# ADDRESSING THE INSTRUMENT OBSOLESCENCE PROBLEM - OPTIONS AND SOLUTIONS

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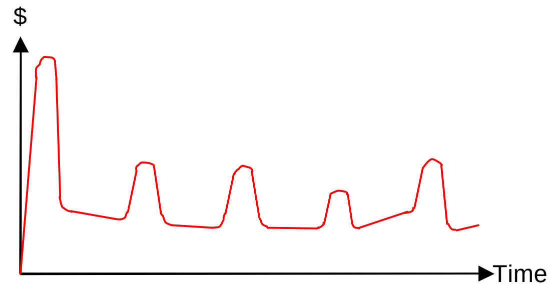
## INTRODUCTION

Military, aerospace and even commercial products need support equipment for production and maintenance. One important type of support equipment is functional Automated Test Equipment (ATE). When a dedicated test system fails and is not available, there is usually an immediate impact on the product it supports. It can be a monetary impact or even worse, readiness impact.

Legacy ATE systems are being pushed into extended service, beyond the service years for which they were originally intended, and as they age, the downtime increases. Instruments obsolescence is one of the major reasons for test systems down time on aging systems. If a system resource fails, it must be repaired or replaced. If the instrument is no longer produced (i.e. obsolete), then other, less traditional remedies must be employed.

## PRESERVING INVESTMENT

Over the life span of a test system it accrues a big investment. A typical ATE cost would start with the initial investment for designing, building and developing Test Program Sets (TPSs).




Typical ATE cost over time

After the initial investment the persistence cost component is maintenance with cost peaks for adding TPSs, building more copies of the system and upgrade phases. As the ATE gets older, the maintenance cost increases because of ageing and obsolescence issues. Any solution to obsolescence issues should take into consideration preserving this investment.

## STOCKPILING SPARES

Stockpiling of spare instruments is one way of reducing system down time. The spare instruments may be procured as part of the initial investment, during the ATE life span or as a life time buy when the notice of end of life is received. Stockpiling of spare instrument may be an effective approach however; this is only a short-term solution to buy some time until more permanent solution can be placed. The spare instruments will eventually break and end up the same as the original instruments.

## ON GOING MAINTENANCE AND REPAIR

The obsolete instrument may be continued to be maintained and repaired, either in-house or outsource. The problem with this approach is the ever-increasing cost and time to repair. It is hard to get parts for an obsolete instrument and in many cases, the components are obsolete as well. One way to get around it is to take parts from other systems. However, even if a large number of in-service systems are decommissioned to be cannibalized for replacement parts, the parts will eventually run out. This is a short-term solution at best.

## USED INSTRUMENTS

A tempting solution is to find an instrument replacement in the secondary market. Many test equipment distributors offer used instrument and there is a good chance finding any instrument for sale on the internet and even on E-Bay. Used equipment in prime condition usually comes with a corresponding price tag. Used instruments can be found also at a surplus auction or sale for low price; however, this is very chancy as the used instrument may be just as problem-prone as the original. There is a reason why the instrument wound up as surplus in the first place. Even if the used instrument is in pristine condition, this is a short-term solution and the challenge for long-term support still exists.

## TPS MIGRATION

Long-term solution could be the migration of the Test Program Sets to a new, up-to-date test system. This approach can be very expensive, especially if a large number of TPSs is involved. The only case where the price tag on such process may be acceptable is if the interface of the new hosting system is the same as the one of the legacy system, so the test adapters can be reused and thus preserving some of the investment. In many cases there is no test set that can support the legacy TPSs and one has to be designed and build from scratch, making this solution even more expensive.

Although a valid long-term solution, this approach may not be practical due to associated costs. It does not preserve the investment, it's expensive, and as most big engineering projects, it usually takes a long time to implement and involves high degree of risk. It may be a viable solution if there is an added value, like a new test system that can host new TPSs that are needed, or it can host TPSs from several test systems with obsolescence issues but it is still an expensive approach. An example to such approach is the recent U.S. Navy CASS Offload program in which 700 TPSs from obsolete testers are being migrated to CASS at an estimated cost of $1B. The problem is that by the time all 700 TPSs are migrated and validated on the CASS tester, CASS itself may become obsolete.

## COTS WITH ADAPTERS

Another long term solution is finding a Commercial Of The Shelf (COTS) functional replacement: a modern instrument that has all the functional capabilities and meets or exceeds the specifications of the obsolete instrument. In some cases manufacturer may come up with new generation of an instrument which are also backward-compatible with a legacy command set.

Identifying a COTS functional replacement should be done with care. The candidate instrument's specification should be scrutinized closely to verify that all the features used in the ATE are compatible, all the levels and ranges are covered, and all required inputs and outputs exist. An important issue that must be addressed is the improved performance of the new instrument. Newer instruments will, in most cases, have much faster or better performance than the obsolete instrument which will typically lead to TPS failures. For example, a DMM with a reading rate of 100 readings per second is being replaced by a new DMM with a reading rate of 1000 readings per second. This means that a single reading now takes 1mS instead of the 10mS it took before and a delay may be needed or else the test would fail.

Once a COTS instrument is selected, it should be adapted and integrated into the legacy ATE. It's possible that some mechanical adaptation for mounting and cabling is required but for the most part it is a simple task. In most cases the new instrument is not compatible with the legacy command set and translation is required. The translation should take care of the commands going to the instruments as well as the instrument response. There are several ways to go about the translation, as listed below.

### Software Driver

If the legacy ATE was designed using Instrument Interchangeability Technology (I2T) or Interchangeable Virtual Instruments (IVI) technology then the task to integrate the new instrument should be easy. A new I2t or IVI instrument driver needs to be created (if one does not exist already) and installed on the test system. TPSs should be able to use the new instrument with virtually no changes (assuming the new instrument matches the exact specifications of the obsolete instrument).

If I2T or IVI were not employed in the original design than the task to integrate the replacement instrument is not that easy, but the rest of the process is the same. If the legacy system did not use software Instrument driver but rather direct ASCII string commands in test programs, then in order to integrate the new instrument another adaptation method should be exercised, or all test programs using this instrument need to be modified.

One drawback for this approach is that once the new driver is installed, the legacy instrument can not be used any more.

## Software Adapter

Instrument adaptation can be achieved by implementing a software conversion layer. This software module can intercept commands intended for the original instrument and substitute them with compatible commands for the replacement instrument. It can do the same thing for the responses. As with a software driver approach, TPSs should be able to use the new instrument with virtually no changes but once installed, the legacy instrument cannot be used any more.

In some instances this relatively simple concept can be difficult to implement. A simple example is a multi channel instrument. The legacy instrument may use one command to set the channel that the next commands refer to, while the new replacement instrument may need the channel number as a parameter for each command. In this case the software translation module needs to keep track of all transmitted commands and interpret them and not just translate verbatim. Since this approach requires software development, there is also some risk involved.

There are other obstacles that may impede this approach. The operating system in most legacy test systems will not support inserting a software conversion layer and upgrading the controller and operating system is risky. The translation process introduces delays that may cause trigger and interrupt service timing issues. However, if software adapter is implemented successfully, then there is no additional cost for using it on all copies of the same test system except the cost of the COTS replacement instrument.

## Hardware Adapter

Hardware adapter, or Translation Module Adapter (TMA) as it often referred to, is a stand alone unit that connects between the system controller and the new instrument. The TMA has its own processor and uses two ports; one to communicate with the system controller and one to communicate with the replacement instrument. Special firmware needs to be developed to accept the legacy commands from the controller and translate them to the set of commands the new instrument understands. Responses are converted and sent back to the controller.

Like its software counterpart, once a hardware adapter is implemented, TPSs should be able to use the new instrument with virtually no changes but unlike the software adapter, the legacy instrument can still be used. The legacy instrument can be connected directly to the system controller, bypassing the TMA.

Hardware adapters face similar obstacles as their software counterparts. They too need to interpret and keep track of commands. There is some risk involved with firmware development. Propagation delays introduced by the additional hardware in the communication loop may create timing issues with trigger and service requests. An extra complication for TMAs is the additional hardware cost for each copy on top of the cost of the COTS replacement instrument.

# FORM FIT AND FUNCTION REPLACEMENT

A Form Fit and Function (FFF) replacement instrument is an instrument that when installed in an ATE instead of a legacy instrument, it fits in its place and performs exactly as the instrument it replaces without any additional changes. Although it may sound utopist, there are instruments like that available, some pictured below.

GP1552 replaces Wavetek 859 and HP8160A

FFF replacements are based on modern COTS instruments with a build-in adapter. The approach of implementing the adapter as part of the instrument firmware has few benefits. There is no additional cost for hardware. The command interpretation and tracking is part of the standard instrument firmware. There is no extra hardware to cause propagation delays.

FFF Instruments are drop in replacements, thus preserving the investment that went into the ATE over the years. The legacy instrument can still be used interchangeably with the replacement.

GP1665 replaces Wavetek 178 and HP8165A

One of the challenges in fielding COTS functional replacement instruments, including FFF replacements, that most people are not aware of, is mimicking the "un-documented" behavior of a legacy instrument. User manual document how an instrument response to command, but they are lacking in documentation of what happened if an invalid command, invalid parameter, or out of range value is send to the instrument. The error message is usually documented, but not the state of the instrument. Unfortunately, some TPSs treat this state as a feature and rely on it, forcing the replacement instrument to behave the same.

## SAMMARY AND CONCLUSION

As described above there are few approaches for dealing with instrument obsolescence, some are for short-term solution and some are for long term and each has its pros and cons.

- Stockpiling spares:
  - Pros: alleviates readiness issues.
  - Cons: short term, Initial high cost.
- On going maintenance and repair:
  - Pros: none.
  - Cons: short term, long periods of down time. This approach should be use as last resort.
- Used instruments:
  - Pros: relatively low cost, preserve investment.
  - Cons: short term, chancy.

- TPSs migration:
    - Pros: long term.
    - Cons: high cost, does not preserve investment, long development time with high degree of risk, requires skilled resources.
- COTS with software driver:
    - Pros: long term, relatively easy task, preserve investment.
    - Cons: original instrument can't be used anymore, requires skilled resources, can be implemented in very few cases.
- COTS with software adapter:
    - Pros: long term, preserve investment.
    - Cons: original instrument can't be used anymore, requires skilled resources, can be implemented in very few cases, some degree of risk.
- COTS with hardware adapter:
    - Pros: long term, preserve investment
    - Cons: extra hardware cost, requires skilled resources, some degree of risk.
- Form, Fit and Function replacement:
    - Pros: long term, preserve investment
    - Cons: none.

An approach good for one application may not be so for another and there is no one option that will be a solution for all obsolescence issues. In general terms, Form, Fit and Function replacement is the first best choice and COTS with adapter is second best.

## BIO

David Manor is a co-founder of Geotest- Marvin Test Systems, a supplier of instrumentation and test systems for the commercial and military – aerospace markets. Mr. Manor holds a BSEE degree from Tel-Aviv University and has over thirty years of experience in the test and measurement industry.

As VP of Engineering for Geotest, Mr. Manor is responsible for the definition, design and manufacturing of all of Geotest's products. He has been instrumental in the development of hundreds of instruments and modules, including some of the company's core products such as the GTXI family of instrumentation platforms, the GX7xxx family of PXI Chassis, the GT/GC/GX5xxx Digital IO boards, GT/GX6xxxx Switching cards, GP1xxx family of obsolescence replacement signal sources as well as other instruments and systems.

Prior to founding Geotest, Mr. Manor was a consultant to John Fluke Mfg, a Program Manager at RSI and a crew chief in the Israeli Air Force (IAF). Mr. Manor has a wife and two children and his interests include skiing, biking and traveling.