

**GAO**

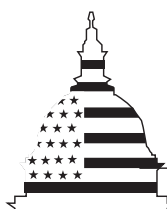
Report to the Chairman of the  
Subcommittee on Defense, Committee on  
Appropriations, House of  
Representatives

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October 1999

**DEFENSE  
COMPUTERS**

**DOD Y2K Functional  
End-to-End Testing  
Progress and Test  
Event Management**



**G A O**

Accountability \* Integrity \* Reliability

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## Abbreviations

|      |                                    |
|------|------------------------------------|
| DISA | Defense Information Systems Agency |
| DOD  | Department of Defense              |
| JUSE | Joint User Switch Exercise         |
| OMB  | Office of Management and Budget    |
| OSD  | Office of the Secretary of Defense |
| PSA  | Principal Staff Assistant          |
| Y2K  | Year 2000                          |

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United States General Accounting Office  
Washington, D.C. 20548

Accounting and Information  
Management Division

B-283564

October 18, 1999

The Honorable Jerry Lewis  
Chairman, Subcommittee on Defense  
Committee on Appropriations  
House of Representatives

Dear Mr. Chairman:

Complete and thorough Year 2000 (Y2K) testing is essential to provide reasonable assurance that new or modified systems process dates correctly and will not jeopardize an organization's ability to perform core business operations after the millennium. This is especially true for the Department of Defense (DOD) which relies on a complex and broad array of interconnected computer systems—including weapons, command and control, satellite, inventory management, transportation management, health, financial, personnel and payment systems—to carry out its core business functions and military operations.

At your request, we initiated a review of the effectiveness of DOD's efforts to perform Year 2000-related end-to-end tests for its major business functions, including Health Affairs, Communications, Personnel, and Logistics. Together, these functional areas are performing thousands of end-to-end tests to ensure that key business processes and systems can continue operating into the year 2000. Specifically, for each functional area, we analyzed reported information on the status and progress of all test events. We also selected and reviewed a critical test event in each functional area to determine whether it was planned and managed in accordance with our Year 2000 testing guide.<sup>1</sup> On September 14, 1999, we briefed you on the results of our review. This report provides a summary of our briefing and a recommendation to Defense for strengthening oversight of end-to-end testing for the Communications functional area. Subsequent to our briefing, logistics officials submitted additional information on the inclusion of installation telecommunications providers in related test events. We have clarified the briefing slides to reflect this. These clarifications, however, do not affect our overall conclusions and recommendation. The briefing slides are presented in appendix I, and our

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<sup>1</sup>Year 2000 Computing Crisis: A Testing Guide (GAO/AIMD-10.1.21, November 1998).

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objectives, scope, and methodology are in appendix II. The Office of the Assistant Secretary of Defense provided written comments on a draft of this report. These comments are discussed at the end of this report and reprinted in appendix III. We performed our audit work from March through September 1999 in accordance with generally accepted government auditing standards.

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## Results in Brief

Because Year 2000 conversions often involve numerous large interconnecting systems with many external interfaces and extensive supporting technology infrastructures, Year 2000 testing should be approached in a structured and disciplined fashion. Our Year 2000 guidance recommends that in planning and managing end-to-end tests, agencies define test boundaries, secure the commitment of data exchange partners, prepare test procedures and data, define exit criteria,<sup>2</sup> and document test results, among other steps. Each of the individual test events we attended and reviewed within the four functional areas generally satisfied the key processes that our Year 2000 test guide defines as necessary to effectively plan, conduct, and report on end-to-end testing.<sup>3</sup> Moreover, while the events' respective approaches to implementing the key processes varied, these differences were appropriately based on consideration of the event's scope and complexity.

In addition, overall end-to-end test efforts within three of the four functional areas were reported to be largely on schedule and expected to be completed by October 1999. However, at the time we briefed the Communications functional area on the results of our review, it could not provide complete progress information. While information was subsequently provided by Communications, it showed that the functional area had not yet developed plans to test 31 mission-critical systems. We are making a recommendation to Defense to ensure that these systems are tested or that there is adequate justification for their exclusion from end-to-end test events. While Defense only partially concurred with this recommendation, it provided information showing the status of the systems in question. We did not verify this information.

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<sup>2</sup>Exit criteria are test conditions or requirements for successfully completing testing.

<sup>3</sup>Our observations are limited to the specific events we witnessed, and we cannot draw conclusions regarding end-to-end testing from an overall functional area perspective.

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## Background

In August 1998, the Deputy Secretary of Defense recognized the need to ensure that various key lines of business or functional areas within the department could continue to operate effectively at and after the turn of the century. Therefore, the Deputy Secretary directed Office of the Secretary of Defense focal points, known as Principal Staff Assistants (PSAs), to verify that all functions would be unaffected by Year 2000 issues. In doing so, the PSAs were to (1) document mission-critical functions and systems supporting those functions, (2) coordinate, facilitate, and monitor Year 2000 end-to-end test and evaluation activities of services, agencies, and commands, and (3) in some cases, conduct Y2K end-to-end functional testing.

The purpose of end-to-end testing is to verify that a defined set of interrelated systems, which collectively support an organizational core business area or function, interoperate as intended in an operational environment (either actual<sup>4</sup> or simulated). These interrelated systems include not only those owned and managed by the organization, but also the external systems with which they interface or that otherwise support the core business area or function.

The boundaries for end-to-end tests can vary depending on a given business function's system dependencies and criticality to the organizational mission. Therefore, in managing end-to-end test activities, it is important to analyze the interrelationships among core business functions and their supporting systems, and the mission impact and risk of date-induced systems failures and to use these analyses to define test boundaries. It is also important to work early and continually with functional partners to ensure that related end-to-end test activities are effectively coordinated and integrated. As highlighted in table 1, our Year 2000 test guide, which has been adopted by the Office of Management and Budget (OMB), recommends that federal agencies take the following actions in planning and managing end-to-end tests.

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<sup>4</sup>Risks of testing in the production environment must be thoroughly analyzed and precautions taken to preclude damage to systems and data.

**Table 1: Summary of Recommended End-to-End Test Management Processes**

|                                                                   |                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Define the system boundaries of the end-to-end test(s)            | Agencies should define boundaries for the end-to-end test based on an assessment of their mission-critical business functions, inter- and intraorganization system dependencies, as well as the probabilities and impacts of any of these systems suffering a date-related failure. |
| Secure the commitment of data exchange partners                   | Because end-to-end testing addresses business areas or functions that involve multiple internal and external organizations, participation by all key data exchange partners should be solicited and obtained.                                                                       |
| Establish an interorganizational test team                        | A team composed of representatives from each of the organizations participating in the test should be formed to manage the planning, execution, and reporting of the test.                                                                                                          |
| Confirm Year 2000 compliance of telecommunications infrastructure | In order to execute end-to-end testing and ensure that all systems in the chain of support to core business areas function as intended, agencies should ensure that the telecommunications infrastructure that interconnects the systems is compliant and ready for testing.        |
| Schedule and plan end-to-end test(s)                              | A plan should be developed specifying key tasks and requirements for test planning, execution, and validation as well 25 milestones and resources associated with performing these tasks.                                                                                           |
| Prepare end-to-end procedures and data                            | Interorganizational test procedures and data, including steps, cases, and input conditions that verify the correct handling of critical dates, should be prepared and approved by team representatives.                                                                             |
| Define end-to-end test exit criteria                              | The conditions or requirements for successfully completing end-to-end testing need to be established.                                                                                                                                                                               |
| Execute end-to-end test(s)                                        | Tests should be executed in accordance with established plans and procedures.                                                                                                                                                                                                       |
| Document test results                                             | Test results should be documented so that the data can be used to validate that test exit criteria had been met and to assess and correct problems discovered during the testing.                                                                                                   |
| Correct Year 2000 defects                                         | On the basis of interorganization specified criteria, such as defect severity and test exist criteria, defects identified during the test should be prioritized and corrected.                                                                                                      |
| Ensure that end-to-end test exit criteria are met                 | Test results should be compared to test exit criteria to ensure that specified conditions are met.                                                                                                                                                                                  |



The table below explains how the four functional areas included in our review approached their end-to-end tests.

**Table 2: Summary of the Four Functional Area Test Approaches**

| <b>Function</b> | <b>Description of decomposition</b>                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Health Affairs  | Health Affairs divided its function into three business processes: patient care, patient administration, and medical logistics. Health Affairs then broke down each process into several sub-processes, termed “threads.”                                                                                                                                                                                                      |
| Communications  | Because Communications cross cuts all functional/operational areas, Communications is testing based on system user. Therefore, Communications divided its function into 263 mission-critical systems. Various military services, Defense agencies, and commanders-in-chief own these systems.                                                                                                                                  |
| Personnel       | Personnel divided its function into six areas: Army, Navy, Air Force, Marine Corps, Civilian, and DEERS/RAPIDS (personnel systems). Personnel then broke down each area into sub-processes, termed “threads.” Personnel is not conducting its own end-to-end tests. Instead, Personnel is participating in and observing service-level testing.                                                                                |
| Logistics       | Logistics divided its function into four business processes: requisition, receipt, shipment, and inventory control and asset status. Logistics then broke down each process into several sub-processes, termed “threads.” Logistics tested these four processes in two phases: intracomponent (within each military service or Defense agency) and intercomponent (joint testing with military services and Defense agencies). |

The test events we selected from each area to review ranged from a simple test involving two information systems located within one organization to an intricate test of DOD’s voice and data telecommunications networks involving several commands and multiple systems. Specifically, the Health Affairs test event we reviewed assessed the ability of two interfacing systems to issue and process blood requests after the calendar year rollover. The Communications test event that we observed was a portion of a larger test and assessed whether voice communications could be sent from Fort Monmouth, New Jersey, to St. Louis, Missouri, using DOD telecommunications networks and equipment and whether messages could be exchanged using the Defense Messaging System from the Strategic Command to the Atlantic Command. The Personnel test event assessed the Army’s ability to create active duty units for deployment from the Army Reserve and Army National Guard. Finally, the Logistics event focused on intercomponent testing—between the Army, Air Force, Navy, Marine Corps, and Defense Logistics Agency—and was designed to verify the Year 2000 readiness of 17 of the 53 total logistics requisition and receipt processes.

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## End-to-End Tests Reported to Be on Schedule

Available information for the respective areas indicates that, as of August 1999, end-to-end tests were largely on schedule and expected to be completed by October 1999. In particular,

- Health Affairs, which had three primary business processes, completed testing for two—patient care and patient administration business processes—and was on schedule to complete tests for the third—medical logistics—by the end of September 1999.
- Personnel tests for the Army, Air Force, and Civilian areas had been completed, while the Navy tests were scheduled to be done October 17, 1999. The Marine Corps was behind schedule on one test. However, it completed the test by September 9, 1999.
- Logistics intra- and intercomponent tests, which involve four primary business processes—requisition, shipment, receipt, and inventory control and asset status—had been completed for intercomponent transactions. Tests were scheduled to be done by the end of August 1999 and, according to Logistics officials, were completed on schedule.
- When we briefed the Communications functional area on the results of our review in July 1999, it was unable to provide progress information on all of its 263 mission-critical systems. Subsequently, Communications reported that 77 mission-critical systems had completed testing and 155 systems did not require testing.<sup>5</sup> The functional area also reported that the remaining 31 mission-critical systems<sup>6</sup> did not yet have plans for testing and were considered to be behind schedule.

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## Selected End-to-End Test Events Were Managed According to GAO Guidance

We selected one test event from each functional area, determined whether the key processes outlined in our Year 2000 testing guide were followed and found that DOD had completed the majority of the processes called for in the guide. For example, for the four test events reviewed, DOD had defined test boundaries, defined exit criteria that would be used to determine when a test was successfully completed, and described how the test results would be documented. While the event's respective approaches to implementing the key processes varied, these differences were based on

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<sup>5</sup>The Communications function considers systems that do not require end-to-end testing to be developmental systems, those that do not process dates, and stand-alone systems.

<sup>6</sup>According to Communications officials, some of these systems are satellite and control systems, which may require waivers.

the consideration of the event’s scope and complexity and inherent business risk. Our test guidance permits such differences when justified on the basis of business value and risk.

Table 3 summarizes the results of our review. As the table notes, of the possible 44 key processes spanning the 4 test events, 34 were fully satisfied while another 2 were partially satisfied. For the remaining 8 key processes, 4 were still in progress, and 4 processes concerning correcting defects found were “not applicable” because initial testing results had not yet disclosed Year 2000 defects. However, some of the test results that were obtained during our review were still being analyzed by DOD.

**Table 3: Summary of Test Events Satisfying GAO Key Processes**

| Selected functional area test event | Fully satisfied | Partially satisfied | In progress | N/A      | Total     |
|-------------------------------------|-----------------|---------------------|-------------|----------|-----------|
| Health Affairs                      | 8               | 1                   | 1           | 1        | 11        |
| Communications                      | 9               | 0                   | 1           | 1        | 11        |
| Personnel                           | 9               | 0                   | 1           | 1        | 11        |
| Logistics                           | 8               | 1                   | 1           | 1        | 11        |
| <b>Total</b>                        | <b>34</b>       | <b>2</b>            | <b>4</b>    | <b>4</b> | <b>44</b> |

Note: Due to differences in scope and complexity of the test events, the results of individual functions are not comparable.

In all cases where we determined that the test events’ key processes called for in our guide had only been partially satisfied, the PSAs and test managers agreed to address our concerns and initiate corrective actions. For example:

- While Health Affairs prepared procedures for its test event, these procedures were not sufficiently detailed and did not define each step to be executed or precisely define input data. As a result, it was necessary for system operators to augment the test procedures during the test’s execution. While this approach was satisfactorily carried out because the relative simplicity of the test event permitted face-to-face coordination and synchronization of the procedures, it was unnecessarily risky and could have been easily avoided by ensuring that test procedures were complete. Health Affairs officials agreed that more detailed procedures should have been established, and they committed to ensuring that other Health Affairs test events have them.

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- Although the Logistics function is reliant on telecommunications providers such as military installations and the Defense Information Systems Agency (DISA), at the time of the test event we observed, documentation offering assurances that installations' telecommunications infrastructures were Y2K compliant was not provided by Logistics functional managers. Our test guide states that, in order to ensure that all systems in the chain of support function as intended, the telecommunications infrastructure that interconnects the systems must be compliant and ready for testing. Subsequent to our review, Logistics officials provided information showing that installations' telecommunications infrastructures had been included in installation test events. Logistics officials agreed, however, that they had not yet confirmed the Y2K compliance of the infrastructures, and reported that they have subsequently initiated steps to do so.

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## Conclusions

Given that virtually all Defense business functions and military operations rely heavily on technology, it is vital that Year 2000 end-to-end testing efforts be effectively planned and executed. All four of the individual test events that we reviewed were well-managed because each either satisfied or had steps underway or planned to address all relevant end-to-end management key processes specified in our test guide. Moreover, differences between the functional areas' approaches to implementing these key processes were generally commensurate with the events' scope and complexity. Finally, reported functional area status information indicates that end-to-end tests are generally progressing on schedule. However, DOD does not yet have assurance that all of its communications systems will be Year 2000 compliant and, as such, should ensure that all mission-critical communications systems are tested.

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## Recommendation

We recommend that the Secretary of Defense direct the Senior Civilian Official of the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence to report to the Deputy Secretary immediately on plans for end-to-end testing the 31 mission-critical communications systems, including milestones for executing tests and reporting test results, or to otherwise justify in writing to the Deputy Secretary why any of the systems will not be included in an end-to-end test event.

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## Agency Comments and Our Evaluation

DOD concurred with our findings and partially concurred with our recommendation to report to the Deputy Secretary on the status and plans for Y2K testing of the 31 mission-critical communications systems disclosed in our report.

In partially concurring on the recommendation, DOD stated that during the July through August 1999 period of our review, testing data in the OSD Y2K database was still evolving, and as a result, test data were incomplete for many of the 31 systems. Since then, resolution has been reached on the testing status of the 31 communications systems. DOD reported and provided documentation to show that (1) Y2K testing for 14 of the 31 systems has been completed, (2) 9 systems do not process dates and are exempt from end-to-end test requirements, (3) 4 systems are trusted systems, which cannot be tested in a Y2K environment due to safety, security, or operational necessity reasons, (4) 2 systems are developmental systems that will not be deployed before the millennium rollover, (5) 1 system has been reclassified as a nonmission-critical system and does not require additional testing, and (6) 1 system is scheduled to complete testing by October 15, 1999. We have not verified the status information provided by DOD.

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We are sending copies of this report to Representative John P. Murtha, Ranking Minority Member, Subcommittee on Defense, House Appropriations Committee; Senator John Warner, Chairman, and Senator Carl Levin, Ranking Minority Member, Senate Committee on Armed Services; Senator Ted Stevens, Chairman, and Senator Daniel Inouye, Ranking Minority Member, Subcommittee on Defense, Senate Committee on Appropriations; and Representative Floyd Spence, Chairman, and Ike Skelton, Ranking Minority Member, House Committee on Armed Services.

We are also sending copies to the Honorable John Koskinen, Chair of the President's Year 2000 Conversion Council; the Honorable William Cohen, Secretary of Defense; the Honorable John Hamre, Deputy Secretary of Defense; General Henry Shelton, Chairman of the Joint Chiefs of Staff; Arthur Money, Senior Civilian Official of the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence; and the Honorable Jacob Lew, Director of the Office of Management and Budget. Copies will also be made available to others upon request.

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Should you or your staff have any questions concerning this report, please contact me at (202) 512-6240. I can also be reached by e-mail at *brockj.aimd@gao.gov*. Other points of contact and key contributors to this report are listed in appendix IV.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'J. Brock, Jr.', with a long horizontal flourish extending to the right.

Jack L. Brock, Jr.  
Director, Governmentwide and Defense  
Information Systems



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# Briefing on DOD Y2K Functional End-to-End Testing: Progress and Test Event Management

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## **DOD Y2K Functional End-to-End Testing: Progress and Test Event Management**

**House Appropriations Committee  
September 14, 1999**

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## **Briefing Overview**

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- Introduction
- Objectives
- Scope and Methodology
- Background
- Objective 1: Status and Progress Information Summary
- Objective 2: Results of Specific Test Events Reviewed
- Findings
- Conclusions
- Recommendation



## Introduction

- In August 1998, the Deputy Secretary of Defense directed the Principal Staff Assistants (PSAs), who are responsible for Defense’s functional areas, to coordinate, facilitate and monitor a series of Year 2000 functional evaluations (Y2K functional testing) to ensure functions will operate properly in a Y2K environment.
- Y2K functional testing is one of three Defense Y2K end-to-end test and evaluation efforts. Y2K end-to-end testing is testing performed to verify that systems collectively supporting an organizational core business function or operation interoperate as intended in a Y2K environment.
- The PSAs core business processes are referred to as “threads.”



## GAO Objectives

- At the request of the Chairman, House Appropriations Committee, Defense Subcommittee, we initiated a review of the effectiveness of DOD Y2K functional end-to-end test management. The objectives of the review are to:
  - Assess status/progress on all test events within four functional areas: Health Affairs, Communications, Personnel, and Logistics
  - Review the management effectiveness of a critical test event for each of the four functional areas



## Scope and Methodology

- The test events we reviewed were:
  - Health Affairs
    - Patient Care/Issuance and Processing of Blood Requests
  - Communications
    - Joint User Switch Exercise (JUSE-99-Y2K)
  - Personnel
    - Army Personnel/Mobilization/Reserve Unit
  - Logistics
    - Joint tests of requisition and receipt processes



## Scope and Methodology

- For all test events, we compared reported status information to test plan milestones to identify variances.
- For the selected test events, we:
  - observed a part of the test event for each functional area and
  - compared event management activities to the key processes for end-to-end testing as specified in our Year 2000 Test Guide.
- The test events we reviewed were selected based on the PSA's designation that the events were of key importance to the business function.



## Scope and Methodology

- The test events we reviewed assessed calendar year rollover only.
- We briefed the respective PSAs and test event managers on the results of our reviews following the conclusion of each event.
  - Health Affairs, June 15, 1999
  - Communications, July 12, 1999
  - Personnel, July 15, 1999
  - Logistics, August 17, 1999



## Scope and Methodology

- In commenting on the briefings, PSAs and test managers agreed with the results. This briefing consolidates the results of those individual briefings, and provides updated status information on each functional area's testing progress. We also clarified the results of our analysis of the Logistics test event based on additional information provided by Logistics officials after our September 14, 1999 briefing.
- Due to differences in scope and complexity, the results of our review of the test events are not comparable across functions.
- We performed our audit work in accordance with generally accepted government auditing standards between March and September 1999.



## Background

- DOD requires PSAs to verify that their respective critical business processes can function properly in a Y2K environment.
- PSAs are to:
  - document mission-critical functions and systems supporting those functions,
  - coordinate, facilitate, and monitor Y2K end-to-end test and evaluation activities of services, agencies, and commands, and
  - in some cases, conduct Y2K end-to-end functional testing.





## Background

- The scope and complexity of the test events varied in terms of, for example, the numbers of systems tested and locations involved.
  - Health Affairs test event involved a two system cluster in a simulated Y2K environment. In contrast, the Logistics test event included 6 operational systems and multiple geographical dispersed installations.
  - Personnel test event involved only Army systems. Communications, Logistics and Health Affairs test events involved more than one Defense component.



## Background

- Army Personnel and Logistics chose different methods for testing threads that spanned more than one day.
  - Army Personnel divided its threads into what are termed “pairs” and tested transactions across each “pair” of systems using the critical rollover date.
  - Logistics used a 5-day test cycle that commences on the day before rollover (i.e., 9/30/1999, 12/31/1999, and 2/28/2000). This strategy verifies the mission-critical thread across the date rollover, rather than verify all systems ability to correctly perform their respective function across the date rollover.



## Objective 1: Status and Progress Information Summary

- *Criteria:* Management should collect timely, reliable test progress and status information in order to ensure that testing is progressing according to plans and that problems are resolved and testing requirements are met.
- *Finding:* Health Affairs, Personnel, and Logistics are collecting the progress and status information.
- *Finding:* At the time of our July 1999 briefing to the PSA, Communications was unable to provide us with complete information on functional test event's progress for all mission-critical systems it had identified. Subsequently, additional information was provided that shows the status of all systems; however, Communications reported that tests have not yet been planned for 31 of the systems.



## Objective 1: Status and Progress Information Summary (continued)

- *Finding:* With the exception of the tests that need to be planned for the 31 Communications systems, the *available* test progress information shows that functional areas end-to-end test events are on schedule.



## Objective 1: Status and Progress Information

### Health Affairs

| Test Type                                                                | Reported Status of Testing Efforts                                                                                                        |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Patient Care</li></ul>           | 26 out of 26 threads have been tested. Testing was completed on schedule.                                                                 |
| <ul style="list-style-type: none"><li>• Patient Administration</li></ul> | 30 out of 30 threads have been tested. Testing was completed on schedule.                                                                 |
| <ul style="list-style-type: none"><li>• Medical Logistics</li></ul>      | 26 out of 55 threads have been tested. Testing commenced on July 2, 1999 and is on schedule to be completed by the end of September 1999. |



## Objective 1: Status and Progress Information (continued)

### Communication

| Test Type                                                        | Reported Status of Testing Events                                                                                             |
|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Army</li> </ul>         | Of 68 systems: 19 have been tested, 4 have not been planned and are late, and 45 systems do not require tests. <sup>1</sup>   |
| <ul style="list-style-type: none"> <li>• Air Force</li> </ul>    | Of 32 systems: 10 have been tested, 14 have not been planned and are late, and 8 systems do not require tests. <sup>1</sup>   |
| <ul style="list-style-type: none"> <li>• Navy</li> </ul>         | Of 123 systems: 30 have been tested, 4 have not been planned and are late, and 89 systems do not require tests. <sup>1</sup>  |
| <ul style="list-style-type: none"> <li>• Marine Corps</li> </ul> | Of 6 systems: 1 has been tested, 1 has not been planned and is late, and 4 systems do not require tests. <sup>1</sup>         |
| <ul style="list-style-type: none"> <li>• CINCs</li> </ul>        | Of 15 systems: 5 have been tested, and 8 have not been planned and are late, and 2 systems do not require tests. <sup>1</sup> |
| <ul style="list-style-type: none"> <li>• DISA</li> </ul>         | Of 19 systems: 12 have been tested and 7 systems do not require tests. <sup>1</sup>                                           |

<sup>1</sup>Communications relied on the Y2K Office database to identify systems that do not require testing. Systems that do not require tests are: 1) developmental systems, 2) do not process dates, or 3) are stand alone systems.



## Objective 1: Status and Progress Information (continued)

### Personnel

| Test Type                       | Reported Status of Testing Efforts                                                                                                                       |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| • Army                          | 19 out of 19 threads have been tested. Testing was completed on schedule.                                                                                |
| • Navy                          | Testing is in progress, 0 out of 18 threads are complete. The testing was started ahead of schedule and is planned to be completed by October 17, 1999.  |
| • Marine Corps                  | 7 out of 7 threads have been tested. The testing began on time; however, 1 thread was not completed until September 9, 1999, instead of August 20, 1999. |
| • Air Force                     | 10 out of 10 threads have been tested. Testing was completed on schedule.                                                                                |
| • Civilian                      | 2 out of 2 threads have been tested. Testing was completed on schedule.                                                                                  |
| • DEERS/<br>RAPIDS <sup>2</sup> | 4 out of 4 threads have been tested. Testing was completed on schedule.                                                                                  |

<sup>2</sup>Defense Enrollment Eligibility Reporting Systems (DEERS), Real Time Automated Personnel ID Card System (RAPIDS)



## Objective 1: Status and Progress Information (continued)

### Logistics

| Test Type                                            | Reported Status of Testing Efforts                                    |
|------------------------------------------------------|-----------------------------------------------------------------------|
| • Intra-component                                    | All components have completed testing.                                |
| • Inter-component (Requisition)                      | 41 of 41 threads have been tested. Testing was completed on schedule. |
| • Inter-component (Shipment)                         | 4 of 4 threads have been tested. Testing was completed on schedule.   |
| • Inter-component (Receipt)                          | 4 of 4 threads have been tested. Testing was completed on schedule.   |
| • Inter-component (Inventory Control & Asset Status) | 4 of 4 threads have been tested. Testing was completed on schedule.   |





## Objective 2: Results of Specific Test Events Reviewed

| GAO Test Criteria                                      | HA <sup>3</sup> | Comm <sup>3</sup> | Pers <sup>3</sup> | Logistics |
|--------------------------------------------------------|-----------------|-------------------|-------------------|-----------|
| Define the system boundaries of the end-to-end test(s) | ●               | ●                 | ●                 | ●         |
| Secure the commitment of data exchange partners        | ●               | ●                 | ●                 | ●         |
| Establish an inter-organizational test team            | ●               | ●                 | ●                 | ●         |
| Confirm Y2K compliance of telecommunications           | ●               | ●                 | ●                 | ◐         |
| Schedule and plan end-to-end test(s)                   | ●               | ●                 | ●                 | ●         |
| Prepare end-to-end procedures and data                 | ◐               | ●                 | ●                 | ●         |
| Define end-to-end test exit criteria                   | ●               | ●                 | ●                 | ●         |
| Execute end-to-end test(s)                             | ●               | ●                 | ●                 | ●         |
| Document end-to-end test results                       | ●               | ●                 | ●                 | ●         |
| Correct Y2K defects                                    | ○               | ○                 | ○                 | ○         |
| Ensure that end-to-end test exit criteria are met      | ◐               | ◐                 | ◐                 | ◐         |

Note: Due to differences in scope and complexity of the test events, the results of individual functions are not comparable.

<sup>3</sup>The functional areas were abbreviated: Health Affairs (HA), Communications (Comm), and Personnel (Pers)



## Finding: End-to-end test boundaries defined

- *Criteria:* Organizations need to assess their mission-critical business functions and dependencies and, on the basis of this assessment, define boundaries for end-to-end tests.
- *Finding:* All of the functional areas defined test boundaries for the test events we witnessed. For example, Communications defined boundaries, including geographic sites, deployed forces, satellites, and control centers. Health Affairs identified three critical functions: Patient Care, Patient Administration, and Medical Logistics. Patient Care was broken down into mission-critical threads, one of which was issuing and processing blood requests.



## Finding: Commitment of key data exchange partners secured

- *Criteria:* Because end-to-end testing addresses business areas or functions that involve multiple organizations, participation of all key business area data exchange partners should be secured.
- *Finding:* All of the functional areas secured the commitment of key data exchange partners. For example, Communications data exchange partners from different parts of the world agreed to send and receive data, including Ft. Monmouth, St. Louis, Atlantic Command, and Strategic Command for the test that we reviewed.



## Findings: Interorganizational end-to-end teams established

- *Criteria:* A team composed of representatives from each of the organizations participating in the test should be formed to manage the planning, execution, and reporting of the test.
- *Finding:* All functional areas established an inter-organizational team that planned, executed, and reported on the test event. For example, Health Affairs established a team that included the TRICARE Management Activity Office, IV&V contractors, and technical support staff from Advanced Technology Integration Center.
- *Finding:* Logistics interorganizational team included relevant data exchange partners, such as the military services and Defense Logistics Agency.



## Findings: Y2K compliance of telecommunications partially ensured

- *Criteria:* In order to ensure that all systems in the chain of support function as intended, the telecommunications infrastructure that interconnects the systems must be compliant and ready for testing.
- *Finding:* Health Affairs ensured that its telecommunications infrastructure for the test (i.e., local area network) was Y2K compliant.
- *Finding:* Communications, Personnel, and Logistics end-to-end test events used the Unclassified (but Sensitive) Internet Protocol Router Network (NIPRNET). Defense Information Systems Agency reported that the NIPRNET has been certified Y2K compliant and is fully implemented.



## Findings: Y2K compliance of telecommunications partially ensured (continued)

- *Finding:* Communications and Personnel have verified that their local telecommunications infrastructure are Y2K compliant. Logistics had not verified that its local telecommunications infrastructure is Y2K compliant, but has since initiated steps to do so.



## Finding: End-to-end tests planned and scheduled

- *Criteria:* A plan should be developed that defines key tasks and requirements in preparing for, executing, and documenting results of testing. Responsibility for performing key tasks and quality assurance/Independent Verification and Validation (IV&V) need to be established.
- *Finding:* All functional areas established plans that identified key tasks, schedules, roles and responsibilities for the participants in the test events. For example, detailed plans and schedules were provided in the Health Affairs Master Test Plan and Patient Care Event Plan, which addressed the IV&V contractor's roles and responsibilities. Also, Personnel had an Army Master Test Plan and Army System Test Plans that identified key tasks, schedules, roles and responsibilities.



## Findings: End-to-end test procedures prepared

- *Criteria:* Test procedures and data should include steps, cases, and input conditions that verify the correct handling of critical dates.
- *Finding:* Most functional areas prepared test procedures and data. For example, Army Personnel prepared baseline input test data and generated baseline output. Army Personnel then aged the baseline test data inputs and outputs to reflect a Y2K environment and used these to verify correct handling of the calendar year rollover date.
- *Finding:* Health Affairs developed high-level test procedures; however, it was necessary for operators to augment the test procedures to complete the test. Health Affairs officials agreed that more detailed procedures should have been established.





## Finding: Test exit criteria defined

- *Criteria:* The conditions or requirements for successfully completing end-to-end testing need to be established.
- *Finding:* All functional areas defined test exit criteria for the specific test events. For example, Communications specified that the test exit criteria for successfully completing voice communications were to hear a person at the other end of the line with a specified clarity. It specified that the test exit criteria for successfully completing data communications were for all the message recipients to receive the “test” message with all attachments over a 72-hour period.



## Finding: End-to-end test plans were followed

- *Criteria:* Tests should be executed in accordance with established plans and procedures.
- *Finding:* All test events adhered to the established plans and procedures. For instance, the Army Personnel test event was executed in accordance with both the master and system test plans. Similarly, the Logistics test event was executed in accordance with the test plans and procedures.



## Finding: Test results were documented

- *Criteria:* End-to-end test results should be documented so that the data can be used to validate that test exit criteria have been met and to assess and correct problems discovered during testing.
- *Finding:* All functional areas documented test results. Both Health Affairs and Personnel documented results by printing out computer screen information. Logistics and Communications documented test results on a results reporting form.



## Finding: No Y2K defects were found during the test event

- *Criteria:* On the basis of interorganization specified criteria, such as defect severity and test exit criteria, defects identified during the test should be prioritized and corrected.
- *Finding:* Initial results from the part of the test event that we observed indicated that none of the functional areas experienced Y2K defects. However, analysis of the test results has not yet been completed by all of the functional area data analysis centers.



## Finding: Effort to ensure end-to-end test meets exit criteria is ongoing

- *Criteria:* Test results should be compared to test exit criteria to ensure that specified conditions are met.
- *Finding:* All functional areas are still reviewing test results at the data collection centers. For example, Logistics' Exercise Operation Center is collecting results reporting forms and assessing the satisfaction of test exit criteria. In addition, Communications-Electronics Command is collecting test results for analysis and determination of test exit criteria satisfaction.



## Conclusions

- Three of the four PSAs were able to provide us with information needed to effectively track the progress and status of their respective inventories of end-to-end test events. Communications was not initially able to provide this information on all its test events. While additional status information was provided recently, this information identified mission-critical systems for which end-to-end testing had not yet been planned, thus leaving very little time to ensure that they are included in an end-to-end test event.
- The four test events that we reviewed were effectively managed based on the satisfaction of most, if not all, of the key end-to-end testing processes in our guidance.



## Conclusions

- The Logistics test event was somewhat limited by not ensuring the Year 2000 compliance of the end-to-end partners' local telecommunications equipment connecting the partners to the NIPRNET. Logistics has initiated appropriate steps to do so.
- The test events' respective approaches and the degree of test planning, execution, and reporting on the four test events varied. However, the variances were generally commensurate with the unique characteristics of the respective events. Such variability in test approaches is consistent with our test guidance.



## Recommendation

- We recommend that the Secretary of Defense direct the Senior Civilian Official of the Office of the Assistant Secretary of Defense for Command, Control Communications, and Intelligence to report to the Deputy Secretary immediately on plans for end-to-end testing the 31 systems, including milestones for executing tests and reporting test results, or to otherwise justify in writing to the Deputy Secretary why any of the systems will not be included in an end-to-end test event.



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# Objectives, Scope, and Methodology

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As requested by the House Committee on Appropriations, Subcommittee on Defense, our objectives were to (1) assess the status and progress of all test events within four functional areas—Health Affairs, Communications, Personnel, and Logistics—and (2) review the management effectiveness of a critical test event for each of the four functional areas. Together, these functional areas are performing thousands of end-to-end tests to ensure that key business processes and systems can continue operating into the year 2000.

To meet our first objective, we obtained status and progress information for the aforementioned functional areas and compared the reported status information to milestones contained in individual functional test plans<sup>1</sup> to identify variances. We discussed this information with DOD officials and personnel from the Office of the Assistant Secretary of Defense (Health Affairs), the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence, the Office of the Undersecretary of Defense (Personnel and Readiness), and the Deputy Undersecretary of Defense (Logistics). Also, for each of the functional areas, where necessary, we obtained updated status and progress information on end-to-end test events.

To meet our second objective, we selected one specific test event for each functional area. The four selected test events were based on each PSA's designation that the test event was of key importance in ensuring that the function could continue unaffected at and after the turn of the century. The selected test events, and the dates and locations we observed the events, were

- **Health Affairs**—Patient Care/Issuance and Processing of Blood Requests (May 18, 1999) at the Advanced Technology Integration Center in Falls Church, Virginia.
- **Communications**—Joint User Switch Exercise (JUSE-99-Y2K) (June 10, 1999) at the Army Communications-Electronics Command, Fort Monmouth, New Jersey.
- **Personnel**—Army Personnel/Mobilization/Reserve Unit (June 17, 1999) at the Army Personnel Command, Alexandria, Virginia.

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<sup>1</sup>Updated plans included in our review were the December 15, 1998, plan for communications; the January 1999, plan for health affairs; the January 31, 1999, plan for logistics; and the January 28, 1999, plan for personnel.

- **Logistics**—Intercomponent test of requisition and receipt processes (June 24-25, 1999) at the Navy Fleet Material Support Office in Mechanicsburg, Pennsylvania.

For the selected test events, we interviewed DOD officials and reviewed pertinent documentation for each event, including test event plans,<sup>2</sup> procedures, conditions, exit criteria, results, reports, defects, correction action plans, and we observed the actual execution of the test event. We then compared the particulars of each event to our Year 2000 test guide's end-to-end testing key processes, identified variances, and discussed with test officials the reasons for and impacts of any variances.

To supplement our documentation reviews and observations, we interviewed DOD officials, including those from the TRICARE Military Health Systems, the Army Communications-Electronics Command, the Office of the Deputy Chief of Staff for Personnel, and the Office of the Deputy Undersecretary of Defense (Logistics); test event coordinators; and test directors regarding additional clarifications after our visit. These officials addressed telecommunications infrastructure Year 2000 compliance issues. They also provided additional documentation from the test event we witnessed (i.e., test results, quick look, and final reports). Due to the time criticality of the year 2000, as our reviews were completed on each of the functional areas, we provided briefings detailing our observations to each Defense PSA and test director as follows:

- Health Affairs—June 15, 1999,
- Communications—July 12, 1999,
- Personnel—July 15, 1999, and
- Logistics—August 17, 1999.

We performed our audit work primarily at DOD headquarters and at the test event locations described above. We requested and received comments on a draft of this report from DOD and incorporated those comments as appropriate. We performed our audit work from March through September 1999 in accordance with generally accepted government auditing standards.

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<sup>2</sup>Test event plans included in our review were: Military Health Systems Patient Care Functional Readiness Assessment Test Plan, v1.2, April 1999; Communications Joint User Switch Exercise 99-Y2K Exercise Directive, April 1999; Army Personnel Command Test Plan, June 1999; Army System Test Plans, June 1999, for EDAS, SIDPERS-3, and PEPDUS; and Logistics Exercise Directive, May 1999.

# Comments From the Department of Defense



COMMAND, CONTROL,  
COMMUNICATIONS, AND  
INTELLIGENCE

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE  
6000 DEFENSE PENTAGON  
WASHINGTON, DC 20301-6000

October 05, 1999

Mr. Jeffrey C. Steinhoff  
Acting Assistant Comptroller General  
Accounting and Information Management  
Division  
U.S. General Accounting Office  
Washington, DC 20548

Dear Mr. Steinhoff:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, GAO/AIMD-99-288, "DEFENSE COMPUTERS: DoD Y2K Functional End-to-End Testing Progress and Test Management," dated September 17, 1999, (GAO Code 511659/OSD Case 1896). The Department acknowledges receipt of this report.

The Department of Defense concurs with the Draft GAO Report and partially concurs with the recommendation. The report identifies testing issues associated with 31 communications systems. During the investigation period, July 1999 and early August 1999, testing data in the OSD Y2K database was still evolving. This resulted in incomplete test data for many of the 31 systems identified in this report. The referenced DoD communication systems status has been resolved and no additional test events beyond those listed are necessary.

The DoD appreciates the opportunity to comment on the draft report. Technical comments were provided under separate cover.

Sincerely,

A handwritten signature in black ink that reads "Arthur L. Money".

Arthur L. Money  
Senior Civilian Official

Enclosure



GAO DRAFT REPORT DATED SEPTEMBER 17, 1999  
(GAO CODE 511659) OSD CASE 1896

**SUBJECT: "DEFENSE COMPUTERS: DOD Y2K FUNCTIONAL END-TO-END TESTING PROGRESS AND TEST EVENT MANAGEMENT"**

**GAO Recommendation:** We recommend that the Secretary of Defense direct the Senior Civilian Official of the Office of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) to report to the Deputy Secretary immediately on plans for end-to-end testing the 31 mission-critical communications systems, including milestones for executing tests and reporting test results, or to otherwise justify in writing to the Deputy Secretary why any of the systems will not be included in an end-to-end test event.

**DoD Response:** The Department of Defense concurs with the Draft GAO Report and partially concurs with the recommendation. The report identifies testing issues associated with 31 communications systems. During the investigation period, July 1999 and early August 1999, testing data in the OSD Y2K database was still evolving. This resulted in incomplete test data for many of the 31 systems identified in this report. However, since that time, added clarity in the CINC mission critical listings and synchronization of the OSD data base and actual Y2K Operational Evaluations (OPEVALS) have resulted in resolution of the current testing status of the identified 31 communications systems. The following summary provides a brief overview of the resolved status of the 31 systems. Detailed resolution for each system is included as an attached chart.

**Testing completed:** 14 of the 31 systems have completed their required Y2K testing.

**Testing planned:** One (1) system (Senior SPUR) of the 31 systems now has a test planned for October 15, 1999. This will complete the required testing for this system.

**No testing required/Trusted:** Four (4) of the 31 systems do not require testing because they have been identified as trusted systems. Trusted systems are those systems that cannot have their clocks rolled forward into a Y2K environment for evaluation due to safety, security, or operational necessity. Most of these systems are Satellite systems that are supporting deployed forces.

**No testing required/Developmental System:** Two (2) of the 31 systems do not require testing because they are developmental and will not be deployed before the millennium rollover. However, these systems are identified in the Y2K Database. They are currently going through the five phase validation process.

**No testing required/Does process dates:** Nine (9) of the 31 systems do not process dates and are exempted from end-to-end test requirements.

**No testing required/Not mission critical:** One (1) system has been re-classified as a non-mission critical system and does not require additional tests.

**Appendix III  
Comments From the Department of Defense**

**GAO DRAFT REPORT DATED 17 SEPTEMBER, 1999 (GAO CODE 511659) OSD CASE 1896  
DEFENSE COMPUTERS: "DOD Y2K FUNCTIONAL END-TO-END TESTING PROGRESS AND TEST EVENT MANAGEMENT"**

| Component | Req | Comp | Plan | System Name                                     | System Acronym    | ID       | MC | Remarks                                 | Test Dates           | Test Event                                    |
|-----------|-----|------|------|-------------------------------------------------|-------------------|----------|----|-----------------------------------------|----------------------|-----------------------------------------------|
| CENTCOM   | 2   | 2    |      | Automated Message Handling System               | AMHS              | CENT-008 | Y  | Completed testing                       | 19990804<br>19990823 | CENTCOM Opeval<br>CENTCOM Opeval              |
| CENTCOM   | 1   | 1    |      | USCENTCOM Headquarters Unclassified Lan         | CENTCOM UNC LAN   | CENT-006 | Y  | Completed testing                       | 19990731             | CENTCOM Opeval                                |
| CENTCOM   | 1   | 1    |      | USCENTCOM Command and Control Network           | CENTCOM C2 LAN    | CENT-005 | Y  | Completed testing                       | 19990731             | CENTCOM Opeval                                |
| PACOM     | 1   | 1    |      | HQ LAN                                          | USFJ              | 16       | Y  | Completed testing                       | 19990515             | USFJ Unclass Lan Opeval                       |
| SOCOM     | 0   | 0    |      | InterTeam Radio (ITRADIC)                       | MBITR             | 34       | Y  | Dev (1) system; No testing required     | NA                   |                                               |
| SOCOM     | 0   | 0    |      | Advanced Data Controller                        | ADC               | 1019     | Y  | No date processing; No testing required | NA                   |                                               |
| SOCOM     | 0   | 0    |      | Multiband Radio                                 | MBMMR             | 36       | Y  | Dev (1) system; No testing required     | NA                   |                                               |
| SOCOM     | 2   | 2    |      | Improve SOF High Frequency Manpack Radio System | ISHMRS            | 32       | Y  | Completed testing                       | 19990812<br>19990719 | SOCOM Opeval<br>SOCOM Integration Test        |
| ARMY      | 1   | 1    |      | DSCS FDMA Cntr System AN/FSC-96                 | DFCS              | DA01908  | Y  | Completed testing                       | 19990618             | JUSE Exercise                                 |
| ARMY      | 0   | 0    |      | State-of-the-Art Heavy Term/Med Term Mod (SEC)  | SAMT              | DA00588  | Y  | No date processing; No testing required | NA                   |                                               |
| ARMY      | 0   | 0    |      |                                                 | HT/MT MOD         | DA02441  | Y  | No date processing; No testing required | NA                   |                                               |
| ARMY      | 1   | 1    |      | Satellite Configuration Control Element         | SCCE              | DA00589  | Y  | Completed testing                       | 19990618             | JUSE Exercise                                 |
| NAVY      | 2   | 2    |      | Submarine Satellite Information                 | SSIXS             | 5498     | Y  | Completed testing                       | 19990716<br>19990521 | STRATCOM Force Direction<br>STRATCOM Phase IV |
| NAVY      | 2   | 2    |      | Integrated Submarine Automated                  | ISABPS            | 5535     | Y  | Completed testing                       | 19990716<br>19990504 | STRATCOM Force Direction<br>STRATCOM Phase IV |
| NAVY      | 2   | 2    |      | Integrated Verdin Transmit Terminal             | IVTT              | 5592     | Y  | Completed testing                       | 19990716<br>19990504 | STRATCOM Force Direction<br>STRATCOM Phase IV |
| NAVY      | 1   | 1    |      | SSIXS Sub Message Automated Routing             | SSIXS-SMART       | 5497     | Y  | Completed testing                       | 19990507             | E2E Integration Test                          |
| USMC      | 1   | 1    |      | Communications                                  | AN/MS-63A         | 11624    | Y  | Completed testing                       | 19990505             | KS                                            |
| USAF      | 0   | 0    |      | Defense Satellite Communication                 | DSCS-GROUND       | 99007983 | Y  | No date processing; No testing required | NA                   |                                               |
| USAF      | 0   | 0    |      | Milstar - Ground Segment                        | MILSTAR-GROUND    | AS003964 | Y  | Trusted system                          | NA                   |                                               |
| USAF      | 0   | 0    |      | Milstar - Satellite                             | MILSTAR-SATELLITE | AS003473 | Y  | Trusted system                          | NA                   |                                               |
| USAF      | 0   | 0    |      | Survivable Low Frequency Single Channel         | SLFCS             | 99005314 | Y  | No date processing; No testing required | NA                   |                                               |
| USAF      | 0   | 0    |      |                                                 | AFSATCOM SCT      | AS006739 | Y  | Trusted system                          | NA                   |                                               |
| USAF      | 1   | 1    |      | Universal Protocol Translator                   | UPT               | AS006817 | Y  | Completed testing                       | 19990228             | NORAD (AV 99-2)                               |
| USAF      | 0   | 0    |      | Milstar Terminals                               | MILSTAR           | 99004732 | Y  | Trusted system                          | NA                   |                                               |

9/30/99

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**Appendix III  
Comments From the Department of Defense**

**GAO DRAFT REPORT DATED 17 SEPTEMBER, 1999 (GAO CODE 511659) OSD CASE 1896  
DEFENSE COMPUTERS: "DOD Y2K FUNCTIONAL END-TO-END TESTING PROGRESS AND TEST EVENT MANAGEMENT"**

|      |   |   |                                      |              |          |   |                                           |          |                 |
|------|---|---|--------------------------------------|--------------|----------|---|-------------------------------------------|----------|-----------------|
| USAF | 0 | 0 | Space and Missile Separation System  | SAMS-R       | 99004764 | N | Non-Mission Critical; No testing required | NA       |                 |
| USAF | 0 | 0 | Single Channel Transponder Injection | SCTIS        | 99008022 | Y | No date processing; No testing required   | NA       |                 |
| USAF | 0 | 0 | Miniature Receive                    | MRT          | 2001545  | Y | No date processing; No testing required   | NA       |                 |
| USAF | 1 | 0 | 1 Senior SPUR                        | SPUR         | AS006411 | Y | Scheduled for U2 E2E 19991015 test        | NA       |                 |
| USAF | 0 | 0 | Dual Data Link                       | DDL          | AS006408 | Y | No date processing; No testing required   | NA       |                 |
| USAF | 1 | 1 | Air Force Command                    | AFSN (AFC2N) | 99005509 | Y | Completed testing                         | 19990317 | JTIC Y2K Opeval |
| USAF | 0 | 0 | Interoperable Airborne               | IADL         | AS006406 | Y | No date processing; No testing required   | NA       |                 |

NOTE: 1) Dev(1) - Developmental 1 - Brand new system with new functionality  
2) Trusted System: Trusted systems are those that cannot have clocks rolled into a Y2K environment for evaluation due to safety, security, or operational reasons.

# GAO Contact and Staff Acknowledgements

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## GAO Contact

Randolph C. Hite, (202) 512-6240

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## Acknowledgements

In addition to those named above, Ronald B. Bageant, Cristina T. Chaplain, Katherine I. Chu, Richard B. Hung, Myong S. Kim, Madhav S. Panwar, and Alicia L. Sommers made key contributions to this report.

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