LOGISTIC SUPPORT - A COMPUTER MANUFACTURER'S VIEWPOINT

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ABSTRACT

When the Department of Defense directed that commercially available standard off-the-shelf computer systems would be used for military simulation programs in place of special militarized computers the intent was clear: Cut costs! Now, more than a decade after that DOD directive, it is possible to look back, recognize the value of the decision, and identify many of the problem areas that have been created for the military simulation program organizations. The military services have attempted to address the problems posed by the apparent conflict of needs but have met with minimal success to date. This paper is a computer manufacturer's look at some of the support problems that have been created by the use of commercially available computer systems, some of the solutions that have been considered, and some actions that should be explored if resolutions to the problems are to be achieved.

INTRODUCTION

When the Department of Defense directed that commercially available standard off-the-shelf computer systems would be used for military simulation programs in place of special militarized computers the intent was clear: Cut costs! Now, more than a decade after the DOD directive, it is possible to look back, recognize the value of the decision, and identify many of the problem areas that have been created for the military simulation program organizations.

Though the commercial computer has provided state-of-the-art solutions for the increasing demands of simulation requirements, the long term support of simulation systems has been a problem that has eluded the most conscientious efforts of the military services. The need of the computer industry to stay current with the dynamic technological advances is directly opposed to the military need to support a simulator for a useful life of up to twenty years. The commercial computer has a production life of possibly five to seven years. This production cycle is steadily decreasing. The computer system support software has a considerably shorter product life.

The military services have attempted to address the problems posed by the apparent conflict of needs but have met with minimal success to date. How then can the benefits of commercially available computers be realized without the excessive costs associated with the long term life cycle support of those systems?

This paper is a computer manufacturer's look at some of the support problems that have been created by the use of commercially available computer systems, some of the solutions that are currently being used and some future actions which should be explored if resolutions to these problems are to be achieved. The paper is broken down into three sections to discuss these support issues and their resolution in terms of Long Term Support, Software Compatibility, and Obsolescence. The three sections are Historical Problems, Current Solutions, and Recommended Solutions.

THE HISTORY OF BUY COMMERCIAL OFF-THE-SHELF COMPUTER EQUIPMENT

In the early 1970s it was mandated that commercial general purpose off-the-shelf computers be used to replace the specialized simulation computers for military simulators.

The directive was intended to reduce acquisition costs and to reduce support costs. Historically, in a training device environment, these computers which were used to simulation on-board computers have allowed cost effective performance and versatility which was not available with specialized computers or the on-board militarized computers. The on-board computers were targeted for operational environments in airborne, aerospace, surface vehicles and submarine applications and clearly had an adverse impact on simulator costs both in acquisition and support.

It was further envisioned that documentation costs could be reduced by using standard off-the-shelf commercially available documentation, i.e., operation and maintenance manuals. This is a significant cost savings in itself considering that the mil-spec documentation can cost more than the computer system it is intended to support. The use of commercially available documentation projects even greater life cycle cost savings as the computer equipment is upgraded since the associated data revision costs will be minimal.

These cost reductions also apply to the spares provisioning area. It was envisioned that the cost of procuring and maintaining spares for commercial off-the-shelf equipment would be less than both the specialized computers and for militarized computers. The plan was based on using the existing supply system.

As the directive to buy commercial off-the-shelf computers began to be executed several problems arose. It must be said that the intention of the buy commercial idea was valid and appropriate. The implementation across the board however, was not as effective as it could have been.

HISTORICAL PROBLEMS

It has been field proven that commercial off-the-shelf computers can be used in production of high fidelity training devices. Major commercial computer manufacturers generally employ people who can understand military training device computer requirements and can communicate effectively in the military support environment. There are several major problems that must be addressed to field and maintain simulators with commercial computers. The three most significant problem areas are:

1. Long Term Support
2. Software Compatibility
3. Obsolescence

This paper addresses these areas from the computer manufacturer's point of view. Several beneficial results may arise if the military and the prime contractors understand the commercial manufacturer's viewpoint on these problems and how the computer vendors would propose to solve them.

1. Long Term Support. Typically a commercial system is obsolete in about five years in the commercial marketplace and as technology advances this life cycle is becoming shorter. A military simulator is not planned to be obsolete until ten to twenty-five years after initial acceptance/deployment. The wide divergence in the timframe is part of the problem. Also, the command philosophy of long term support is different in the military environment. The problem is further complicated by the nature of change in the two environments and by the methods used to address change.

If, for example, we take a commercial application which is doing engineering work, it would be expected that its useful life would be approximately seven years. At the end of this period the system will be replaced with a newer model with more capability. At the initial purchase of the system no documentation other than commercial manuals would be provided. The user of the system would opt for maintaining the system himself or would have the supplier do the maintenance. If he chose to maintain the system himself he would either buy the appropriate spares to support the system at the time of purchase or an as-required basis.

The military application for simulator work would be expected to have a useful life of approximately twenty years. At the end of this period the system would be updated or retired. Under the "buy off-the-shelf" philosophy the documentation would be standard commercial manuals or possibly modified commercial manuals. The customer could opt to maintain the system himself, have his prime contractor maintain the system or have some third party maintain the system. It should be noted that commercial manuals probably won't be sufficient since maintenance personnel are rotated through the sites at intervals which don't allow them to become familiar enough with the equipment to handle major failures.

Now, from a commercial computer manufacturer's point of view the easier system to support is the commercial application. First of all, the maintenance on the system is over a shorter period and he can keep technicians who are trained on its maintenance and who feel that they are not working on antiquated equipment. Second, he can supply the latest revision level of parts direct from the factory since he is maintaining the equipment. Third, he doesn't have to worry about the technical training and documentation since he is providing his current technical manuals and providing maintenance training to his service people on his current equipment.

The peripherals issue is also one of the areas which is effected by long term support requirements. From a military simulator viewpoint it is expected that the system, including peripherals, will have a useful life of twenty years. As with the computer, the peripherals have to be supported with spares including mechanical parts which tend to wear. After approximately five to seven years the peripheral manufacturer ceases to manufacture the peripheral and discontinues spares. If enough spares are not acquired by the user while they are available then the equipment will become rapidly non-functional.

Figure 1 indicates the levels associated with sparing peripherals. This figure indicates a simplistic view of the levels that must be addressed to obtain spares for long term support. When multiple manufacturers and multiple component vendors are considered the picture becomes extremely complicated. When multiple revision levels from multiple manufacturers are considered it becomes even more complicated.

The military simulator as viewed from a commercial viewpoint is fraught with potential pitfalls. The computer manufacturer must change the way he does business in spares, technical resources and in his change control systems. The commercial manufacturer must also change his management style instituting a program management function, and keeping product lines alive which would otherwise be terminated. This is not to say that simulator business is not profitable to the computer manufacturer, if properly managed, but is complicates matters and adds to the cost of procurement and life cycle maintenance.

2. Software Compatibility. Software is hard and hardware is soft. This statement expresses the paradox of the problem relating to commercially available software used on simulator programs. A computer manufacturer constantly produces changes to hardware which have little or no effect on the system software. However, if he changes the software, then watch out! These changes ripple through a simulator system causing repercussions randomly throughout the entire system.

The problem can be exemplified by a simulator system which is hit with a major operating system change by the computer manufacturer while in final government acceptance after two and a half years of development effort. If the simulator manufacturer doesn't provide the latest commercially available software both the prime contractor and the computer vendor may be technically in default of their contracts. If the computer vendor implements the new operating system he may not be able to pass the acceptance tests due to the systems impact, and he could then be in default for system acceptance testing. It is a "Damned if you do and damned if you don't" situation.

Even frozen configurations of software and/or hardware create problems. In this scenario the software and/or hardware configuration is frozen to specific revision levels. If a new device is added or a bug is found in the software which requires a change then the problems rise to the surface. Since the revision levels were frozen, x changes have probably occurred in the commercial releases of the software. Therefore, the simulator program is faced with either creating a non-standard, non-commercial software package which fixes the bug or having to test the latest release of the software and face the risk of incompatibilities and the potential new bugs. Yet another problem is the failure of software which works at revision X to work at Y. This may occur if programming or language standards were not followed by the programmer. This can occur when one revision of the software is forgiving in allowing the programmer to deviate from standards and the next revision demands rigid comformity to standards.

Disaster lurks in the multi-system environment when all developers are not using the same revision of the computer manufacturer's software. Software control or lack thereof is perhaps the greatest problem area. The clever programmer who gets around the software assures that future updates to the system software are not compatible with the previous release which worked. This must be handled by imposing and enforcing development standards on the prime contractor.

3. Obsolescence. The environment which is typified by the simulator world is one of constant change. By this, I mean everything is changing but not necessarily at any fixed rate. The state-of-the-art in computer hardware is changing. The software techniques are changing. The level of technical expertise and the vehicle being simulated is changing.

Hardware trends indicate that the following things will occur in the future. First, memory will become cheaper. Second, computational power will become cheaper. Third, packaging will become smaller. From a simulator viewpoint this means that in spite of long term planning, a program started in 1975 will be using a computer which is expensive to expand, expensive to maintain and technically obsolete in 1982.

This is acceptable from a military user point of view as long as spare capacity/growth provisions for computer time and memory remain and the simulator meets its operational requirements. Their viewpoint soon degenerates to unhappiness when the simulator changes eat up the growth capacity and the device can no longer meet its performance or supportability requirements. From a logistics point of view it can approach a nightmare.

How can that happen, you may ask? Well, for one thing, spares are in the national supply system at assorted revision levels. Unless spares are kept with a simulator, there is no guarantee that a board from the national supply system will work in a given system because of the revision level differences. There is, on the other hand, no certainty that it won't work either.

How did this mess come about? Simple, we procured and engineered ourselves into it. For example, Program X freezes its configuration of hardware at level B (B is made up of multiple boards at various levels). Program Y maintains its systems at current manufactured revision levels. Program Z opts to block upgrade its simulators so that the first shall be like the last in revision level and is currently halfway through a program which will field simulators for the next five years. Obviously some programs spares are obsolete and more than likely most are. There is no logistics program that crosses contract lines to assure that all parts of the same number from the same commercial manufacturer are interchangeable.

The availability of parts at some future date is also an issue of obsolescence. How many integrated circuits will become obsolete and impossible to procure, even at prohibitive costs in the future? Or, will magnetic core planes be readily available in twenty years? If they are not available, commercial computer manufacturers would probably rather give the manufacturing drawings to the government than be burdened by trying to make technically obsolete parts.

Cost effectiveness is an issue key to obsolescence. If hardware trends continue at their current rate, some systems could be replaced by a chip in the future. Would it be practical to manufacture a fifteen year old computer board when the entire computer could be replaced by a chip?

CURRENT SOLUTIONS

If the problems referenced in the previous section are to be overcome it is perhaps wise to study the current approaches being taken by today's simulator programs from both a military and commercial computer manufacturer's point of view.

1. Long Term Support. The current trend is to contractually commit a computer vendor to support the product provided to the simulator manufacturer for X years. (X means the maximum number which the computer vendor can be coerced into without extra cost) This approach is unrealistic as it really doesn't solve the problem but rather shifts the problem into the future where hopefully all concerned participants are retired, at another company, or another job. Typically, the support requirement is very vague and difficult to understand or provide.

The spares issue is also an interesting problem. Under the current system only initial spares are procured with the simulator while formal spares provisioning is performed later by another organization. This other organization is not capable of determining revision levels on cards unless they are issued an NSN (National Stock Number) on a per revision level basis. Acceptance is interesting since the spares are procured by spec control drawings. The commercially manufactured spares probably won't meet the drawings since the parts are many revision levels advanced when the procurement finally takes place.

Typically a computer supplier or a peripheral manufacturer is not interested in making boards which are at revision level B when T is the current manufacturer's revision level. Depending on when the order is placed the board may not have been in production for many years. Manufacturing to the old level would result in premium costs for special production runs. Some suppliers have an automatic upgrade to the latest revision level when a board is returned for repair. Therefore, a repaired board may differ significantly in configuration or performance from like units in the supply system.

Attempts have been made to buy the spares with the computer and hope that they will last for the life of the program. This approach will work if estimates are good, if there is enough funding to procure the necessary spares concurrently with each delivered machine, and if the spares can be controlled and co-located with the simulator. This requires that the shelf life for the spares exceeds the program requirements which may not be true.

"The first shall be like the last" approach demands that the previously delivered systems will be upgraded to the configuration of the last delivered system in a procurement. This approach also can work, but the potential problems previously indicated are still distinct possibilities. Depending on the timeframe between acquisition of the first and the last multiple sets of spares, the spares may or may not be of value when the systems are upgraded.

The block update scheme is a variation on "the first shall be like the last" approach. The first units are gradually brought up to the following units configuration as they are fielded. For multi-year procurements multiple upgrades to delivered systems are a foregone conclusion. For example, units 1-5 will be upgraded to look like units 6-11, then units 1-11 will be again upgraded to look like units 12-15. This approach is workable if managed correctly but can still be costly depending on the timeframe and operational requirements of the system.

Perhaps the most realistic approach which has been suggested is the preplanned replacement of computer hardware X years into the program. For example in a program with a twenty year life cycle which will be fielded over a period of seven years the computer system would be replaced at year eleven and spares would be procured to last the additional nine years.

2. Software Compatibility. There have been two major approaches recently to address the software compatibility problem. The first approach was the higher order language mandate. The second was use of the commercial off-the-shelf computer vendor supplied Operating System. Software Configuration Management has been required but as yet has not met with the anticipated results due to lack of enforcement on the Government's part.

The higher order language mandate proved to be beneficial to both the government and the manufacturers as Engineering Change Proposals (ECPs) are not the great mystery they once were from a software point of view. Also, it is easier to train and obtain people who are conversent in a higher order language such as FORTRAN. This will also be true if ADA becomes the standard in the future.

The computer manufacturer supplied OS software approach removed the custom tailored OS as produced by the individual simulator manufacturer. This allowed easier maintenance and easier ECP incorporation along with easier training of support and operational personnel. All is not perfect, however, the computer vendor OS is constantly changing and must be tracked via software configuration management to insure that current software and documentation are correctly distributed among the development and field systems.

Another system used for controlling the software is the software development center. On some simulators the Software Support Center concept of single point control of software change has been initiated. Under this concept, a single site is responsible for dissemination of all software, software updates and documentation. This ensures that all sites will be running the same software. This does not alleviate the obsolete software problem in regards to the computer manufacturer's latest revision level but at least it makes it more manageable.

None of the current schemes really address the issue of the compatibility between the software on a simulator system, which has been in the field for ten years, and the latest release of a computer vendor's software. This is an issue which must be faced.

3. Obsolescence. It appears that we are kidding ourselves as to the real operational life of the systems. Certain components have a fifteen to twenty year operational life but these systems change greatly. Of course, there are probably exceptions which would dispute this point. However, during these times of rapid technological change these exceptions will become fewer and fewer. As a system, the battleship New Jersey is radically different today from what it was in the 1940s. The B-52 Strategic Bomber is today radically different from what it was in the 1960s.

The average life of a computer and its associated peripherals from a manufacturer's viewpoint is about five years. After five years it is superceded by a new generation and is considered obsolete from a technology, price, or performance point of view. This does not mean that the manufacturer will stop manufacturing the machine because established customers generally buy for sometime after newer models are available. For example, the manufacturing life of a computer and peripherals would be from seven to ten years, for the computer and three to five years for the peripherals today. After ten years it probably would not be possible to continue manufacturing due to low demand and lack of availability of component parts.

Changing technology is the biggest reason for the demise of a computer. For example, computer memory technology has evolved from core to 16K metal oxide semiconductor chips to 64K chips to 256K chips and should evolve to megabyte chips and multimegabyte chips. Pricing reflects the technology. Core is considerably more expensive than 256K chip technology.

Not only does the hardware become obsolete but the software becomes obsolete. Currently there are assembly language systems and FORTRAN systems in the field. In the future ADA systems will be fielded. How difficult will it be to maintain and update the existing assembly language systems which need to be modified due to changed in the aircraft systems in the future? It will be very difficult if not impossible due to the lack of motivation for people to learn the intricacies of assembly language programming. Will the same thing be true of FORTRAN based systems in twenty years?

RECOMMENDED SOLUTIONS

There are several possible solutions which may alleviate the problems indicated in the previous sections. Whether they will be implemented will depend on how serious we are about solving the problems. The solutions as summarized in Figure 2 will necessitate cooperation between the services, the logistic portions of the services, the prime contractors and the computer manufacturers. They will necessitate a change in the way we all look at a program such that we take our special interests and set them aside in favor of realistic needs, thus providing efficient, effective, and maintainable systems. Whether this is possible or not only time will tell. If it isn't, we will all have failed.

1. The government must recognize that commercial computers and their associated spares have a maximum useful life of ten years and plan to replace them with software compatible units in the ten to twelve year timeframe. This requires planning at the inception of the program, not after it it ten years old.

This would minimize the spares, obsolescence, and the compatibility problems.

2. Change the way we handle computer spares in the National Supply System or mandate that the spares for a given simulator reside at the support center of the simulation system and be dispursed from that location so they they reflect rev levels of the cards.

3. Make the computer supplier the depot level support unit and fund it appropriately to insure a steady stream of spares flow through to the simulators and simulator manufacturer who support them.

4. Establish a review process which includes the computer manufacturer to determine the best time for major hardware and software replacements.

5. Simulators must be maintained at the current computer manufacturer's revision of the operating system.

6. Establish a interservice/prime computer manufacturer committee to recommend ways to change the way we handle support for simulators.

7. Commission a life cycle analysis of real data on simulators currently fielded to determine what is viable from the current methods and problems need to be overcome.

LAYERS OF CONTRACTORS ON PERIPHERALS

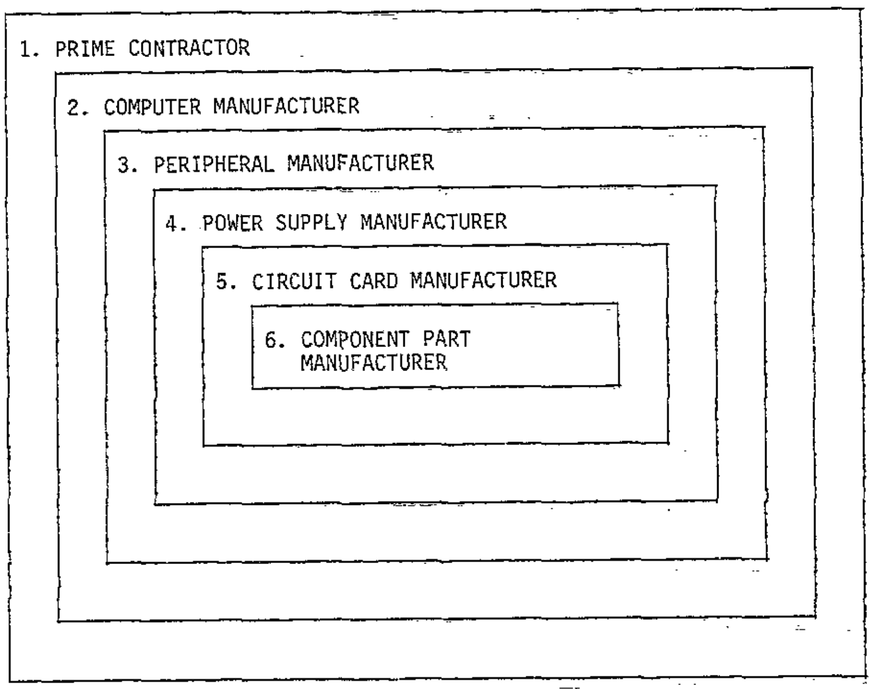

FIGURE 1

SUMMARY OF PROBLEMS AND SOLUTIONS AND FUTURE RECOMMENDATIONS

PROBLEM	CURRENT SOLUTION	FUTURE RECOMMENDATIONS
1. Inappropriate Life Cycles	Commitment	Planning Replacement
2. Incorrect Spares	Spares Stay On-Site	Change Stock System
3. Source for Updated Spares	Field Modify	Depot Becomes Computer Manufacturer
4. Software and Hardware Update Planning	Unplanned From Computer Manufacturer Point of View	Joint Effort
5. Software Obsolescence	Varies From Program to Program	Update to Current Revision Level
6. Lack of Common Interest in Problem	Adversary Role	Joint Team Approach
7. Lack of Current Data	None	Study Program

FIGURE 2

ABOUT THE AUTHOR

Mr. McCaskill has accumulated over twenty years of engineering and marketing management experience in the Military/Aerospace sector. Mr. McCaskill is currently with Burtek, Inc. as Vice President of Marketing. Previously at Perkin-Elmer Corporation, he was responsible for Government Marketing. Prior to Perkin-Elmer Mr. McCaskill was employed by the Harris Corporation, he was responsible for program management for such programs as F-15, UPTIFS, B1, A4S, and B-52. At General Electric he was involved with the Poseidon and Polaris program in a Field Engineering capacity.