Automated Test Solves Maintenance Issues for Military Vehicles

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Long life spans of vehicle-based electronics, combined with the inevitable obsolescence issues, are an ongoing problem in the military. Automated test technologies are easing the pain.

The military sector uses electronics on an extremely large scale, ranging from radars, navigation and control electronics on board ships to portable, telecommunication equipment for ground personnel. Due to the large defense budgets involved, the equipment used by the military around the world also requires a long life span.

Keeping obsolete and disparate systems running reliably is a constant task for military planners. Ensuring the reliable and safe operation of a wide variety of military systems—wheeled and tracked equipment, tanks, ground and air transportation—often means that electronic assemblies and boards that malfunction or need routine testing are returned to their respective OEMs for evaluation. This creates expensive and inconvenient downtime for equipment out of service. In order to reduce operating costs, and improve response times and shorten repair cycles, operators often set up a local electronic repair workshop within their own field maintenance centers to test and find faults with the electronic assemblies and PCBs to avoid sending subsystems far out of the field of operations. This not only saves time and money, but also reduces the unavailability of vital transport stock and equipment. Reduced in-service breakdowns and improved fleet capability ensure that transit and field systems run more smoothly.

Maintenance Difficulties

And with recent developments, U.S. military is handing over leftover equipment from the Iraq conflict to police under a military surplus program. American law enforcement agencies have received 165 Mine Resistant Ambush Protected vehicles (MRAPs)—18-ton, armored vehicles with gun turrets—this year, according to an AP investigation. Military officials say police have filed requests for 731 more. Each military vehicle can cost $500,000 or more, but before they can be used by law enforcement agencies they have to be refitted for civilian use. Many vehicles lack documentation—making it hard to fix the electronics in them (Figure 1).

Figure 1
Mine Resistant Ambush Protected vehicles (MRAPs) can cost $1M or more, but it’s not so easy to have them refitted for civilian use. Many vehicles lack documentation—making it hard to fix the electronics in them.

Regular routine maintenance is a key aspect of the military transport industry in all countries as part of a strategy to keep aging infrastructure running without delays. This applies throughout the complete operation at all levels for permanent infrastructures, signaling, radar and communications. Whether testing, repairing, solving obsolescence issues or re-manufacturing obsolete devices, a complete maintenance system can help keep vital electronics working and bring increased asset availability, shorter repair times and the ability to support legacy and third-party equipment.

Incompatibilities and Obsolescence

In many cases, military transport infrastructures are made up of older, legacy equipment combined with latest-release products. The problem of incompatibility of test equipment for each technology is thus an additional difficulty. Maximizing fleet availability through extending Mean Distance Between Failure (MDBF) is a key parameter. Aging electronic parts are subject to increased failure rates and component obsolescence as well as increased stress in theater operation. Electronic circuits can be stressed beyond economic repair and require costly replacement.
All sectors of transportation have similar problems. Aviation is one of the most critical arenas in which maintenance must leave no room for error, for obvious reasons. While some aircraft still use technology from the ’70s and ’80s, newer aircraft still have to follow a strict maintenance program of state-of-the-art electronics on board (Figure 2). The long development programs for new planes adds to this problem, as the technology specified at the design stages can become technically obsolete when reaching production.

The military transport sector also uses electronics on an extremely large scale, ranging from radars, navigation and control electronics to portable, telecommunication equipment for ground personnel. Defense products require a long life span—some of the electronics in use are based on designs from as far back as the 1970s. In some cases, equipment that is deemed obsolete by one nation may be sold to another country for continued use. This situation creates a lack of information and support for the maintenance and repair of PCBs.

Choosing to use local maintenance tools not only speeds up the repair process but also broadens the range of equipment that can be fixed. Do-it-yourself testing gives confidence in ensuring safety (circuits can be extensively tested for full confidence, with improved reliability), extending product service through refurbishment, time-savings with fast turnaround times for repairs by technicians who need little training, and saving capital expenditures through maintenance and life-extension of high value electronic circuits.

**Moving to Automated Test**

So the need for repair and maintenance can be found in all sectors and applies to almost any product containing at least one electronic PCB. In former times, numerous separate instruments, manually wired connections and paper test procedures operated by skilled technicians were adequate. These repairs were covered by trained-technician repair shops in dedicated off-site repair centers. Nowadays, with the emphasis on efficiency and reduced costs, universal automated test systems have replaced individual test instruments, but these can be extremely expensive and some of them come with a steep learning curve.

Automatic test equipment (ATE) products perform automated or computerized test procedures on a device under test, including functional testing of ICs, analog and digital components, complete boards, etc., and they vary in complexity in order to provide repair capabilities with different levels of test capabilities for differing board complexities. Computer-based automated test procedures can run reliably and consistently with test results being captured automatically, with high accuracy, high test speeds and extreme flexibility. Typical ATEs include: In-Circuit Testers, performing device level tests on components mounted circuit boards; Functional Testers, used to test full functionality of boards and modules via edge connectors; Boundary Scan Testers for products that are JTAG-compliant such as BGA, FPGA, CPLDs, or even complete boards with a JTAG connector.

ATEs have given power and independence to military forces when it comes to electronic repair. Becoming equipped with automatic testing means that repair facilities don’t have to rely on outside contractors; they can reduce repair time and cost, and even refurbish and repair outdated and old electronics closer to their use.

**ATE Solutions**

Diagnosys is probably the largest player in this market with its PinPoint System. They manufacture and sell automatic test equipment and services for the test, fault finding and repair of electronic circuits to customers in defense, industrial and
mass transit market sectors. Their website lists customers as diverse as Ingeniería Integrada (Columbia), Mitsubishi Electric (Florida), ADATS (Air Defence and Air Traffic Systems Delivery Team - UK), Porterbrook Leasing (UK) and Naval Air Systems Command (USA). Diagnosys’ testers diagnose and repair circuit card assemblies from weapons replaceable assemblies, where failures typically occur in components for which test programs or schematics are generally not available.

An up-and-coming challenger to Diagnosys’ products is the more affordable solutions provider UK-based ABI Electronics. ABI products are well known around the world, but are just becoming known in the USA. Their test equipment is used in naval bases around the world, as well as by BAE and NASA. The Naval Precision Electronics Complex (NPEC) of Karachi, for instance, uses 20 SYSTEM 8 BFL modules every day to ensure the maintenance of their fleet. Other SYSTEM 8 modules are widely used in the air force, including the British R.A.F. and the Egyptian Air Force, for the diagnostics of onboard electronics.

Schematic Creation

Interestingly, some sites are also using ABI’s RevEng (schematic learning) systems to generate missing schematics in order to support their repair processes on obsolete equipment. ABI products are employed in aviation repair by commercial airlines in the UK, Turkey, Indonesia, New Zealand and the USA for all aspects of avionics, including communications, navigation, monitoring, flight-control and simulators, and management systems (Figure 3). Euro Disney—often a leader in systems efficiency—uses ABI’s modules in Paris for their ride and park transport maintenance needs. ABI’s System 8 is particularly easy to use since it can rapidly compare (and remember) known good boards with suspect ones to quickly find faults without needing supporting documentation. This is very handy for obsolete or irreplaceable equipment.

![Figure 3](image)

_Schematic learning systems to generate missing schematics are employed in aviation repair by commercial airlines for all aspects of avionics, including communications, navigation, monitoring, flight-control and simulators, and management systems._

When it comes to circuit boards, it is more cost-effective to repair than replace and transport, and defense systems around the world have begun to realize this trend and have started incorporating ATEs into their support and development infrastructure. Factors to consider when selecting a suitable product include cost, ease-of-use, training availability and expandability. Care must be taken to consider if the system can cope with obsolete and state-of-the-art electronics.

Whether you are a military planner, an engineer, or a servicing officer, there are test products to be found that will provide solutions to meet individual requirements to keep transportation electronics working and reduce system costs. While today’s ATE systems are modular and configurable to support multiple different test methods, they need to be easy to use and to become familiar with. The criteria for selecting suitable test systems for use in house should include: simplicity of operation, technical capability, product quality, reliability, flexibility, accurate fault identification and long-term support. The challenge is to find test equipment that is capable of testing legacy equipment as well as latest-release products, that is flexible to apply to a wide range of disparate products, that does not need extensive training, and that can provide comprehensive final reports—and is affordable too.