The Case for Change: PXI Express (PXIe) vs. PXI

In the communications and cellular industry equipment needs change fast. Particularly when it comes to communications testing, it doesn't always seem worthwhile to invest in equipment that lasts. After all, next month you'll be testing a different type of phone and next year it will be a different configuration of cell tower. Unlike avionics or machinery – where test configurations last years or decades – the lifetime of a testing setup in communications can be a few months or a few years.

For that reason, communications test systems have increasingly relied on modular instrumentation systems that allow you to upgrade individual components rather than replacing the entire system. The older PXI standard is one modular instrumentation standard that has seen broader adoption in the communications industry over the past two decades. PXI has served the industry well, providing an easier means of upgrading components.

However, as the industry moves forward, the inherent performance limitations of the PXI bus make it important to consider the advantages of the newer, higher-performance PXI Express (PXIe) standard for new test systems. Due to PXIe's performance improvements and older PXI component availability, instrument manufacturers are less inclined to create advanced components for the older PXI standard, so most of today's high-end and modern testing equipment is available only in the PXIe standard. The PCIe data bus PXIe provides even more future-proofing – each new generation of PCIe offers faster data throughput without changing the physical interface of the PCIe/PXIe connection.

In this whitepaper we discuss the advantages of the PXIe standard over the PXI standard specifically as it relates to testing of communications equipment. Many of the improvements of PXIe affect other industries beyond the communications industry. However, the communications industry in particular sees more rapid adoption of new technology standards than other industries. This means testing needs change faster and more frequently require the latest instrumentation technology available. This paper outlines some of the typical testing components found in a communications test system and describes how PXIe provides higher-performance testing than the older PXI instruments.

Background: What Is PXIe?

PCI eXtensions for Instrumentation (PXI) is a computer-based hardware and software platform for test and measurement systems. The open standard emerged in the late 1990s as a spinoff from the PCI computer bus standard because an instrumentation system requires more complex timing and synchronization, and more robust hardware. In 2005, the PXI Express (PXIe) standard was developed to address the need for faster communications protocols leveraging the newer PCIe communications bus. The PXI and PXIe standard is governed by the PXI systems Alliance (PXISA) which maintains and controls the evolution of the standard to insure interoperability of instruments from hundreds of vendors.

Eventually the older protocol will become obsolete, but today PXI and PXIe live side-by-side, literally, even in the

same chassis. Many PXIe chasses today include module slots that can accept either PXI, PXI hybrid, or PXIe modules. These hybrid systems allow the use of both standards within the same chassis, permitting newer PXIe instruments to coexist with older, existing PXI components. While these hybrid systems accept upgrades while preserving the investment of older PXI instrumentation, over the long run, those older slots will become obsolete with newer replacement modules only available in PXIe.

The following are some benefits of using PXIe rather than the older PXI standard:

- Longevity: the newer standard will ultimately replace the older standard
- Higher data throughput: the PCIe data bus provides significantly faster backplane data rates, with up to 8 GB/s per PXIe module slot
- Lower latency backplane communications
- Improved backplane timing and trigger bus
- Higher power available for each module

Communications Testing Equipment

Speed and performance matter in the communications testing industry. PXIe instruments offer faster data-throughput speeds, more power, a wider range of frequencies, and better accuracy for communications testing applications. The following are some common instruments used for communications testing and the benefits of using PXIe-based instruments rather than those based on the older PXI standard.

Signal Switches and Programmable Resistors

Switches are often a crucial piece of a test system because they allow you to more cost-effectively use high-cost instruments to measure more channels, test multiple devices-under-test (DUTs) near simultaneously or connect multiple instruments to the same source signal without making any physical wiring changes. Programmable resistors (aka resistor ladder) are designed to emulate the use of resistive sensors and variable resistors and can be used in many applications, such as simulating strain, temperature, pressure, fault insertion and more.

Switches and programmable resistor modules benefit from the higher power output of the newer PXIe standard compared to the lower power provided by PXI. More power available per module-slot allows the instrument to actuate more relays, which is particularly beneficial for high-density switch modules that otherwise have restrictions on how many paths can be activated simultaneously. In addition, the future longevity of PXIe means that more vendors are focusing on PXIe-only, parts are easier to come by and the expected supportable lifetime of PXIe switches and programmable resistors will be much longer than older PXI-based alternatives.

Data Acquisition, General Purpose Analog Inputs/ Outputs, and Digital Inputs/Outputs

Compared to older PXI instruments, newer PXIe instruments used for data acquisition and general-purpose analog input/ output channels offer the following advantages:

- Faster sampling and update rates than older PXI modules
- Wider voltage ranges
- Higher channel density (more channels per module)
- Higher accuracy
- Faster data download rates

Technically, many of these features could be built into older PXI modules, but it's no longer done because of the increasing obsolescence of the PXI platform.

Power Supplies, Source Measure Units (SMUs), and Digital Multi-meters (DMMs):

Newer PXIe power and precision measurement instruments benefit from the higher per-module power output of the newer PXIe standard. More power supplied to the module means more power can be provided to the output of the SMU or power supply. PXIe power and precision measurement instruments offer the following advantages over older, PXI-based instruments:

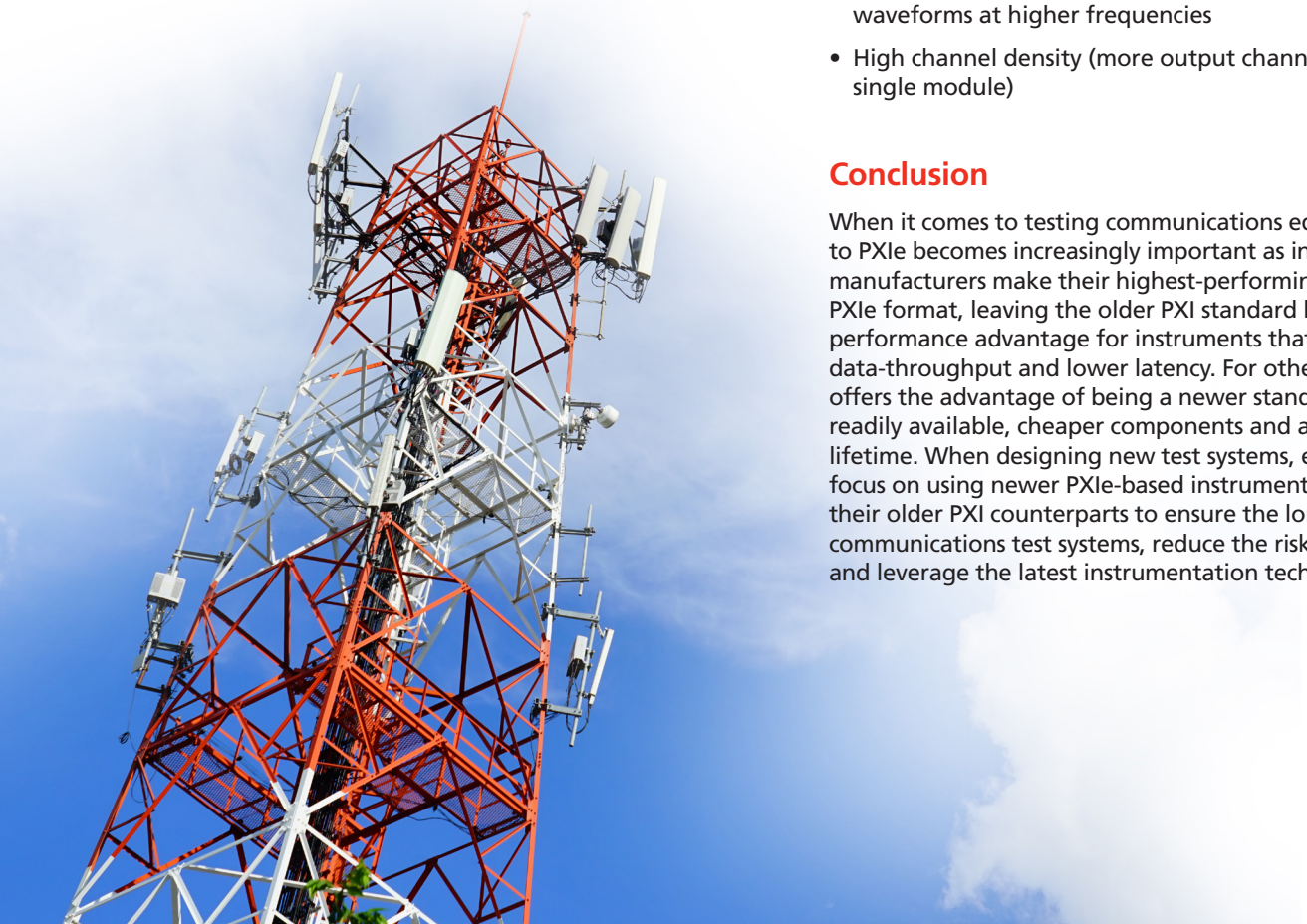
- Higher output voltage range
- Greater total power output
- Higher accuracy
- Higher channel density (multiple channels in a single PXIe module)

Vector Signal Analyzers (VSAs), Vector Network Analyzers (VNAs) and Spectrum Analyzer

VSAs, VNAs, and spectrum analyzers are often the most critical component for a communications test system. These instruments benefit greatly from the data-throughput performance improvements of the newer PXIe bus. RF test scripts often require a large number of measurements acquiring a large amount of data, sometimes up to dozens of GBs of raw data over a full characterization test. Furthermore, many of these instruments require streaming raw data to other instruments in the chassis. The faster PXIe bus means that this data can be captured, transferred, and processed in a fraction of the time it would take compared to an older PXI-based instrument. This means faster test-times, which translates to lower cost and shorter time-to-market.

PXIe-based RF instruments offer the following advantages over their older, PXI-based counterparts:

- Higher frequencies, up to 26.5 GHz and above
- Wider instantaneous bandwidth
- Higher accuracy
- Onboard FPGA configuration
- Faster tuning times
- Better resolution bandwidth
- Faster data throughput, enabling faster data processing and lower test times



High Speed Digitizers and Oscilloscopes

Similar to the RF instruments mentioned above, high speed digitizers and oscilloscopes benefit greatly from the improved data throughput of the PXIe standard. This offers much faster data transfer and processing, which results in faster test times. In general, PXIe-based digitizers have the following benefits over older PXI digitizers:

- Higher maximum bandwidth, up to 2 GHz
- Higher maximum sample rate, up to 12.5 GSa/s
- Greater onboard memory
- Greater input voltage range
- Onboard FPGA configuration
- Smaller footprint
- Higher accuracy

Signal Generators and Arbitrary Waveform Generator (AWG)

Signal generators (both Vector/RF generators, and non-RF generators) and AWGs based on the newer PXIe platform have similar benefits over older PXI-based options:

- Higher maximum bandwidth
- Higher update rates
- Wider voltage ranges
- Greater onboard memory, allowing more complex waveforms at higher frequencies
- High channel density (more output channels on a single module)

Conclusion

When it comes to testing communications equipment, moving to PXIe becomes increasingly important as instrumentation manufacturers make their highest-performing instruments in the PXIe format, leaving the older PXI standard behind. PXIe offers a performance advantage for instruments that benefit from faster data-throughput and lower latency. For other instruments, PXIe offers the advantage of being a newer standard with more readily available, cheaper components and a longer foreseeable lifetime. When designing new test systems, engineers should focus on using newer PXIe-based instruments as opposed to their older PXI counterparts to ensure the longevity of new communications test systems, reduce the risk of obsolescence, and leverage the latest instrumentation technologies.