office of Management and Budget and the Department of the Treasury to establish government-wide data standards to improve the transparency and quality of federal spending data.

^bThe systems expected to begin decommissioning through the Enterprise Voucher Management Systems investment include the HUD Centralized Accounting and Program System, Line of Credit Control System, and Program Accounting System.

⁹According to the National Institute of Standards and Technology, cloud computing is a means for enabling on-demand access to shared and scalable pools of computer resources with the goal of minimizing management effort or service provider interaction.

¹⁰The remaining 19 percent (\$7 million) of requested modernization funds are expected to be spent on the following investments: (1) Affirmatively Furthering Fair Housing Initiative; (2) Fair Housing and Equal Opportunity Section 3 Performance and Evaluation and Registration; (3) Grants Management System Consolidation; (4) HUD Enterprise-wide Records Management System; and (5) Next Generation Management System.

Cost Estimating Best Practices

Our prior work has shown that implementing repeatable, disciplined processes that adhere to federal law and best practices can help agencies effectively plan, manage, and oversee modernization efforts.¹¹ Disciplined processes include establishing guidance that can be used for developing reliable cost estimates that project realistic life-cycle costs. Such estimates are critical to a modernization effort's success because they can be used to support key investment decisions that help to ensure finite resources are wisely spent. In addition, a reliable estimate is the foundation of a good budget and budget spending plan, which outlines how and at what rate an investment's funding will be spent over time. Put another way, reliable cost estimates are essential for successful IT investments and modernization efforts because they help ensure that Congress and the department itself can have reliable information on which to base funding and budgetary decisions.

OMB¹² calls for federal agencies to maintain current cost estimates that encompass the full life-cycle of an investment. Building on OMB's requirements and drawing on practices promulgated by federal cost estimating organizations and private industry, GAO's *Cost Guide*¹³ identifies cost estimating practices that, if followed correctly, have been found to be the basis for a reliable cost estimate.

¹¹GAO, *Farm Program Modernization: Farm Service Agency Needs to Demonstrate the Capacity to Manage IT Initiatives*, [GAO-15-506](#) (Washington, D.C.: June 18, 2015); *Library of Congress: Strong Leadership Needed to Address Serious Information Technology Management Weaknesses*, [GAO-15-315](#) (Washington, D.C.: Mar. 31, 2015); *Information Technology: HUD Can Take Additional Actions to Improve Its Governance*, [GAO-15-56](#) (Washington, D.C.: Dec. 10, 2014); *OPM Retirement Modernization: Progress Has Been Hindered by Longstanding Information Technology Management Weaknesses*, [GAO-12-430T](#) (Washington, D.C.: Feb. 1, 2012); and *Information Technology Investment Management: A Framework for Assessing and Improving Process Maturity (Supersedes AIMD-10.1.23)*, [GAO-04-394G](#) (Washington, D.C.: Mar. 1, 2004). Also see Project Management Institute, Inc. (PMI), *The Standard for Program Management*, Third Edition (2013); and Software Engineering Institute (SEI) at Carnegie Mellon University, *CMMI® for Acquisition (CMMI-ACQ)*, Version 1.3 (Pittsburgh, Pa.: November 2010).

¹²Office of Management and Budget, *Capital Programming Guide: Supplement to OMB Circular A-11: Planning, Budgeting, and Acquisition of Capital Assets*, app. 8 (V 3.0, July 2012).

¹³[GAO-09-3SP](#).

An estimate created using these practices exhibits four broad characteristics: it is comprehensive, well-documented, accurate, and credible. Moreover, each characteristic is associated with a specific set of best practices. Table 2 summarizes, by characteristic, the best practices for developing reliable cost estimates identified in the *Cost Guide*.

Table 2: Four Characteristics of a Reliable Cost Estimate and Summary of Best Practices

Characteristic	Summary of best practices
Comprehensive	The cost estimate should include both government and contractor costs of the investment over its full life-cycle, from inception through design, development, deployment, and operation and maintenance, to retirement of the investment. It should also completely define the investment, reflect the current schedule, and be technically reasonable. Comprehensive cost estimates should be structured in sufficient detail (at least three levels of cost elements) to ensure that costs are neither omitted nor double counted. Specifically, the cost estimate should be based on a product-oriented work breakdown structure that allows an investment to track cost and schedule by defined deliverables, such as hardware or software components. Finally, where information is limited and judgments must be made, the cost estimate should document all cost-influencing ground rules and assumptions.
Well-documented	A good cost estimate—while taking the form of a single number—is supported by detailed documentation that describes how it was derived and how the expected funding will be spent in order to achieve a given objective. Therefore, the documentation should capture in writing such things as the source data used, the calculations performed and their results, and the estimating methodology used to derive each work breakdown structure element’s cost. Moreover, the cost estimate information should be captured in such a way that the data used to derive the estimate can be traced back to and verified against their sources so that the estimate can be easily replicated and updated. The documentation should also discuss the technical baseline description and how the data were normalized. Lastly, the final cost estimate should be reviewed and accepted by management on the basis of confidence in the estimating process and the estimate produced by the process.
Accurate	The cost estimate should provide results that are unbiased, and it should not be overly conservative or optimistic. An estimate is accurate when it is based on an assessment of most likely costs, adjusted properly for inflation, and contains few, if any, minor mistakes. A cost estimate should be updated regularly to reflect material changes in the investment, such as when schedules or other assumptions change, and actual costs, so that it is always reflecting current status. The estimate should be grounded in a historical record of cost estimating and actual experiences on other comparable investments.
Credible	The cost estimates should discuss any limitations of the analysis because of uncertainty or biases surrounding data or assumptions. Major assumptions should be varied, and other outcomes recomputed to determine how sensitive they are to changes in the assumptions (i.e., sensitivity analysis). A risk and uncertainty analysis should be performed to determine the level of risk associated with the estimate. For management to make good decisions, the investment’s estimate must reflect the degree of uncertainty, so that a level of confidence can be given about the estimate. Having a range of costs around a point estimate is more useful to decision makers because it conveys the level of confidence in achieving the most likely cost and also informs them on cost, schedule, and technical risks. The estimate’s results should be cross-checked and an independent cost estimate conducted by a group outside the acquiring organization should be developed to determine whether other estimating methods produce similar results.

Source: GAO-09-3SP | GAO-17-281

Because specific and discrete best practices underlie each characteristic, an agency’s performance in each of the characteristics can vary. For example, an organization’s cost estimates could be found to be comprehensive and well-documented, but not accurate or credible. According to the Cost Guide, a cost estimate is considered reliable if each of the four characteristics is substantially or fully met; in contrast, if any of the characteristics are not met, minimally met, or partially met, the cost estimate cannot be considered reliable.

HUD’s Cost Estimates for Selected IT Investments Exhibited Significant Weaknesses That Made Them Unreliable

The cost estimates that HUD developed for each of the four selected investments exhibited significant weaknesses in that they did not meet or substantially meet best practices for each characteristic. As such, the estimates were unreliable and did not provide a sound basis for informing the department’s investment and budgetary decisions. Specifically, none of the estimates exhibited all of the characteristics of a reliable estimate, as they were not substantially or fully comprehensive, well-documented, accurate, and credible.

Only one estimate—for the Customer Relationship Management investment—more than minimally met best practices associated with any of the four characteristics because it partially met the practices for a comprehensive and accurate estimate. The remaining three investments minimally met or did not meet the best practices associated with the four characteristics. For example, the Enterprise Data Warehouse estimate minimally met all four characteristics; the Enterprise Voucher Management System estimate did not meet the characteristic for being accurate, and minimally met the other three characteristics; and the Federal Housing Administration Automation and Modernization estimate did not meet the characteristic for being credible, while minimally meeting the rest of the characteristics.

Table 3 provides a summary of the extent to which the four investments’ cost estimates were comprehensive, well-documented, accurate, and credible.

Table 3: GAO Assessment of Cost Estimates for Selected Information Technology Investments at the Department of Housing and Urban Development (HUD)

Investment	Comprehensive	Well-documented	Accurate	Credible
Customer Relationship Management	Partially met	Minimally met	Partially met	Minimally met
Enterprise Data Warehouse	Minimally met	Minimally met	Minimally met	Minimally met
Enterprise Voucher Management System	Minimally met	Minimally met	Not met	Minimally met

Federal Housing Administration Automation and Modernization	Minimally met	Minimally met	Minimally met	Not met
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Legend:

- =Fully met—All of the best practices associated with a characteristic are satisfied.
- =Substantially met—A large portion, more than half, of the best practices associated with a characteristic are satisfied.
- ◐=Partially met—About half of the best practices associated with a characteristic are satisfied.
- ◑=Minimally met—A small portion, less than half, of the best practices associated with a characteristic are satisfied.
- =Not met—None of the best practices associated with a characteristic are satisfied.

Source: GAO analysis of data provided by HUD officials. | GAO-17-281

Comprehensive. Of the cost estimates for the four selected investments, none were comprehensive. While one investment partially met associated best practices, the remaining three investments minimally met these practices. Specifically, although all of the estimates included costs for specific elements and phases of the investments, none of the estimates included both government and contractors costs of the investment over the life-cycle, from inception through design, development, deployment, and operations and maintenance, to retirement of the investment.

In addition, the Customer Relationship Management investment partially met the best practice related to defining the investment by, for example, explaining that the effort would result in a cloud-based solution that allowed the department to consolidate existing systems. However, none of the estimates fully met this practice, in part because investment documentation did not completely define system requirements, reflect current schedules, and demonstrate that efforts were technically reasonable. Further, work breakdown structures that had been developed were not sufficiently detailed for any of the investments to ensure that cost elements were neither omitted nor double counted, and allowed for traceability between the investment’s costs and schedule by deliverable, such as hardware or software components.

Moreover, although various assumptions were factored into the cost estimate for the Customer Relationship Management investment, the basis for the assumptions was not documented and, as a result, their reasonableness could not be determined. For the remaining three investments, where information was limited and judgments had to be made, the estimates did not contain cost-influencing ground rules and assumptions.

Well-documented. The four investments did not develop well-documented cost estimates because none were supported by detailed documentation that described how the estimate was derived and how the expected funding would be spent. This characteristic's best practices were minimally met by all of the investments. In discussing the estimating methodologies used to develop the estimates, HUD officials reported using analogy, expert opinion, parametric, and other methods; however, the department did not document the specific methodologies used for any of the investments.

Specifically, HUD did not adequately document for each estimate the sources of data used, any assessments of data accuracy and reliability, and other circumstances affecting the data, such as the details related to calculations performed. The estimating information for the investments also was not captured in a way that the data used could be easily replicated and updated. Further, the documentation did not sufficiently discuss the technical baseline—which is intended to serve as the basis for developing an estimate by providing a common definition of the investment—or how the data were normalized.¹⁴

In addition, while HUD officials reported briefing management on each of the investments and on the high-level estimate for the Enterprise Voucher Management System, the department did not brief management on the ground rules and assumptions underlying the estimate. A cost estimate is not considered valid until management has approved it, yet the department did not provide documentation that any of the four cost estimates had been reviewed and accepted by management.

Accurate. Overall, the four estimates were not accurate because only one estimate partially addressed the best practices associated with this characteristic, two estimates minimally addressed the best practices, and one estimate did not meet any of the associated practices. As such, we could not determine whether the cost estimates provided results that were unbiased and were not overly conservative or optimistic. More specifically, the estimate for the Customer Relationship Management investment partially addressed the best practices in that its calculations did not contain errors and actual costs from existing programs or

¹⁴The purpose of data normalization (or cleansing) is to make a given data set consistent with and comparable to other data used in the estimate. Data can be gathered from a variety of sources and are often in many different forms and need to be adjusted before being used for comparison analysis or as a basis for projecting future costs.

historical data were used to develop the estimate. However, analyses had not been performed for any of the investments to ensure that the cost estimates were based on an assessment of most likely costs.

In addition, none of the investments' estimates had been properly adjusted for inflation to ensure that cost data were expressed in consistent terms, which is important because doing so can help to prevent cost overruns. For example, officials for the Federal Housing Administration Automation and Modernization investment stated that the cost data had not been adjusted for inflation or normalized to constant year dollars to remove the effects of inflation. Further, the estimating techniques used to determine costs were not documented, which prevented an assessment of the accuracy of any calculations performed. Finally, while HUD officials responsible for the investments stated that the estimates were grounded in historical data, such as actual costs from comparable investments, they did not provide evidence to support this assertion for all four investments.

Credible. Three of the investments minimally met the best practices associated with developing a credible cost estimate and one investment did not meet the practices. Specifically, the estimates did not fully discuss limitations of the analyses because of uncertainty or biases surrounding the data or assumptions. For example, none of the investments conducted a sensitivity analysis, which is intended to reveal how the cost estimate is affected by a change in a single assumption and allows for the cost estimator to understand which variable most affects the cost estimate.

In addition, risk and uncertainty analyses were not conducted in a manner that conformed to the practices in the *Cost Guide*. For example, while HUD officials responsible for Enterprise Data Warehouse and Customer Relationship Management investments stated that risks were evaluated, evidence supporting these assertions was not provided. In addition, risk documentation was provided for the Federal Housing Administration Automation and Modernization investment, but the analysis was limited to a portion of the investment and, therefore, did not provide a comprehensive view of the level of risk and the degree of uncertainty associated with the estimate.

Moreover, department officials stated that cross checks were conducted for three of the investments' estimates to determine whether applying other methods produced similar results; however, evidence was not provided to demonstrate how this was done. Lastly, an independent cost

estimate developed by a group outside of the acquiring organization was not conducted to validate the reasonableness of the cost estimates developed for the four investments.

(Additional details on our assessments of the four investments' cost estimates can be found in appendix I.)

The significant weaknesses in the cost estimates can largely be attributed to the department's lack of established guidance for developing reliable cost estimates, which is contrary to our prior work related to disciplined processes. HUD officials responsible for the selected investments' estimates stated that department guidance had not yet been established and that IT investments were not required to develop estimates that exhibit the four characteristics of a reliable estimate. As a result, according to these officials, cost estimating practices are inconsistently implemented across the department and are decentralized because of the reliance on the efforts and experience of various subject matter experts and contractors.

With regard to improving its cost estimating practices, in January 2014, the department began efforts to develop cost estimating guidance by conducting an internal review of approaches used for developing estimates. Following this review, the department drafted guidance in June 2015 that was intended to conform to best practices in the *Cost Guide*. In August 2016, officials from the Offices of Strategic Planning and Management, the Chief Financial Officer, and the Chief Information Officer stated that HUD was in the process of further developing the guidance to reflect cost estimating best practices. However, as of December 2016, the guidance had not yet been established. According to the officials, finalizing the guidance has been a challenge due to competing priorities within the department, such as addressing weaknesses in its governance structure and management processes. Additionally, these officials stated that the department's focus has been on establishing an infrastructure that is expected to enable implementation of better cost estimating practices. Moving forward, the officials stated that they expect to continue efforts to finalize and establish the guidance in the future, although time frames for doing so had not been determined.

Until HUD establishes guidance that calls for the implementation of best practices identified in the *Cost Guide*, the department is less likely to develop reliable cost estimates for its IT investments that can serve as the basis for informed investment decision making. In going forward

without addressing the weaknesses identified in this report, the department risks being unable to effectively estimate funding needs for IT investments and using unreliable data to make budgetary decisions.

Conclusions

While it is critical that HUD's IT investments develop cost estimates that provide Congress and the department reliable information on which to make decisions, the cost estimates for the four selected investments had significant weaknesses. Specifically, none of the cost estimates for these investments were reliable because they did not fully or substantially implement best practices that result in exhibiting characteristics of being comprehensive, well-documented, accurate, and credible. Many of the weaknesses found in the investments can be attributed to the lack of established cost-estimating guidance, which the department has not yet finalized because it has focused on addressing management weaknesses and taking action to establish an infrastructure to support improved cost estimation practices. Until HUD finalizes and ensures the implementation of guidance to improve its cost estimating practices, the department is at risk of continuing to make investment decisions based on unreliable information.

Recommendation for Executive Action

To increase the likelihood that its IT investments develop reliable cost estimates, we recommend that the Secretary of HUD finalize, and ensure the implementation of, guidance that incorporates the best practices called for in the *GAO Cost Estimating and Assessment Guide*.

Agency Comments and Our Evaluation

We received written comments on a draft of this report from HUD, which are reprinted in appendix II. In its comments, the department agreed with our recommendation and indicated that it plans to take action in response.

HUD also provided technical comments, which we incorporated as appropriate. Among these comments, the department took issue with our conclusion that cost estimation had not been a priority and stated that HUD had been focused on establishing an infrastructure so that it could

improve its cost estimating practices. We revised our conclusion to reflect the department's actions in this regard.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Housing and Urban Development, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-6304 or melvin@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

Valerie C. Melvin

Valerie C. Melvin Managing Director, Information Technology

Appendix I: Assessments of Cost Estimates for Selected IT Investments at HUD

The following tables summarize our assessments, for each selected IT investment, regarding the extent to which each met the characteristics of a reliable cost estimate—comprehensive, well documented, accurate, and credible. Specifically, our assessments identified whether the investments estimates met, substantially met, partially met, minimally met, or did not meet each of the four characteristics and provides key examples of the rationale.

Customer Relationship Management

The Customer Relationship Management investment's cost estimate partially met best practices for developing a comprehensive and accurate estimate and minimally met best practices for developing a well-documented and credible estimate.

Table 4: GAO Assessment of the Customer Relationship Management Cost Estimate

Characteristic	Key examples of rationale for assessment
Comprehensive	Partially met. The cost estimate included rough order of magnitude costs for government and contractors through fiscal year 2021. However, the estimate did not include costs over the investment's full life-cycle, including operations and maintenance and retirement of the system. The estimate lacked sufficient detail to ensure that it completely defined the investment, reflected the current schedule, and was technically reasonable. For example, documents that were provided as part of the technical baseline contained descriptions of the investment's goals and future state of the investment, but did not describe technical requirements or attributes of the investment. In addition, although two work breakdown structures were developed, they were not sufficiently detailed to ensure that costs were neither omitted nor double counted. Also, one of the work breakdown structures was not product-oriented and, therefore, did not allow cost and schedule to be tracked by defined deliverables, such as hardware and software components. Moreover, while various assumptions were reflected in the estimate, we could not determine if they were reasonable and to what extent costs would be changed because the details of the assumptions were not included in the estimate.

**Appendix I: Assessments of Cost Estimates
for Selected IT Investments at HUD**

Characteristic	Key examples of rationale for assessment
Well documented	Minimally met. Officials within the Office of the Chief Information Officer responsible for developing the investment's estimate, the Deputy Chief Information Officer for Customer Relationship and Performance Management, and the acting Chief Technology Officer stated that data were collected from sources such as program offices that had costs from existing programs. However, supporting documentation did not identify the source of the data and the method used to develop the estimate, and did not describe step by step how the estimate was developed. As a result, questions about the approach or data used to create the estimate could not be answered, an analyst unfamiliar with the program would not be able to understand and replicate the program's cost estimate, and the estimate was not useful for updates. In addition, while supporting documentation showed that stakeholders had approved the business requirements for the investment, the department did not provide evidence of the cost estimate's approval. According to best practices, providing a briefing to management about how the estimate was constructed is necessary for management to gain confidence that the estimate is accurate, complete, and high in quality.
Accurate	Partially met. Our assessment determined that the estimate's calculations did not contain errors and met certain practices for ensuring that an investment is accurate. For instance, according to officials responsible for the investment, the estimate was developed using actual costs from existing programs and historical data. However, the department did not conduct a risk and uncertainty analysis for the estimate to ensure that it was based on an assessment of most likely costs. As a result, we could not determine whether the estimate was unbiased or if it was overly conservative or optimistic. In addition, while the estimate included some adjustments for inflation, this was not done properly, resulting in a lack of assurance that cost data were expressed in consistent terms. Although HUD officials stated that the estimate had been updated to include operations and maintenance costs, investment documentation did not support this assertion. Finally, according to department officials, the estimate was grounded in actual costs from comparable investments. However, historical data sources and explanations of how such data were used to develop the estimate were not referenced.
Credible	Minimally met. While officials responsible for the investment stated that a risk analysis was conducted and that a risk management plan was being developed, a mathematical method to model risk and uncertainty was not used. In addition, the department had not conducted a sensitivity analysis to better understand the assumptions that most affect the cost estimate and how changes would influence the results of the estimate. Further, although officials responsible for developing the investment's cost estimate stated that they had conducted cross-checks of the estimate to determine whether applying other estimating methods produced similar results, investment documentation provided by HUD did not support this assertion. Moreover, an independent cost estimate by an outside group was not performed to validate and increase the likelihood that management would have confidence in the estimate.

Source: GAO analysis of data provided by HUD officials. | GAO-17-281

Enterprise Data Warehouse

The Enterprise Data Warehouse investment's cost estimate minimally met best practices for developing a comprehensive, well-documented, accurate, and credible estimate.

Table 5: GAO Assessment of the Enterprise Data Warehouse Cost Estimate

Characteristic	Key examples of rationale for assessment
Comprehensive	Minimally met. The cost estimate primarily included contractor costs and, according to HUD officials, assumptions about the investment were documented. However, the estimate did not include all life-cycle costs because the complete set of projects to be included as part of the investment had not yet been determined. As a result, the estimate lacked adequate detail to ensure that it completely defined and reflected the current investment. Also, the estimate did not contain a technical baseline, which would provide a common definition of the investment, including detailed technical, investment, and schedule descriptions. In addition, a work breakdown structure was not used as the basis for the cost estimate to help ensure that cost elements were neither omitted nor double-counted, and to improve traceability between estimated costs and the investment's deliverables, such as hardware or software components. Further, the estimate did not identify global ground rules and assumptions that could be used to establish parameters around investment's schedule, labor rates, inflation indexes, or use of government equipment.
Well documented	Minimally met. According to HUD officials within the Office of the Chief Information Officer responsible for developing the investment's cost estimate, including the Deputy Chief Information Officer for Customer Relationship and Performance Management and the acting Chief Technology Officer, the cost estimate was supported by documentation which demonstrated that calculations performed were mathematically sensible and logical, including costs by labor category and rates. In addition, the officials stated that the data could be referenced when developing future estimates. However, the documentation provided to us did not capture the source data used to develop the estimate, the calculations performed and their results, and the estimating methodology used to derive each cost element. As a result, the estimate was not captured in such a way that it could be easily replicated and updated. Further, a specific technical baseline was not documented for the investment and, therefore, we could not determine whether the technical baseline was consistent with the cost estimate. The officials also stated that the estimate was presented to and approved by management. However, the department did not provide evidence that the estimate was reviewed and accepted by management, which is needed to convey a level of confidence in the estimating approach and the estimate produced.
Accurate	Minimally met. While HUD officials responsible for developing the investment's estimate stated that an uncertainty analysis had been performed for the estimate to help ensure that the estimate was neither overly conservative nor optimistic and based on an assessment of most likely costs, no documentation of this analysis was provided. In addition, the officials stated that the estimate had been adjusted properly for inflation, which is important because cost data must be expressed in consistent terms or cost overruns can result. The officials also stated that the estimate had been checked for accuracy, double-counting, and omissions to verify its accuracy. Further, the officials stated that they based the estimate on other agencies' work or on efforts to implement data warehouses of similar scale and reliability. However, the cost estimate documentation did not support these assertions. Lastly, the estimating techniques used to determine costs were not included in the estimate and, as a result, did not allow us to determine accuracy.
Credible	Minimally met. Officials responsible for the investment stated that the credibility of the estimate was reinforced by using alternative estimating methods and cross checking to see if other estimating methods produced similar results. However, the officials did not provide documentation showing that any cross checks had been performed. These same officials also stated that a risk and uncertainty analysis had been performed to quantify risks and identify the effects of potential changes to key cost drivers, but did not provide documentation to back up the claim. Further, while an independent government cost estimate ^a was performed for use in contract negotiations for the investment, the department did not provide documentation of the independent cost estimates developed.

Source: GAO analysis of data provided by HUD officials. | GAO-17-281

^aThe independent government cost estimate is the government's estimate of the resources and projected cost of the resources a contractor will incur in the performance of a contract. This estimate is developed by the requiring activity and used to establish a realistic price/cost for budget purposes.

Enterprise Voucher Management System

The Enterprise Voucher Management System investment’s cost estimate minimally reflected best practices for developing a comprehensive, well-documented, and credible estimate and did not reflect best practices for developing an accurate cost estimate.

Table 6: GAO Assessment of the Enterprise Voucher Management System Cost Estimate

Characteristic	Key examples of rationale for assessment
Comprehensive	Minimally met. The cost estimate included costs associated with the implementation phase of the investment. However, the estimate did not include all life-cycle costs, such as those for operations, maintenance, and decommissioning activities. It also did not include cost drivers, such as for hardware, labor, and software. The estimate was not supported by a technical baseline and lacked adequate details that stakeholders could use to track cost and schedule status. For example, while a work breakdown structure was created, we found that it did not include sufficient detail to help ensure that cost elements were neither omitted nor double-counted, as well as to improve traceability between estimated costs and the investment’s deliverables, such as hardware or software components. Lastly, supporting documentation for the estimate did not contain cost-influencing ground rules and assumptions—for example, accounting for inflation, budget constraints, and technological maturity—to provide assurance that decision makers could understand the conditions under which the estimate was developed.
Well documented	Minimally met. According to HUD officials responsible for the investment, including the Deputy Chief Information Officer for Customer Relationship and Performance Management and the Director, Office of Housing and Voucher Programs, the investment used requirements definition documents that were created by subject matter experts to help develop cost drivers. The officials reported that the data used were obtained through extensive review with technical team representatives who had experience researching and analyzing the relevant components. However, the cost estimate’s supporting documentation provided to us did not capture in writing the source data used, the reliability of the data, or how the data were normalized. Further, although officials stated that the cost estimate had been presented to management we found no documentation supporting the claim. Without clearly documenting how the estimate was developed, management cannot have confidence in the results of the cost estimate.
Accurate	Not met. Officials responsible for the investment stated that a risk and uncertainty analysis was not performed to determine where the estimate fell against the range of all possible costs. As a result, the department lacked assurance that the estimate represented the most likely costs to be incurred. The estimate also was not adjusted for inflation, which is important when developing an estimate because cost data must be expressed in consistent terms or cost overruns can result. In addition, the officials did not provide evidence that costs were grounded in a historical record or cost estimating and actual experiences from comparable investments. Moreover, detailed calculations were not documented to show how costs were determined. Without this information, the estimate cannot be assessed for accuracy.
Credible	Minimally met. The department did not conduct a sensitivity analysis to better understand the assumptions that could affect the cost estimate and how changes would influence the result of the estimate. In addition, a risk and uncertainty analysis was not performed to increase the level of confidence associated with the estimate. Officials responsible for the estimate stated that cross checks were performed that were appropriate for high-level planning, but did not provide evidence to support this assertion. While an independent government cost estimate was developed for use in contract negotiations, an independent cost estimate by a group outside the acquiring organization was not conducted to determine the reasonableness of the estimate.

Source: GAO analysis of data provided by HUD officials. | GAO-17-281

Federal Housing Administration Automation and Modernization

The Federal Housing Administration Automation and Modernization investment's cost estimate minimally met best practices for developing a comprehensive, well documented, and accurate estimate and did not meet best practices for developing a credible cost estimate.

Table 7: GAO Assessment of the Federal Housing Administration Automation and Modernization Cost Estimate

Characteristic	Key examples of rationale for assessment
Comprehensive	Minimally met. HUD officials responsible for the estimate, including the interim director of the Federal Housing Administration's systems and technology division, stated that relevant costs were addressed in a business case analysis. However, this analysis was limited to costs for 2 fiscal years and did not represent the life-cycle of the investment, which is necessary for understanding the full cost impacts of a program. Although requirements and high-level technical descriptions were developed for portions of the investment, these documents did not provide comprehensive data that we could use to understand how the estimate was developed. The estimate also lacked a common definition of the investment, including sufficiently detailed technical, investment, and schedule descriptions. In addition, we found that a work breakdown structure was created for the investment, but it was not sufficiently detailed to ensure that cost elements were neither omitted nor double counted. Furthermore, the estimate did not contain ground rules and assumptions to provide assurance that decision makers understood the conditions under which the estimate was developed.
Well documented	Minimally met. The estimate documentation contained costs for a portion of the investment and HUD officials stated that various methods were used for its development. However, the methodology and source data used were not sufficiently documented to ensure that the calculations could be easily replicated and updated. Moreover, department officials responsible for the investment stated that presentations were made to executive leadership regarding the investment's budget request, yet they did not provide evidence showing that the estimate was reviewed and accepted by management. In the absence of such a review, management could not have a clear understanding of how the estimate was developed, including the risks associated with the underlying data and methods used.
Accurate	Minimally met. HUD officials responsible for the investment stated that the estimate was checked for accuracy, double counting, and omissions, but evidence was not provided to demonstrate that these activities had been performed for the investment. The data used to create the estimate came primarily from the Federal Housing Administration roadmap, prior experiences, and industry-based data; however, the accuracy and reliability of the data were not documented. In addition, the officials stated that the estimate had not been adjusted properly for inflation to ensure that the estimate was expressed in consistent terms. Further, the estimating techniques used to determine costs were not documented to allow for the accuracy of the estimate to be determined.
Credible	Not met. Officials responsible for the developing the cost estimate stated that neither a risk and uncertainty analysis nor a sensitivity analysis was performed to quantify risks and identify the effects of potential changes to key cost drivers. In addition, no independent cost estimate was developed for the investment. Further, a cross check and independent cost estimate conducted by an outside group were not completed to validate the estimate and ensure that different methods would produce similar results.

Source: GAO analysis of data provided by HUD officials. | GAO-17-281

Appendix II: Agency Comments



U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, DC 20410-3000

CHIEF INFORMATION OFFICER

JAN 23 2017

Ms. Valerie C. Melvin
Managing Director
Information Technology
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Ms. Melvin:

Thank you for the opportunity to comment on the Government Accountability Office (GAO) draft report entitled, *Information Technology: HUD Needs To Address Significant Weaknesses In Its Cost Estimating Practices* (GAO-17-281).

The Department of Housing and Urban Development reviewed the draft report and concurs with the recommendation for Executive Action. More definitive information with timelines will be provided once the final report has been issued. Enclosed are the Department's comments on the draft report.

If you have questions or require additional information, please contact Janice Ausby, Deputy Chief Information Officer, Business and IT Resource Management Office, at (202) 402-7605 (Janice.L.Ausby@hud.gov), or Juanita L. Toatley, Audit Liaison, Audit Compliance Branch, at (202) 402-3555 (Juanita.L.Toatley@hud.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "Kevin R. Cooke, Jr.", written over a white background.

Kevin R. Cooke, Jr.
Acting Chief Information Officer

Enclosure

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Valerie C. Melvin, (202) 512-6304 or melvinv@gao.gov

Staff Acknowledgments

In addition to the contact named above, Teresa M. Yost (Assistant Director), Donald Baca (Analyst-in-Charge), Brian Bothwell, Kami Brown, Rebecca Eyler, Amanda Gill, and Karen Richey made key contributions to this report.

Appendix

Appendix IV: Accessible Data

Figure 1: Department of Housing and Urban Development Percentage of Information Technology (IT) Spending on Operations and Maintenance of Existing IT Versus Modernization Efforts for Fiscal Years 2012-2015, 2016 Planned

Year	OM	DME
2012	70	30
2013	75	25
2014	95	5
2015	92	8

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