Technology: insert or preserve?

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Introduction

Safeguarding the future of a defense or aerospace program in terms of its long term viability is typically front and center of the program manager's upfront thinking. How can the length of its deployment be maximized? How will it be designed to respond to changing demands? How can the program's goals be achieved cost-effectively? Well-developed strategies are available to help program managers through this potential minefield, as this white paper describes.

In the embedded electronics marketplace, defense and aerospace programs have significantly different dynamics to most other sectors. Primary among these is that the typical program can have a lifetime measured in decades: the B-52 Stratofortress – its maiden flight took place in April 1952 and, almost 70 years later, it is still in service – is one high profile example. This means that long term reliability and long term supply are king - and preserving and updating systems can be a daunting exercise requiring massive investment.

Avoiding changes necessitating re-qualification - with its concomitant time, cost and risk - is a key focus for program managers across the industry. However: at the same time, new technologies - driven by the commercial market - can open up opportunities to extend system capabilities and help meet ever-changing mission requirements.

So: what's the best approach? Should program managers plan for change with technology insertion strategies - or protect the program for the long term with technology preservation strategies?

First: let's get a clear definition of what the two strategies really mean.

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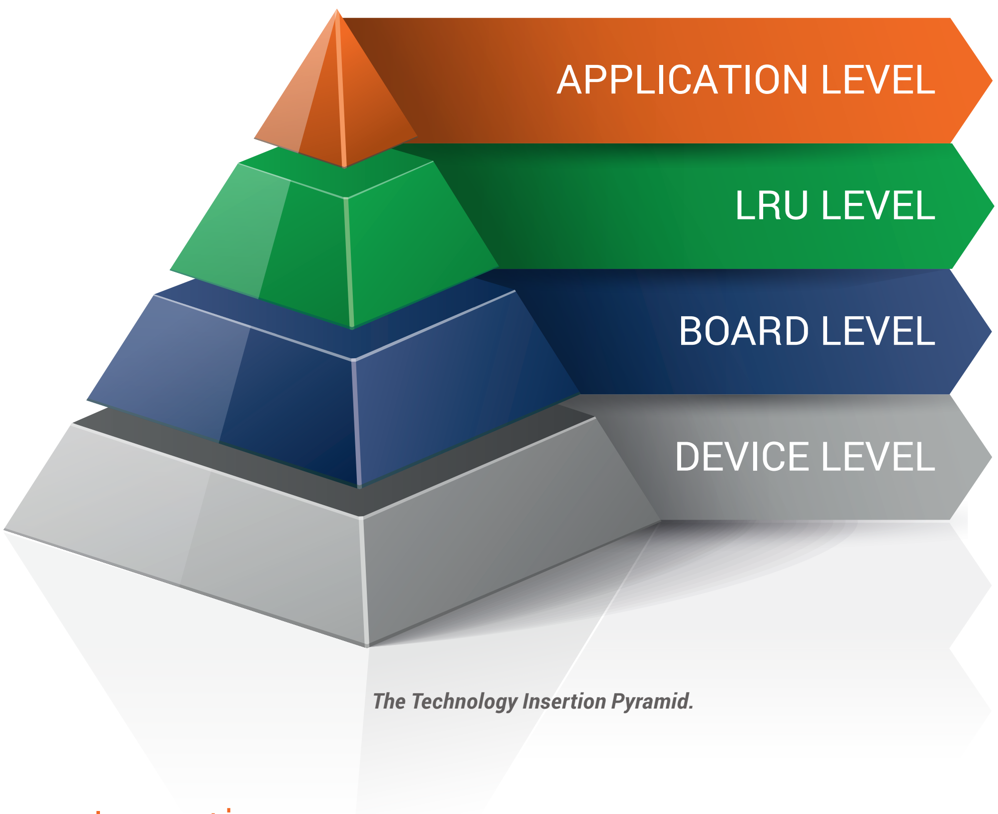

The Technology Insertion Pyramid.

Technology Insertion

A technology insertion strategy is a long term plan to increase a platform's capability by offering higher performance with minimum disruption. There are many different layers in the supply chain where technology insertion can be relevant; it can be thought of as a pyramid of technology insertion strategies which link together, moving towards meeting the needs of the end customer.

Device level

The development of complex integrated circuits such as CPUs or GPUs is driven by the high volume sales available from commercial markets; defense and aerospace programs have to "cling on to the coat tails" of the applications that drive the market. Providing an easy, straightforward, cost-effective upgrade for existing customers is seldom at the forefront of suppliers' minds as they focus on hitting the performance levels that can open up one of the bigger markets – such as gaming, autonomy or AI (Artificial Intelligence) applications. In these volume markets, having to change the host board to accommodate a new device footprint - maybe with a substantially increased power consumption profile - is not seen as a major issue. Maximum performance is everything.

However: at the edge of the IoT (Internet of Things) market, device roadmaps with predictable features - both physical and electronic - are extremely valuable. Suppliers such as Intel and NXP understand this, and often offer new generations of footprint-compatible devices that have the same physical characteristics and power consumption as previous generations - but offer incremental (and sometimes significant) performance increases. They also often offer guaranteed 10- or 15-year availability lifetimes. This device-level technology insertion strategy leads directly to the next tier.

Board level

With a footprint-compatible processor, for example, a host board manufacturer can introduce the new technology with the minimum of effort, and is able to offer the upgraded product (same board, newer processor) to higher tiers in the chain within a short time and with the supporting evidence that should enable customers to avoid requalification of their system or platform.

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However: device footprint compatibility often doesn't last for more than one or two cycles - at which point, the board manufacturer has to preserve technology insertion at the board level. This means keeping the physical, electrical and software interfaces at the board edge the same - but the internal design could be completely different. Changes are, in effect, transparent to the host system and the application.

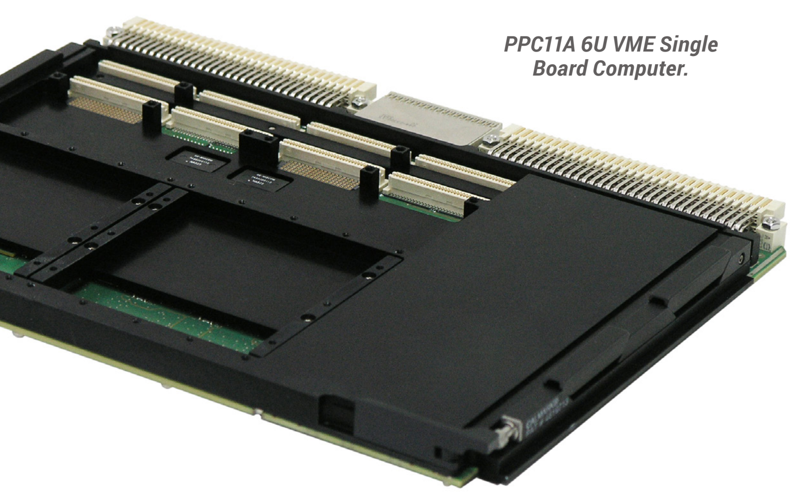
It is, of course, tempting for manufacturers to introduce new features and change things around. This, though, has to be balanced against the needs of long term customers who are comfortable with introducing a new board - but only if it matches the footprint of the previous one.

For example: Abaco has a long history of technology insertion product families with our VME range, based on the PowerPC architecture/processor and currently reaching its eleventh iteration with the PPC11A. The newer Intel-based VPX range is heading towards its seventh generation – all offering technology insertion opportunities. Of course, not every feature has remained entirely unchanged: it's no longer possible, for instance, to support IDE or VGA - but sufficient has remained constant to minimize the integration effort required.

Of course, software doesn't remain static either, and customers are at the whim of the operating system vendors. However: suppliers like Abaco can help with this by abstracting the details of the hardware design though layers of BIOS, BSP or SDK that can protect the investment the customer has made in his application code.

LRU level

At the next level up in the pyramid, truly form-, fit- and function compatible boards can be inserted in a system chassis without changing the backplane – the easiest and most straightforward form of technology insertion.



PPC11A 6U VME Single Board Computer.

But: at the system level, there are other choices too - ranging from minor backplane changes to accommodate a different supplier's I/O mix on the same specification board, to changing the board type altogether – changing from 3U CPCI to 3U VPX and from 6U VME to 6U VPX are the most common. This type of migration to VPX is really gaining momentum and confirms that preserving the basic mechanical formats of CPCI and VME in the OpenVPX standard was a very wise move on the part of VITA, the standards organization that defined it.

Another change is gathering momentum, with standards organisation such as SOSA driving towards more prescriptive pin-out definitions for new OpenVPX boards. The intent is to push multiple vendors to produce pin-out-identical boards to facilitate rapid technology insertion, portability and competition.

One complication of technology insertion is the convergence of a significant technology advance in the form of multi-core CPUs, and the ever increasing relevance of safety certification - particularly in avionics applications. In days gone by, the defense sector could claim exemption from safety certification requirements - but most vehicles have to be safety certified. However: multi-core CPUs add a level of complexity never before addressed in this field – but steadily, operating system vendors and lead customers have broached this subject and are now pushed through to a solution. Abaco is supporting this with both cert and no-cert platforms offering multicore solutions with technology insertion footprints.

Application level

Once a hardware platform has been upgraded with significant new technology, the user has many more options for his application-level software. In addition to being able to accelerate existing applications, the user can also consider adding applications for new mission requirements - maybe even moving applications from two separate systems on to the same hardware. Hypervisor technology means that it is now commonplace to have multiple operating systems running on the same hardware, perhaps even divided into safe and/or secure partitions.

In summary: technology insertion is now well understood and characterized, and has matured significantly. It becomes clear that technology insertion is a highly viable program strategy and opens up a whole new world almost unimaginable 30 years ago when computer board vendors first started using the term.

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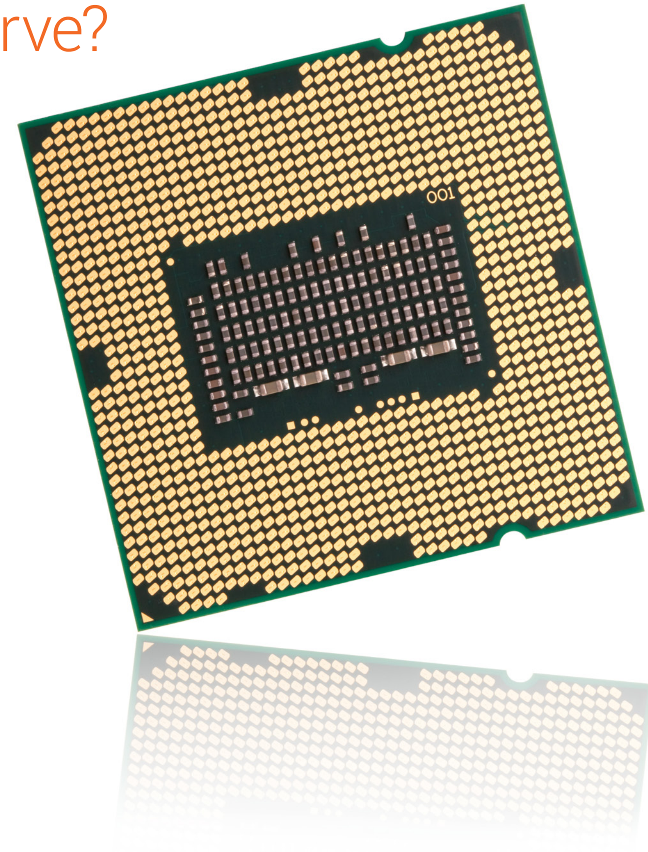

Technology Preservation

For some programs with fixed performance requirements and predictable production life, technology preservation can be the most cost-effective method of long term support.

Technology preservation is all about maintaining the same design for the whole program life by guarding against obsolescence –the biggest threat to the manufacturability of COTS electronics over an extended time period, given the dependence of COTS on commercially-available silicon with its historically much shorter lifecycles.

To avoid obsolescence, it is necessary to proactively monitor component status and take appropriate action when necessary.

Monitoring
In many instances, suppliers to the military and defense industry notify users well in advance of any impending obsolescence and offer a last time buy opportunity. However: some don't…

That's why it's highly advisable to have the best available information on hand at all times and not just wait for the inevitable to happen when suddenly a critical part becomes unobtainable. Obsolescence monitoring services exist, and a subscription is well worth the cost for the level of protection it offers. Abaco offers a service which combines the knowledge of a third party monitoring service with in-house expertise, to offer component health checks on a regular basis to customers who subscribe to our Long Term Support services.

Appropriate action
Once component obsolescence it identified, there are different courses of action that can be taken. One is to simply perform a last time buy. This is the obvious policy if the future quantity required is known. The parts can be bought and stored more or less indefinitely if they're held under the correct conditions. Abaco, for instance, has a long term storage capability on site which houses millions of dollars of customer-owned material, holding it safely until required – which sometimes can extend for many years, particularly when long term repair services are required beyond production life.

However: if future quantity requirements are uncertain, redesign may be an option. Often, a component can be replaced by an alternative part - and indeed can benefit from a lower tier vendor's technology Insertion strategies. If the impact of the redesign can be minimized by maintaining form, fit and function up to the next level in the supply chain, then costly requalification can be avoided.

On occasions, a user will take all appropriate actions but still be confronted by issues - particularly if required quantities change through the program life, such as when a platform upgrade program is cancelled due to changes in government funding and the original equipment has to continue in manufacture for a few extra years. In that case, seemingly terminal cases of component unavailability can be encountered – but even then, it may be possible to circumvent these by recreating the component in an FPGA or ASIC.

Abaco has been through this cycle several times and been able to assist customers in their quest to achieve program extensions without requalification.

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Insertion or Preservation – which is best?

No two aerospace/defense programs are the same – so there is, of course, no 'one-size-fits-all' answer. In fact, a combination of insertion and preservation is generally the optimum solution. The two approaches are far from mutually exclusive.

An excellent example of this is a fire control computer on a ground system in which Abaco has been involved for over 20 years. In the first instance, the solution was a PowerPC board based on a Motorola 603e CPU. Since then, the design has evolved, in the same footprint, through three more iterations of CPU – Motorola 755, Freescale 7448 and NXP P4080 – each providing a worthwhile uplift in capability but at minimal cost and with minimal disruption.

These regular technology insertions have been supported by technology preservation strategies with regular monitoring procurement and storage of devices that could cause potential obsolescence issues.

As with the program described: even if technology insertion is the main strategic choice, technology preservation strategies should not be ignored. They must be used in support of technology insertion strategies as otherwise, in the fast moving world of COTS electronics, there is likely to be an obsolescence issue that will cause disruption and a break down in the supply chain. Abaco's Product Lifecycle Management team ensures that our customers are protected to the maximum extent possible from unpleasant surprises.

Technology insertion or technology preservation is, therefore, not an either/or choice. The optimum solution will invariably be one that combines the two – even if the degree of emphasis on each is different.

What is a choice, however, is whether the chosen vendor has a history of designing-in technology insertion from the outset, a history that can provide confidence for the future – and whether that same vendor has the expertise, experience and infrastructure to provide the technology preservation capabilities that are both necessary and complementary.

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