Key Trends in Automated Test for Warfighters

Major General Stephen T. Sargeant, USAF, Ret.
CEO of Marvin Test Solutions and VP for Strategic Development for The Marvin Group
Delivered at AUTOTESTCON, 27 August, 2019

Thank you for the warm introduction. It's great to be back at AUTOTESTCON, and it is an honor to be asked to kick off this important gathering of dedicated test and measurement innovators and the warfighters many of us serve.

Good morning ladies and gentlemen.   Welcome to AUTOTESTCON! Thanks for coming out at this early hour before some of you have even had your first cup of coffee! Over the weekend I had the chance to spend time with some of my family while preparing my presentation. During that time, I discovered how everyone wanted to assist me. For instance, when my wife started reading over my shoulder her advice was -- Whatever you do, don't try to be too charming, too witty or too clever -- just be yourself.

My son's advice was concise and to the point – emulate the latest fashion trends – be long enough to cover the subject, but short enough to be interesting. Then, begone.

Just to help everyone get an idea who is in the audience today – if you are in the military please raise your hand – thanks; If you are government, please raise your hand – thanks; if you are an exhibitor, please raise your hand – thanks. Now we should all have a good idea of who is with us today.

If this is your first time attending AUTOTESTCON I hope you will take advantage of the time you spend here by visiting the exhibit hall, expanding your network, attending the technical sessions and tutorials. Whether you're tasked with maintaining legacy ATE, designing a new test solution from the ground up, or looking for someone to do that for you, chances are you'll find what you need.

If you've been here before, you probably already have a hot list of exhibitors to see, and people to catch up with. I think this video captures the tough job many of us face matching requirements and technologies, but remember it is honorable and worthy work:

https://www.youtube.com/watch?time_continue=23&v=m_MaJDK3VNE

Since you're here, you are probably already aware of the importance of test in maintaining mission-critical military systems. Mission readiness is the name of the game, and readiness requires comprehensive testing of mission enabling systems - not just during the initial design phase, but throughout the manufacturing process, and at all three maintenance levels once deployed. With lives on the line and mission objectives to be accomplished on the first pass over their targets, the warfighter depends on all of us to ensure the health and readiness of their systems, whether on the flightline, in the backshop, or depot.

This video of an A-10 attacking a fleeing target in Afghanistan drives home the point – systems need to work on the first pass, because there may not be a second chance.
https://www.youtube.com/watch?v=AJX4j0TDiEE#action=share

Over the past several years since retiring from Active Duty in 2011, I've had the opportunity to spend time with maintainers across the globe discussing the manned and unmanned, rotary and fixed wing aircraft they support. That opportunity has led me to collect several improvements they expressed interest in obtaining if possible.

Today I would like to present some of those desirements that I have collected and to combine that with procurement requirement trends that present both opportunities and challenges in the future.

Advanced Weapon Systems

One of the most important advances in military technology since Desert Storm in 1991 is the increasing use of Precision Guided Munitions, AKA Smart weapons. Smart weapons are able to obtain repeatable delivery accuracy based on improved communications with the aircraft that carry them, and often offboard data used to refine guidance to the target. Today they are the weapons of choice for militaries worldwide. That demand is enabling arms producers to deliver record numbers of smart weapons. Smart weapons rely on more complicated interfaces with the armament and aircraft that carry them. Traditional stray voltage and continuity test sets alone cannot functionally test those interfaces. However, most militaries today still have their maintainers using that same type of test equipment that was delivered with the aircraft in the late 70s and early 80s when there were few smart weapons available. Therefore, in many cases they are unable to perform functional checks on their armament to ensure a high degree of reliability on the flightline. That is generally not true for avionics and radar systems as they contain built in test capability.

To give you an example of the growth of Smart weapon use, let's look at some figures from the last 30 years.

In Operation Desert Storm in 1991, only about 8.5% of the munitions employed were Smart.

Moving forward to Operation Iraqi Freedom in 2003, that figure rose to 68%.

And in Operation Inherent Resolve - the campaign against ISIS - in 2017, Precision Guided Munitions represented over 95% of the weapons employed.

And for those weapon systems to be truly reliable – to make sure that the weapon will always function when it's commanded to, and never, ever, when it's not commanded to – test sets need to be up to the challenge: reliable, deployable, easy to use, and provide comprehensive test capabilities to ensure an aircraft's armament systems are Fully Mission Capable.

As these precision-guided munitions are integrated onto an ever-increasing number of legacy and 5th generation aircraft, maintainers are seeking innovative test solutions to better allow them to ensure their aircraft are FMC when aircrews arrive.

To be specific, many maintainers have expressed concerns about the reliability and deployability of their existing test equipment:

- Logistical challenges such as fielding and maintaining test sets in environments that can range from scorching deserts to frozen plains.

- Supporting and using multiple different test sets, each for a different purpose or supporting a different aircraft. Test equipment often requires large, cumbersome paper or digital checklists (or both).

- The continued use of legacy support equipment that was originally deployed for an older generation of aircraft, munitions, or avionics to support the new capabilities that are being added to older aircraft, as well as new aircraft that are coming online. This often results in tests that fall short of checking functionality.

- Large deployment footprints of equipment both for shipment and use on the flightline.

- They are desiring test sets the size of your cellphone capable of connecting to the aircraft possibly via encrypted WI-FI or Bluetooth and capable of simulating a weapon to test armament.

- Excessively long test times to conduct go / no-go tests and follow-on troubleshooting.

- Given the funding challenges that normally accompany either new procurements or major modifications, test and training are often the last to be funded causing maintainers to make do with existing test sets.

To summarize, what maintainers have expressed to me over time is the desire for:

- Smaller test sets – in some cases requesting systems as small as a cell phone and with fewer or no cables to enable easy deployment and reduced clutter on the flightline;
- Rugged, Airmen-proof test sets with high mean time between failure or long calibration cycles;
- Commonality of test sets to support multiple aircraft in deployed environments;
- Innovative test capability that provides comprehensive testing of systems and can easily add future test capability as new munitions are fielded;
- Faster test times with test data that can be captured and eventually incorporated into a preventive/predictable maintenance artificial intelligence environment;
- Recognition that there are new technologies available today to allow maintainers to increase the chances of first-pass mission success and the funding needed to match test capabilities with the total weapons system capabilities that exist today.
- ATE with reduced-sized paper or digital checklists to work with on the flightline.

We have the chance this week to have a lively dialogue between warfighters and industry to further flesh out these areas – I hope you will take the opportunity ATC affords us to do that.

New Technologies Enabling the Future

"We'll be dispersed, with only a minimum number of maintainers, often multiskilling the maintainers we have to do more than one job. … Our units will have to operate more independently with what they've got on hand." General James Holmes, 19 June 2019 at the AF Life Cycle Industry Days Conference

General Holmes went on to say that industry and government should work to boost reliability and reduce the movement of spare parts by exploring modern sustainment initiatives involving predictive maintenance algorithms.

Not all of us get to attend the airshows where the F-35 shows its stuff so this is for all you who have missed seeing it in action:

https://www.youtube.com/watch?v=sGLaLc-fhUU

We must also look at every opportunity to leverage technologies that can enhance the capabilities of the systems that our warfighters depend on. Standards-based, modular test platforms are a good example of how to achieve the ability to build in growth capability. The latest Field-Programmable Gate Array or FPGA technology is another good example of how test sets can be enabled to provide long-term expansion and remain relevant and effective. FPGAs can allow program managers to avoid having to procure new test equipment when a new capability is integrated on an aircraft.

We will need to take a look at how 5G technology can be leveraged for more than just the telecommunications applications we are hearing more and more about. With 5G's low latency and high data rates, real-time data

sharing and sensing can be an enabler of even more precise weapons in the future and better predictive maintenance.

We have already seen unmanned "wingmen" being developed by Kratos and Boeing. An F-35, for example, is envisioned to be able to lead a group of unmanned aircraft much like a quarterback leads a team, coordinating and directing the attack (employing weapons) while remaining at a distance. We will be challenged with testing this mixed configuration of aircraft to ensure this complex and dynamic system of systems is fully capable of reliable communications and successful weapons employment.

https://www.youtube.com/watch?v=QrJmG1g4mFI#action=share

https://images05.military.com/sites/default/files/styles/full/public/2019-03/airpower-teaming-system-900.jpg?itok=_QReA7JS

As the trend toward more frequent and smaller deployments with fewer personnel and fewer aircraft continues, how do we make sure that the available test resources, especially at the O- and I-Level, provide the required capability for maintenance and sustainment far from the home station?

The answer to both is probably more multi-platform supportable test equipment that is easy to deploy and operate – much like is happening in the bomber world today with the Bomber Armament Test (BAT) program.

With 5G still in the first phases of its implementation, some are already working to plan what 6G will be. And, as you know although there is movement afoot to have more military data accessible through the cloud – much work in the policy and security arenas remains to be done, but it will probably happen. So we need to watch it closely. But as of today, the USAF is forging ahead installing 5G on 10 bases in the USA. The vision calls for high-speed wireless connectivity supporting the flightline and enabling the Flightline of the Future. But, one of the biggest hurdles will be securing the maintenance and test data being transferred via an encryption venue that protects the data, but doesn't impede the speed.

Cybersecurity Concerns

Some of the trends that are driving advances in how we design test equipment are related to the trends in the commercial world: big data, cloud computing, artificial intelligence, and an increasing reliance on interconnected systems. The US military services are paying attention to these technologies and are working feverishly to enable netcentric warfare to empower multi-domain operations in order to maintain an overwhelming decisive edge over potential adversaries. These areas present all of us many opportunities to better support the warfighter.

Today we're able to collect, store, and analyze massive amounts of data enabling better predictive maintenance as we detect patterns and trends in the data in real time. Moving from reactive maintenance (fix it when it breaks) to preventive maintenance (fix it when the schedule says to) to predictive maintenance (knowing in advance when maintenance will be required), will streamline logistics processes to deliver exactly what's needed – when and where it's needed.

And just as data security is critical in defense industry facilities, weapons systems must also be protected with robust cybersecurity features. As systems are increasingly interconnected, the risk of intrusion and compromise from malware or counterfeit hardware must be minimized. The days of standalone or isolated non-networked test systems are disappearing, replaced by a sophisticated test ecosystem where data can be shared and, therefore, access must be controlled.

The Defense Information Systems Agency (DISA) has compiled and released a comprehensive document, the Application Security and Development (ASD) Security Technical Implementation Guide (STIG) identifying the configuration standards for DoD IA (Information Assurance) and IA-enabled devices / systems. Since 1998, DISA has played a critical role in enhancing the security posture of DoD's security systems by providing the STIGs. The

STIGs contain technical guidance to "lock down" information systems / software that might otherwise be vulnerable to a malicious computer attack.

The STIG identifies nearly 300 risks, categorized by severity, that apply to all DoD developed and administered applications and systems connected to DoD networks. While not all the requirements are applicable to automated test systems, there are key requirements that certainly apply including:

• TPS audit event log recording
• User audit event log recording
• Idle time locking
• User account handling
• Password policies
• Configuration audit changes

Leading suppliers of test software have already identified the key STIGs that apply to this space and are working to implement these requirements to ensure maximum compliance and protection against malicious attacks.

The DoD and industry are actively working to understand the constantly evolving cyber threats that their digital systems are facing. Recently, a team of white hat hackers was invited to try to exploit vulnerabilities in the F-15's flight systems. And they succeeded! The good news is that they revealed issues that can be addressed before they are discovered by our adversaries. The Defense Digital Service recognizes that security is a continuous process that requires regular re-evaluation, so you can expect to hear more of this kind of story in the future. In fact, if you have a current contract to deliver test equipment to the DoD, I am certain you have a set of robust cybersecurity requirements to meet. But even with some of these emerging technologies in their early stages, we need to think big. Figure out how to take the best of what's out there and make it even better – and more importantly, make it work for the warfighter.

There are hypersonics, directed energy, robotics, satellite constellations, and a host of technologies coming out of innovation hubs like AFWERX and SOFWERX that many of us may not even be fully aware of yet. Maybe some of you are involved in these breakthrough technologies and are on the ground floor of figuring out the test strategies they will need and enable.

Conclusion

As you attend the conference sessions and explore the exhibit hall this week, I'd like you to remember that while the exhibitors and speakers are here to show you what they can do, they are also here to learn from you. So, let's get the dialogue going.

If you had a magic wand, what would you conjure up? What are the features and capabilities that your next test set will need to keep pace with the demands you or your customers are facing? Challenge those around you to find the right solution, and don't let them off the hook easily. We're all here to work toward ensuring mission success, and your voice is a critical element in this conversation.

In closing, I'd like to once again thank IEEE, and the AUTOTESTCON committee for giving me the opportunity to share some thoughts regarding the future of test in the military with you today. Thank you all of you for being here -- I look forward to meeting with you during the show, and to continuing the conversation even after this week is over.

I leave with the following video to get your imagination in overdrive:
https://www.youtube.com/watch?v=HPZpp_Y6Er8
Have a great week!