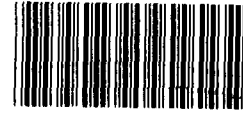


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Importance and Prevalence of Embedded Computer
Systems and Oversight of This Technology
by the Office of the Secretary of Defense

Statement of
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Before the
Subcommittee on Legislation and National
Security
Committee on Government Operations
House of Representatives



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Mr. Chairman and Members of the Subcommittee:

I am pleased to participate in these hearings on the SSN-21 and its computer-based AN/BYS-2 combat system. As you know, we recently reported on several areas of risk with AN/BSY-2 which require the Navy's focused management attention.¹ These areas include (1) developing and integrating a massive amount of software, most of which is planned to be written in a relatively new computer language (Ada) for which there is a shortage of experienced programmers; (2) ensuring that sufficient time exists for the government to witness software testing and resolve identified problems; (3) designing a system with sufficient reliability to ensure that mission needs are met; (4) developing, refining, and testing a model to accurately predict system performance; and (5) ensuring that independent verification and validation assessments are performed on the software development effort.

The ability of this weapons system to meet its mission requirements clearly hinges on the success or failure of this embedded computer system. Nevertheless, it is important not to lose sight of the fact that AN/BSY-2 is but one, albeit one of the most costly and important, of many computer systems on the submarine. These systems perform various functions critical to fulfilling the submarine's overall mission, functions such as communication,

¹Submarine Combat System: Technical Challenges Confronting Navy's Seawolf AN/BSY-2 Development (GAO/IMTEC-89-35, March 13, 1989).

steering, and propulsion system control. Consequently, AN/BSY-2 can be viewed as just the tip of the iceberg when considering the importance and prevalence of computer systems to the submarine.

Dependence on computer systems in meeting mission requirements is not limited to the SSN-21 submarine weapons system. Indeed, this submarine and its high degree of automation is truly a microcosm of the total Defense Department armada. We recently released a report to this Subcommittee on the importance and prevalence of embedded computer resources to Defense weapons systems, and how the Office of the Secretary of Defense oversees the development of these resources.² In that report, we state that embedded computer systems are playing a larger and more significant role in the functioning of virtually all Defense weapons systems. We also note that in the not-too-distant future, it is conceivable that every subsystem in all major weapons systems could be computer-controlled. The evolution of the F-16 fighter aircraft, from the F-16A with its 125,000 lines of software code and 50 processors, to the F-16C with its 230,000 lines of code and 300 processors, illustrates how plausible this is.

This possibility is also evident in the Defense Department's burgeoning budget for mission-critical computer software, where its investment has soared from an estimated \$9 billion in 1985 to \$30

²DOD Embedded Computers: Better Focus on This Technology Could Benefit Billion Dollar Weapons Programs (GAO/IMTEC-90-34, April 19, 1990).

billion today, and expectations are for continued growth in this area. While expensive in and of themselves, the cost of embedded computer systems is but a fraction of the cost of the weapons systems that they support and control. To illustrate, we surveyed nine major weapons systems and found that the embedded computer system development costs reported to us averaged less than 10 percent of the development cost for the entire weapons systems.

Despite their relatively low costs when compared with the literally hundreds of billions of dollars that weapons systems cost, these embedded computer systems are the Achilles heel of our military armament. As embedded computer resources have taken on more and more significance with each new, more sophisticated weapons system, problems with these resources (particularly the software, which is usually the most costly and difficult computer resource to develop and maintain) have been pinpointed as the root cause of weapons system cost overruns, schedule delays, and performance shortfalls. One of the more publicized of these cases is the B-1B bomber's computer-based defensive avionics system. Although the extent of the system's limitations are classified, they center on the radar warning receiver and processor functions, which initiate defensive action by receiving and identifying threat system signals. According to the Air Force program office, software revisions costing \$1 billion will only partially correct known problems with this embedded computer system, but full capability will not be achieved without a major system redesign. This illustration is not

an isolated instance. Embedded computer system problems are occurring more frequently. In our opinion, a real danger lies in the possibility that correcting such problems could become, if they have not already, a significant but hidden cost of weapons system development. Perhaps more important, such problems could become the number one cause of fielded weapons systems falling short of mission requirements.

Clearly, embedded computer systems demand focused management concern and attention, not only by program managers and their staffs as part of the day-to-day management of weapons systems development, but also by Defense corporate management as it discharges its oversight responsibilities on the larger and more significant weapons systems. We found, however, that even though the Office of the Secretary of Defense has in place an established process to oversee the development of major weapons systems, this process does not focus management attention and decisionmaking on (1) the embedded computer systems that are essential to fielding fully capable weapons systems or (2) the technical and managerial risks inherent in developing these embedded systems.

According to Office of the Secretary of Defense officials, reasons for not treating embedded computer systems as a discrete area of management focus include (1) a concentration on the entire weapons system rather than its separate components, (2) a lack of comfort by senior Defense management with computer system issues, and (3)

the absence of a designated Office of the Secretary of Defense entity expressly responsible for overseeing embedded computer resources. In our opinion, such an approach raises the question of whether embedded computer resources are being recognized for what they are: critical and highly complex elements of a weapons system that are extremely difficult to develop and can ultimately determine whether a system succeeds or fails.

Despite the Department's questionable track record in this area, recent management initiatives suggest that an attitude of cautious optimism may be in order. Specifically, the Deputy Secretary of Defense has established an executive-level group to review and make recommendations on the Department's oversight of all software development, which would include embedded computer software. Second, the Department is currently revising its directive that governs the management of embedded computer resources, with the apparent intention of giving these resources more rigorous management attention. Last, the Defense Acquisition Board's Science and Technology Committee is developing a 5-year plan for improving the Department's overall approach to software acquisition and management, including bringing increased management attention to bear on embedded computer resources.

Mr. Chairman, computer technology in today's weapons systems is an area in which management oversight is vital, yet so often absent. My hope is that this hearing will serve as a catalyst for more

focused management attention on this technology. To this end, I would like to suggest that the Secretary of Defense augment his office's current approach to overseeing weapons systems with the following framework for improving disclosure and consideration of embedded computer system issues. Specifically, the Secretary should (1) establish a function under the Defense Acquisition Board or the Defense Acquisition Executive to identify, report, and recommend actions to address technical issues relating to computer systems embedded in major weapons systems; (2) ensure that this function possesses or has access to the requisite technical talent, both from inside and outside the Defense Department, to discharge its responsibilities; (3) hold the function accountable for its responsibilities; and (4) ensure that information on embedded computer system technical risks is available to congressional decisionmakers as part of the authorization and appropriations processes.

This concludes my statement. I would be happy to respond to any questions you or other members of the Subcommittee may have.