Editor's Note: The media tends to focus on the consumer Internet of Things, but thinking of a test system as an IoT device presents additional opportunities. On the small scale, test organizations can optimize the performance of their test hardware assets. On a larger scale, the insights from managed test systems can improve yield, quality, productivity, uptime, and much more. A great example is how large semiconductor manufacturers use real-time data to optimize their processes, and this trend will only increase as test systems become smarter than the devices they're testing.
—Dr. James Truchard

Managed Test Systems

As Moore's law continues to influence the performance and complexity of test systems, the need for robust system management capabilities is increasingly apparent. Test managers responsible for maintaining the uptime of a test system are looking for improved management features in their test equipment. Simply defined, manageability comprises the set of features that support the ability to identify and supervise a computing system. Borrowing from a rich heritage established in the information technology (IT) industry, manageability features enhance a test system's ability to perform its primary task (testing and measuring) by ensuring the components of the system are up to date, healthy, and meeting performance expectations.

In the same way that IT administrators rely on manageability features to efficiently maintain client and server computing assets in a corporate environment, test engineers and operators will benefit from manageability features when developing, deploying, and supporting the operation of test systems.

Elements and Operating Modes of Managed Test Systems

Managed test systems are composed of the system infrastructure, peripherals, and hardware and software elements that manage them, including management consoles and APIs. For example, management console software, such as NI Measurement & Automation Explorer (MAX), can run directly on the test system being managed or be executed remotely via a network on a separate computer. In both cases, the management console issues configuration, calibration, platform monitoring, and deployment requests on behalf of the test engineer or operator managing the system, and the managed system fulfills those requests. In addition to vendor-provided management consoles, users can define their own or integrate manageability features directly into test applications using APIs. With these standard elements, manageability features can operate in two distinct modes: in-band and out-of-band.

In-band management uses the primary computing resources, including the system controller's main CPU, network interface, and operating system, to manage the system. In addition to running the test application, the system controller runs software to enable manageability features, including management consoles and supporting infrastructure. In this way, in-band management can support a rich set of manageability features while the system is operating in the "fully on" state. If the system controller is powered off, unprovisioned, or not operating normally because of a failure, out-of-band management is required.

Out-of-band management can be particularly useful for those diagnosing a system that has failed. While rare today, more test equipment is incorporating these

features by using dedicated computing resources, including a secondary management processor, network interface, and operating system, to manage the test system independently of the system controller's computing resources. For example, if the system controller is unable to boot normally because it has experienced a hard drive failure, out-of-band management can be used to remotely power the system on and execute diagnostics on the hard drive, allowing for remote analysis to determine the cause of the failure. Further, because out-of-band management does not require the use of the system controller's computing resources, the system controller can remain fully dedicated to executing the application. This is particularly important for applications that are sensitive to disruptions in CPU or data bus usage, including real-time and high-throughput measurements.

Trends in Managed Test Systems

As modular instrumentation platforms continue to displace traditional box instruments, the need for asset management capabilities is increasingly important. Because modular test systems separate the system into components (system controllers, chassis, and instruments), the number of assets to be managed naturally increases. By knowing which test assets are being used and how they are being applied, test managers can lower costs by maximizing the use of available equipment. In a validation lab, for example, it is critical that the location and operational state of all assets are known so that components not actively being used can be redeployed in other test systems. The same applies to high-volume production test environments but on a much larger scale.

Increasingly complex measurement devices are also driving the need for comprehensive manageability support, particularly in platform monitoring and control.

Modern modular instruments, especially RF instruments, offer unprecedented measurement flexibility and speed by taking full advantage of the power and cooling capabilities of the modular platforms that support them. Test system designers can maximize the long-term reliability, usability, and measurement accuracy of these systems by selecting platform elements that use monitoring and control features. For example, by monitoring the cooling requirements of the instruments in a chassis, a chassis can optimize its fan speeds to minimize acoustics. This is especially important in an environment where noise must be minimized such as a validation lab. Further, measurement accuracy is optimized when an instrument is operating as close as possible to its calibrated temperature. By monitoring the temperature of an instrument, a chassis can precisely control its fans so that the instrument can maintain a steady temperature at or near its calibrated value to ensure the integrity and repeatability of the measurement.

Benefits of a Managed Test System

Test managers can significantly benefit from improved manageability features, which lower the test system's integration risks by ensuring that issues can be diagnosed and resolved efficiently, especially for large and complex testers and testers in remote locations. Additional benefits include minimizing a test system's "time to value" by ensuring that initial and subsequent test station deployments can be managed in a fast and repeatable manner. Finally, manageability features lower the total cost of ownership of a test system by enabling the ability to proactively monitor and diagnose problems as well as convert unplanned outages into planned outages. Just as manageability features helped drive the transformation of the IT and telecom industries, they will play an increasing role in test systems in the years to come.

Management Console	Laptop	Tablet
Manageability Features	Configuration	Calibration
	System Monitoring	Diagnostics
	Logging/Alerting	Software Deployment
Test Systems	PXI	Instrumentation Rack

Manageability features enhance a test system's ability to perform its primary task by ensuring the components of the system are up to date, healthy, and meeting performance expectations.