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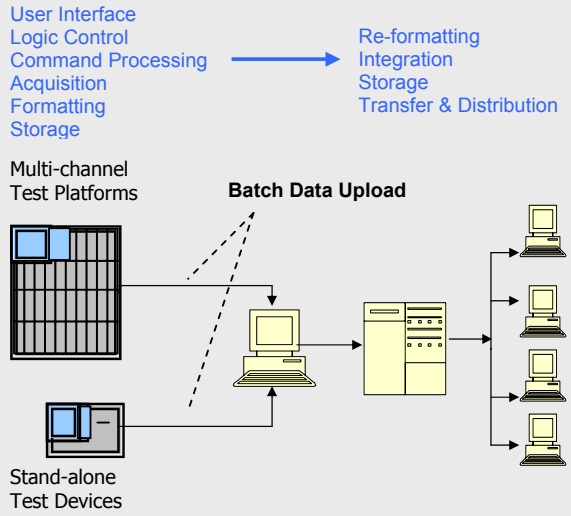
Fiberbyte
Fiber-Optic Test & Measurement

PC-controlled test platforms add flexibility & reduce costs

PC Compatibility

Test equipment is becoming increasingly PC compatible. Most test devices now have some form of PC interface so acquired data can be uploaded to a computer where it is re-formatted, stored, integrated and distributed (see Figure 1). The test device may be where the data is acquired - but the PC is where the data is ultimately used.

Figure 1: PC compatible interfaces



Each new generation of test equipment acquires more data more often - producing ever increasing amounts of data. High end test system like multi-channel test beds acquire enormous amounts of data very quickly. To deal with increasing channel numbers, sample rates and data resolutions industrial platforms with embedded motherboards and real-time expansion backplanes are required. Unfortunately industrial platforms like PXI, CompactPCI, VME and VXI are also expensive.

As individual test modules are not compatible with ordinary PC's the entry cost to real time data acquisition is too high for many customers. Additionally critical test data that may take only a few seconds to be acquired on the test system may take several minutes to be transferred to the PC or notebook where the data is actually used.

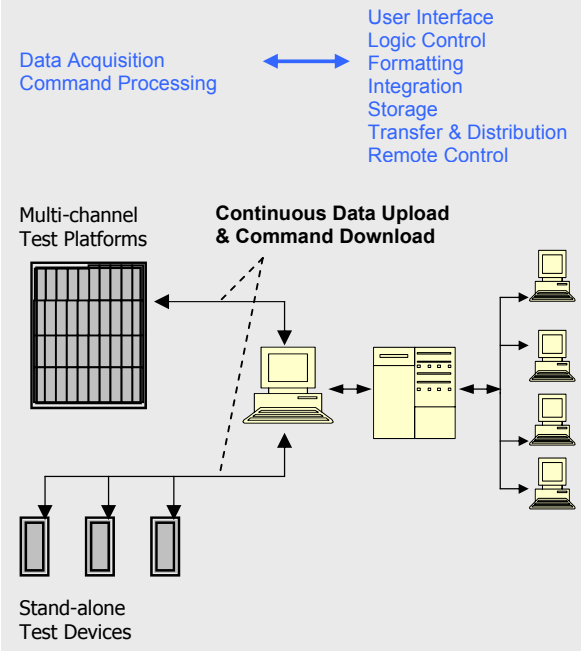
PC Control

Consequently a trend towards PC-controlled test equipment is emerging. The PC-controlled format can eliminate data transfer and formatting problems, reduce overall system cost and improve test efficiency and flexibility.

As opposed to PC-compatible devices that only provide interfaces for batch data upload, PC-controlled platforms continuously enable both upload and download between the test device and PC. This enables simultaneous software control, data acquisition and data storage via the users PC. Consequently many data management processes are eliminated and software compatibility and system flexibility is improved.

In the PC-controlled format the computer performs many tasks that were previously handled onboard the test device itself. Now logic control, data analysis, data storage and user control interfaces reside on the PC (see Figure 2).

Figure 2: PC controlled platforms



Customer Benefits

The major benefits of PC controlled platforms can be summarized in 5 points:

1. Reduced Capex
2. Faster processing of test data
3. Improved software capabilities
4. Better customization and integration
5. Reduced Opex

1. Reduced Capex

The most immediate advantage the customer realizes with PC-control is the reduced cost of test hardware. Conventional test devices have an on-board logic processor, analysis software and user interface specific to the device. Multi-device synchronization also requires an expensive embedded controller and expansion backplane.

However PC-controlled test devices do not need these on-board components because the PC replaces the system controller, logic controller, data storage and user interface found in traditional test equipment. Consequently, PC-controlled systems can immediately save customers up to 40% in cost of components.

2. Faster Data Processing

Whilst speed of data acquisition is important it's what you do with the data that really counts! Conventional data acquisition, storage and PC transfer is usually via discrete batch processes whereby several test scans are acquired, stored and then transferred for use with a PC or printer.

However in the PC controlled format the data is uploaded continuously to the PC - immediately eliminating the need for data storage and batch transfer processes on the test device. Data is automatically acquired and stored where it is used most - on the PC itself. Consequently overall data processing speeds are improved.

3. Improved Software

Current PC-compatible products have on-board software routines and user interfaces that allow the analysis and storage of raw test data. Data upload typically uses an external PC bus interface like GPIB, RS-232, USB or Firewire. The data is formatted in the specific file format used by the particular vendor and the customer often has to write software routines himself to use data in other formats / programs (most notably GPIB).

In contrast PC-controlled devices use Windows based application programs to analyze and store the raw data directly on the PC. The user can immediately access a wide variety of file formats and interface with any Windows application. Systems can be configured to store data in the specific file format that the end-user requires eliminating timely data re-formatting and streamlining data management processes. PC-control translates to improved software capability, compatibility and flexibility.

4. Customization & Integration

PC-controlled platforms offer the flexibility for the user to customize system control and analysis software himself. Users can also link one set of software to other programs, PC's, networks or storage databases. Lab based programs like LabVIEW from National Instruments offer multi-vendor integration of test and automation devices. Other software enables fully integrated test systems to be linked with other network capabilities for applications like remote access, quality system management and fault reporting.

System integration also means integrating different hardware devices from different manufacturers to form complex multi-device test systems. PC-based platforms like USB-inSync even have the advanced timing capabilities of real-time industrial backplanes like PXI. This allows for synchronized operation and real-time sampling of multiple test devices to form fully integrated and automated production beds.

5. Reduced Opex

PC-controlled platforms don't just streamline data processing operations – they make test engineers more efficient. Less time spent on training, installation, hardware customization and software development - more time spent on testing devices and products to produce critical data.

Test systems can now become an integral part of the customers IT infrastructure and quality management system. Faster data processing, improved software capabilities, more options and full system integration all translate to one thing for the customer – improved productivity with reduced operational expenditure.

Traditional PC-controlled platforms

The major drawback of PC controlled test systems relate to the limitations of the standard PC itself. External PC interfaces like USB and Firewire are ideal for data upload applications because of their easy plug-and-play operation and fast data transfer speeds. However USB and Firewire are not suitable for fully integrated PC-controlled test systems.

Simultaneous PC control of multiple test devices requires a PC bus interface with very high levels of synchronization and timing. Whilst the RS-232, ISA and PCI interfaces are popular options for controlling a single test device they are not expandable to multiple test devices. Multi-channel test systems not only require accurate synchronization and real-time sampling capabilities they also need to be scalable and expandable. Consequently the GPIB bus was developed by National Instruments to enable the integration of multiple test devices together via a single PC interface.

GPIB is a T&M specific control platform that fits into a standard internal PCI bus slot. The GPIB controller card allows for real-time sampling and triggering of up to eight GPIB test devices. However GPIB is decades old and has several major drawbacks including slow data transfer rates, difficult installation procedures and expensive controller hardware.

PC-controlled test equipment has always been popular in teaching, research and field-service markets where ease-of-use, portability and connectivity are highly desired. Now, with the increasing integration of business enterprise and manufacturing operations via internal PC networks and the internet, PC-controlled platforms are gaining increasing popularity in new markets. Today's database and network servers that were initially developed for the high reliability requirements of the telecom industry are now providing 24/7 reliability for markets including industrial automation, medical, military/defense and process control.

New developments in PC-control

A recent trend in test equipment has been the implementation of Ethernet. This has the advantages of high data transfer rates and expandable system integration. Ethernet is also widely available on all PC's and controller cards cost less than $100.

Whilst Ethernet is capable of integrating multiple test devices with a PC or network it has limited ability to synchronize them in a real time manner. Ethernet is ideal for linking multiple test databases together for trend monitoring. Most importantly it also provides for new applications like remote control & monitoring via the Internet.

Fiberbyte has developed the *USB-inSync* test platform (see Figure 3) to compliment Ethernet capabilities and provide PC control with real-time performance. USB-inSync offers all the advantages of USB – namely ease-of-use, high speed operation, expandability, wide compatibility and low cost. It also incorporates the advanced synchronization and timing features required for multi-channel test & automation.

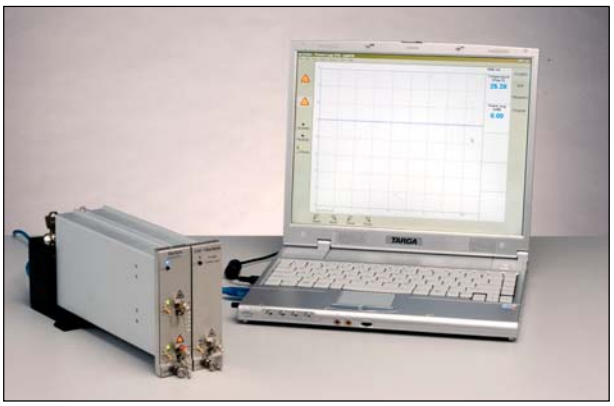


Figure 3: Synchronized PC control of multiple test devices via USB-inSync

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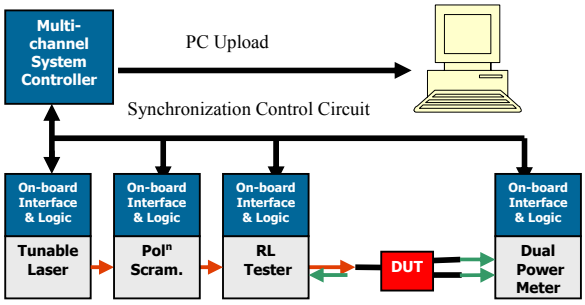
The USB-inSync platform can allow expansion of up to 127 devices and hubs via standard USB architecture and maintain multi-device synchronization to nanosecond accuracies. And importantly synchronization works over standard USB traffic using standard USB hardware. Compared with traditional GPIB architectures USB-inSync offers the following advantages:

1. Faster data transfers up to 12Mbps
2. Expandable to more channels / formats
3. Easier plug-and-play installation
4. Easier operation with hot-swap
5. Lower cost (no bus cards required)

Case Study : Optical Component Testing

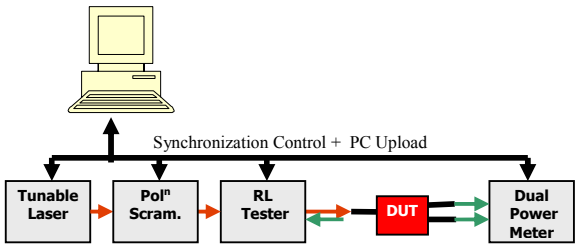
We will now examine the relative customer benefits of USB-inSync compared with traditional proprietary backplanes and PC-compatible upload interfaces. As a case study we will examine the test requirements for Insertion Loss, Return Loss and Polarization Dependent Loss in a 3 port DWDM component such as an OADM module. existing system requirements with dedicated system controller and on-board user interfaces and logic processors (Figure 4).

Figure 4: Traditional system



In contrast, the USB-inSync system (Figure 5) does not require a dedicated system controller, industrial backplane or on-board user interfaces and control logic. This is now handled by the PC and standard USB expansion bus. All logic control, software analysis and user interface components are now in the PC itself.

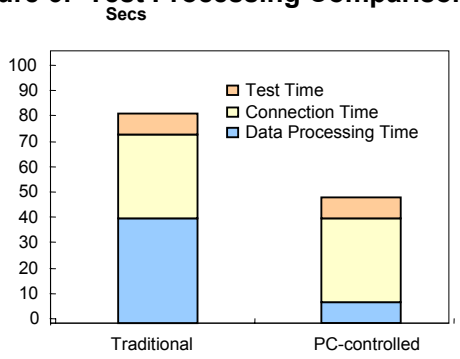
Figure 5: USB-*inSync* system



Elimination of the system controller and backplane immediately reduces system cost by $5000 to $10000 before the first test module is even purchased. Reduced control and interface requirements for the modules then saves the customer a further 30-40% of the cost of each module purchased. Overall cost reductions typically total more than 40% of the traditional price tag for multi-channel test systems.

In terms of improved production efficiency and reduced operational expenditure PC-controlled devices directly reduce the initial set-up, installation and system integration time. More importantly they also reduce the total test processing time (typical times shown in Figure 6).

Figure 6: Test Processing Comparison



The humble PC is an often neglected resource in the lab or factory floor. PC compatible test devices typically use only a few percent of the PC processing power available to them. Most of the processing is done on-board the test device and the results are uploaded to the PC. The PC is little more than an expensive dumb terminal.

The design philosophy behind Fiberbyte products is to unlock the power of the user's own PC. In transferring data processing, storage and control responsibilities to the PC the user gains more software flexibility, compatibility and familiarity. And most importantly the test device requires less hardware and software reducing total system cost.

Multiple application environments

The power of the PC controlled environment offers numerous advantages to a wide variety of potential users. PC control benefits engineers and scientists in a wide variety of application and environments. The low cost, high performance modularity and flexibility of USB-inSync make it an ideal data acquisition platform for teaching, research, manufacturing and field environments.

Education

Fiberbyte's range of fiber optic test and measurement equipment can be used for teaching a whole range of technical skills. Physical principles of fiber optic technology and practical device characterisation techniques can be taught. In addition, practical skills such as device integration, control and automation are easily taught using the Fiberbyte approach to test and measurement.

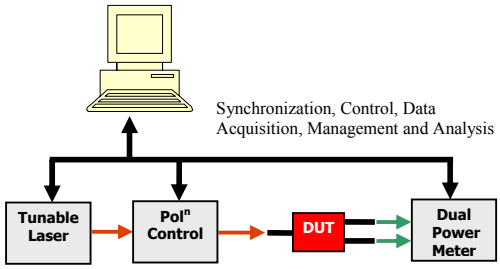
The current generation of scientists and engineers need to be able to design and implement complex experiments, often acquiring huge amounts of data requiring detailed analysis. The whole implementation chain of a production engineer can be effectively demonstrated using the Fiberbyte design philosophy.

USB-inSync provides for instant familiarity with device connection and software operation which makes teaching future engineers and scientists easier. Software can be configured to provide step by step experimental procedures or alternatively students can program the devices themselves.

Cost, upgradeability, customizability and flexibility are paramount issues for budget constrained teaching labs trying to make their funding go as far as possible. Fiberbyte's PC-controlled platform is a low cost, flexible solution with a more affordable entry price into traditional multi-channel test platforms - and also allows for upgrading test sets at a later date. The plug-and-play modular nature of Fiberbyte's test modules allows customers to purchase the most cost effective test set for demonstration of photonic T&M methodologies.

Take the case of an experiment designed to measure some basic loss features of a DWDM multiplexer. The most cost efficient method of performing this test involves a tunable laser source, polarization controller and high speed power meter (as shown in figure 7). The system cost less than $20,000 and provides similar performance to traditional industrial test systems worth several times more.

Figure 7: Fiberbyte System Integration



This scenario would involve measurement of insertion loss with a swept laser at four discrete states of polarization and then performing a numerical approximation based on Matrix mathematics to reveal PDL at each of the sampled wavelengths.

Such an experiment explores the physical concepts of insertion loss (IL) and PDL with planning of the experiment to test these parameters. The system would therefore demonstrate how to operate a series of devices under synchronous control, acquire and manage data and teach several concepts in optical physics.

Device control can then be taught using industry standard control and automation software such as LabVIEW, Visual Basic or C++. Students not only learn the physics involved with fiber-optic technologies, they also learn the software tools they will need in research and manufacturing jobs.

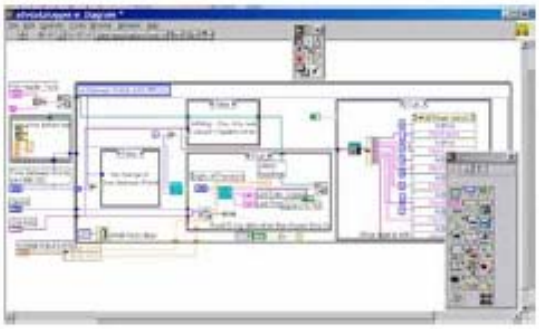
Research

USB-inSync is ideally suited for research environments. The same advantages of cost, flexibility, customizability and ease-of-use are just as important for research and development applications. However, whilst the low cost of USB-inSync provides researchers with reduced capital expenditure, it is the flexibility of the platform that is most attractive for research applications.

Flexible user options for customization are not only an advantage in research environments – they are an essential requirement for developing new technologies that have new test and characterization requirements. Fiberbyte's PC-controlled platform provides a modular, expandable and customizable set of research tools that allow researchers to develop specific test systems to suit the unique requirements of their own technologies.

Data acquisition and automations systems in research environments usually comprise various pieces of hardware glued together by real-time software applications like LabVIEW (example shown in Figure 8). LabVIEW is the de-facto software application for system integration and automation in research environments.

Figure 8: LabVIEW System Integration



LabVIEW allows the user to create sequenced test routines that integrate synchronization and automation functions. Data acquisition and management is just as important. Data management and analysis can be taught in multiple languages by exploiting the database features of the powerful software interface.

Every Fiberbyte test product comes with its own LabVIEW driver so users can easily integrate Fiberbyte products with other equipment such as micro-positioners and optical spectrum analysers. The distributed format of the USB external platform is capable of operating test devices up to 25 meters from the PC controller. This makes for better device sharing, improved space management and simpler system integration within a laboratory environment.

Manufacturing

Manufacturing environments typically use different product types to research environments. Firstly, whilst production test systems are often more highly specialized than research systems they are configured once and then left to operate in the same manner for months or years at a time.

Most production engineers write a lot of their own software as they have to develop not only a test system but a manufacturing and quality assurance system. Consequently software languages like Visual Basic and C++ are used more often than graphical applications like LabVIEW.

Whilst resolution, accuracy and performance of a test system is critical to both research and production engineers the most important features to the production engineer are speed of test and reliability of measurement. The faster and more reliable the testing of a product the less it costs to manufacture. Most customers look for a return on their capital investment within 12 months of purchase via operational expenditure savings.

The size and number of test stations required is also usually much greater than in research environments. Capital expenditure can be a major concern for photonic manufacturers and this even affects their decisions on things like software operating platforms.

Whilst Windows based PC's are dominant in teaching and research environments Linux has significant penetration in production markets. This is because Windows software licenses can become very expensive to run on multiple PC's when all those PC's are doing are the same

automated test and data-acquisition functions. Consequently an open "free" software platform like Linux is more attractive than Windows for manufacturers operating large numbers of PC's on a factory floor.

Fiberbyte's software tools meet the widely varying requirements of manufacturers and system integrators. The USB-inSync engine can be operated on both Windows and Linux platforms making it configurable for the majority manufacturing environments. The platform can also be driven by numerous 3rd party software applications and languages including C++, Visual Basic and even MS Office applications.

As discussed earlier, production test systems are significantly different in size, scope, performance and capabilities compared to systems used in research environments. A PC-based test platform designed for desktop research application does not usually transfer well to production environments or scale to multiple rack systems. Consequently test equipment manufacturers usually offer stand-alone bench-top products to research customers and larger rack-mount platforms to manufacturing customers.

However the USB-inSync platform is ideal for both environments. Stand-alone equipment and rack modules can be fitted with a USB-inSync device controller. Researchers can develop desktop configurations using off-the-shelf USB hubs, and then upgrade their backplane & chassis to industrial rack format at the manufacturing stage. Scaling operations to simultaneous device testing and multiple test locations is now possible with the distributed or "out-of-the-box" format of an external bus and USB's large channel expandability. This offers faster and more cost effective technology transfer from the research stage of the product to the manufacturing stage.

Field Installation & Service

Whilst most PC-controlled test systems in research and manufacturing use desktop PC's or industrial servers there are other more portable possibilities for PC controlled platforms that until now have not been previously available.

The ubiquitous USB port is not only available on every desktop PC - it is also found on every notebook or laptop computer. Internal multi-slot bus standards found on desktop PC's like ISA or PCI are obviously not available on notebooks. Hence notebooks have been unable to control a multi-channel synchronized platform.

A unique feature of USB-inSync is that it is the only multi-channel test platform that can be driven via a USB port – which is available on a portable computer. Now with USB-inSync offering portability and real time performance field engineers can use the same test format used in the lab or factory and take it into the field for installation and service applications. This improves data communication between service and factory staff and provides for a total quality management system. Wireless internet access allows critical field data to be quickly sent to a central office for detailed analysis by more highly skilled engineers or managers.

And portability with USB-inSync goes further than the notebook. Many personal digital assistants (PDA's) now come with a USB host controller port (as opposed to a USB device port). This enables a multi-channel test platform to be controlled via a handheld PDA operating under a Pocket PC software platform. Data can be stored directly into Outlook or Excel format and transferred to a desktop PC at a later time. The impending flood of combination PDA / phone devices ultimately means that field engineers will be able to run sophisticated test procedures in the field from their mobile phone, automatically phone in the data to a central office where it is collated, analyzed and acted upon.

Summary

PC controlled test platforms offer improved flexibility and lower costs. With the advent of Ethernet and USB-inSync, test and measurement is evolving from proprietary mainframe control systems to more flexible, efficient and affordable platforms with direct PC-control and more widely compatible software – just as the computer industry emerged from the dying mainframe business some 20 years ago.