

## The H&L 570E vs Managed Switches with Serial Server Feature

The H&L 570E Fiberoptic Transceiver with Ethernet has a number of features supporting both serial and Ethernet interfaces, as do SCADA-oriented managed switch products. Each product offering has its own particular strengths and application areas. It is important for the customer to understand the difference in capabilities in order to choose the correct device for their application.

**The 570E is primarily a serial communications multiplexer with Ethernet capabilities.** Most of its competitors are primarily managed Ethernet switches with limited serial capabilities, called "serial servers." If the major use for the equipment is setting up a distributed LAN with Ethernet-capable IEDs and a relatively small number of low-speed serial devices, then a managed switch with serial server support may be the best choice. However, if there are a large number of serial devices that are expected to be in service (especially if they require communications among themselves as well as with multiple masters) with Ethernet support (primarily needed to allow a technician in the field to plug in a laptop and access company servers and the Internet), then we believe that the 570E is a better choice.

Although Ethernet switches with serial server support provide most if not all managed switch features, there are many serial configurations they cannot support. For example, a serial server cannot internally support redundant multi-master networks because each slave port must be configured with a single destination IP address and port. As stated in one well-known product's user guide:

*Even if protocol can distinguish between server and client side, for the (product name) there is no difference. Both sides need to know where destination device is. If message is received from the network, destination address must point to the serial port on receiving server. If message is received from the local serial port, destination address must point to the IP Address of the server where addressed device is connected.*

**The 570E uses the concept of "virtual channels" to represent a pseudo-wire running along the entire network to which any serial port may be attached with a role of master, slave or peer.** If more than one master port is assigned to the virtual channel, then identification of the sending unit's network ID is sent with the data to each slave, so that the next response may be sent to the originating master port on the correct unit. This makes redundant masters simple to implement without reconfiguration or hardware data line switches. If a master computer or the 570E unit fails for any reason, the backup master can either recognize this situation automatically in software or an operator can manually initiate the backup master because of an alarm or other notification. No cables have to be moved and no reconfiguration of the 570E is required.

**The H&L 570E supports SEL Mirrored Bits™.** Serial servers do not support Schweitzer Engineering Labs' Mirrored Bits™ communication between relays like the SEL 311, 321, and 351. This is a specialty of the 570E that required a considerable amount of development to perfect. It is in use in a number of sites including municipalities as well as college campuses for S&C Electric's high reliability distribution systems (HRDS). The ability of the system to provide this communication with healing in a fraction of one power cycle has been verified and documented by S&C in numerous conference proceedings and T&D World (<http://www.hlinstruments.com/articles.html>).

**The H&L 570E supports synchronous RS-422 serial communications.** Serial servers do not support *synchronous* RS-422 serial communications. Although their serial ports can be configured to support the RS-422 interface, it is an *asynchronous* configuration. Asynchronous RS-422 has limited application, primarily for long serial cable runs to avoid ground loop problems. The more prevalent application in distribution systems is backup or primary communication of differential current information between SEL 311L relays. This is supported as a standard feature by the 570E. The 570E synchronous RS-422 support has also been used to attach Ardax orderwire equipment for intercom and field telephone applications. This includes the ability to connect 570E-hosted orderwire units to the customer's PBX system for direct inward dial to substation extensions and outside line access from those substations without the expense and system changes needed for VoIP.

**Serial servers use TCP or UDP encapsulation to carry serial traffic,** using a scheme similar or identical to the 20 year old Telnet protocol. This approach introduces a number of difficulties. First of all, the encapsulation requires a minimum of 48 bytes of overhead to carry serial data using raw socket mode and UDP, where the data can be as small as one byte. Because of this overhead, it is common for sys-



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tems, that transfer serial data over IP connections, to use the Nagle algorithm, which involves accumulating serial data until a special character or a timeout occurs, then sending the packet.

**Serial servers using the Nagle algorithm can cause a number of problems;** for example, if the operator makes the timeout too short then 48 bytes or more can be used to send a single character, limiting the amount of serial traffic and raising the latency between successive characters. If the timeout is made too long, then the bandwidth is reduced and a false end of frame can be detected by serial protocols such as DNP, which consider a very short delay between characters to indicate the end of a protocol frame. To get around this, a serial server must be aware of each protocol it must handle to ensure that an entire frame is received and sent as a unit to the remote device to maximize throughput and avoid false end of frame detection. The user guide for one serial server discusses this problem:

*Note: Some polling software packages which perform well over DOS have been known to experience problems when used over Windows based software or port redirection software. If the OS does not expedite the transmission of characters in a timely fashion, pauses in transmission can be interpreted as the end of the message. Messages can be split into separate TCP packets. A locally attached (product name) or a port redirector could packetize and forward the message incorrectly. Solutions include tuning the OS to prevent the problem or increasing the packetizing timer.*

**The advantage of the 570E is that it can send one byte of data with as little as 3 bytes of overhead for simple P2P and master/slave, and can send a maximum of 7 bytes for multi-master channels over an Ethernet link!** This is possible because H&L uses a proprietary MPLS (multi-protocol labeling scheme) over Fast Ethernet fiber links to support a special frame for serial data.

**The 570E is protocol transparent, immediately and efficiently transferring each byte received on a serial port to remote devices without using a timeout or special character recognition.** Due to its very low overhead encapsulation for serial data, the 570E can handle any serial protocol without special software options, configuration or OS "tuning". The special Ethernet frame type also allows the 570E to "leapfrog" high-priority serial data in front of Ethernet frames when necessary.

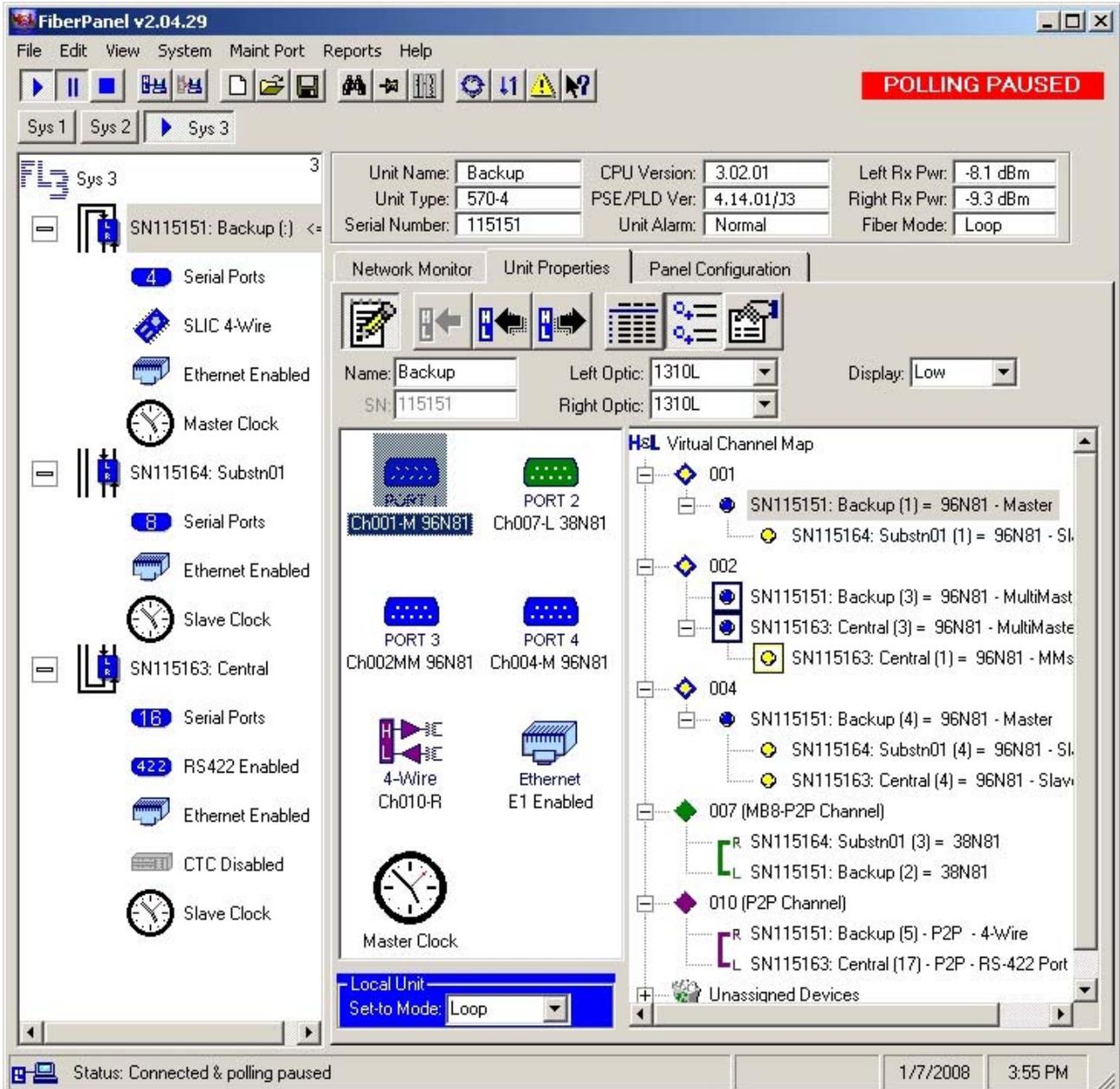
**The 570E, in a system with many serial devices, is much easier to configure and monitor.** Although managed switches support a number of methods including SNMP and RMON for Ethernet configuration and monitoring, serial port configuration, even over Ethernet with a browser as shown below, looks much like the simple character-oriented menu used in DOS systems.

<a href="#">Log out</a>	<a href="#">Serial Ports</a>							<a href="#">access admin</a>	
<a href="#">Back</a>									
Port	Name	Protocol	Type	Baud	Data Bits	Stop	Parity	Turnaround	DSCP
<a href="#">1</a>	Port 1	RawSocket	RS232	9600	8	1	None	0 ms	0
<a href="#">2</a>	Port 2	RawSocket	RS232	9600	8	1	None	0 ms	0
<a href="#">3</a>	Port 3	RawSocket	RS232	9600	8	1	None	10 ms	0
<a href="#">4</a>	Port 4	RawSocket	RS232	9600	8	1	None	10 ms	0

One serial server is claimed to be configurable using SQL-like commands, which is more of a benefit to programmers than technicians, who are probably not familiar with this database query language.

Each Ethernet serial server in a system must be configured individually. There is no cross-checking that a configuration is consistent with the rest of the network, and there is no global view that graphically shows the relationship between the units and the sets of ports on those units that communicate with one another. This method is both awkward and error-prone, especially on systems with many serial ports.

**The H&L FiberPanel network management system for Windows** uses line drawings, icons, colors, drag and drop, cross-checking of configurations, hints and wizards to aid configuration, and many other features to make the configuration and monitoring of the largest 570E network simple and intuitive. FiberPanel supports an option to allow import of configuration information from spreadsheets for organizations that prefer that approach. Best of all, FiberPanel is *free* and updated frequently with new features. It can be downloaded by customers from our website at no charge and no maintenance fee ever. A sample screenshot is shown on the next page.



The 570E far exceeds the capabilities of even the fastest server spanning tree protocols. If healing speed is important, and it certainly is in systems carrying mirrored bits and/or current differential information, then the 570E is the fiberoptic solution. According to one model's datasheet, switches running their proprietary enhanced RSTP can heal in 5 ms *per hop*. The 570 series can heal in 8 ms *maximum*, independent of the hop count. This can make a big difference in systems such as the 20 unit loops used at the S&C Electric UCSB HRDS installation. According to the datasheet for one managed switch product with enhanced RSTP, this network would have required 5 ms per hop \* 20 hops = 100 ms to heal, which is far beyond the 8 ms healing required by S&C for this project (which is met by the 570 design).

There have been side notes in some industrial switch product literature claiming that proprietary fast healing ring systems like the 570 networks cannot interoperate with standard switches like their product can due to their enhanced RSTP support for standard STP and RSTP. The reality is that once a standard Ethernet switch is introduced into a network, the 5 ms spec cannot be met for every hop because some segments are connected to third-party switches. Basically, no sub 10ms healing speed advertised by any

switch vendor can be achieved without healing schemes that are incompatible with existing standards. Most industrial Ethernet switches with serial server support come with the capability to add additional serial ports and change the fiber ports in a modular fashion, but this feature is limited to serial and Ethernet communication interfaces. The 570E provides these capabilities as well, but it also allows hardware customization to a level beyond any other serial gateway/Ethernet switch solution on the market.

**The 570E has been designed to accept any universal socket module manufactured by MultiTech, a long-time respected name in communications systems.** This includes SLIC modules to allow the attachment of standard phones, PBX interfaces, and audio channels; WiFi modules for wireless networking; and mobile phone interfaces such as CDMA to permit new and unique ways of communicating data and control between the 570E and wireless devices. The SLIC module has been used for a variety of purposes by our customers, including a backhaul for audio data from radio towers and the communication of legacy frequency-modulated data between RFL telemetry equipment. The same intuitive, graphical interface is used to configure these devices as is used for serial ports.

**H&L has developed an Eaton INCOM module that allows direct communication between the 570E and any Eaton/Cutler-Hammer device that provides an INCOM interface,** such as the MCPV network protector relay and Eaton's line of smart circuit breakers. The 570E universal socket module interface allows the quick development and integration of custom daughter cards to meet existing or future requirements of customers with unique applications.

**The 570E is not a managed Ethernet switch.** We believe that the inclusion of vendor-specific switch support in our product would restrict the customer's IT department to using whatever switch configuration protocol and software that was dictated by our choice of chipsets. This would mean that the setup and tools used for the SCADA network would likely be different than those used and preferred for other IT applications within the company.

For example, the IT department may be trained and experienced with the use of Cisco switches and how they are configured for advanced features such as VLANs. H&L thinks it is better to allow the IT department to choose IT industry standard managed switch equipment, such as Cisco, that they would likely prefer. This is why H&L provides two simple unmanaged copper Ethernet switch ports to which the managed switch can be attached.

**The 570E places no restriction on the Ethernet traffic presented to its Ethernet ports as long as they have been enabled—outside of flow control.** Packets up to 2048 bytes long can be accepted, so the addition of VLAN tags is not a problem. The 570E presents itself as a transparent device that forwards Ethernet traffic between devices attached to its ports.

If and when the customer wants a managed switch, they can select the model and manufacturer that they prefer and connect it to one of the two Ethernet ports on the 570E. This provides a great deal more flexibility for the IT department, because some of the advanced features, like VLANs, are not always completely compatible between different vendors. If you use a SCADA-oriented managed switch, then the IT department—who may have Cisco gear everywhere else—must deal with using that vendor's proprietary network management system (NMS) and operating system (OS) to effectively configure and manage their switches in addition to the SNMP NMS and OS with which they are familiar for other areas of the company.

**H&L provides the customer with a robust, transparent 2-port Ethernet switch with advanced serial and custom communications support that can be combined with a customer-selected managed switch to meet the needs of both the IT and engineering departments.**