Serial-to-Ethernet Converter for Stellaris® Microcontrollers

Application Note

Texas Instruments

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Table of Contents

Introduction

When a legacy product only contains a serial port for a configuration or control interface, continuing to access the legacy product through the serial interface can become challenging over time. Newer computers, especially laptop computers, do not necessarily have serial ports, and a serial connection is limited by cable length (typically 10 m). Using Ethernet in place of the serial port provides many benefits:

■ Ethernet is a more common interface available on computing equipment.

■ The legacy product can be more easily shared (instead of changing a cable connection, a new connection over the existing network is made).

■ 10 m cable length is no longer an issue (subject to tolerance of the increased transmission delay if the two pieces of equipment are separated by several routers, or are located on a heavily loaded network segment).

The software described in this application note allows an Ethernet-enabled Stellaris microcontroller to be used as a serial-to-Ethernet converter. By placing a serial-to-Ethernet converter on the serial port of a legacy product, it can be given the ability to operate on the Ethernet without requiring any changes to the existing hardware or software. This is especially useful when the legacy product cannot be modified (such as in the case of third-party products).

Texas Instruments provides Serial-to-Ethernet hardware and software solutions in both module and reference design kit (RDK) forms.

■ Stellaris® Serial-to-Ethernet module: www.luminarymicro.com/products/mdl-s2e.html

■ Stellaris® Serial-to-Ethernet RDK: www.luminarymicro.com/products/rdk-s2e.html

The software described in this application note is provided with the module or RDK, or can be downloaded separately as part of the StellarisWare® Driver Library package on the www.luminarymicro.com web site.

Accessing a Serial Port over the Ethernet

In order to access a serial port over the Ethernet, a network protocol must be used to formulate the traffic on the Ethernet. The most commonly used protocol for accessing serial ports is the telnet protocol, which is described by "RFC 854 - Telnet Protocol Specification". While originally defined for an interactive login on a remote system, the telnet protocol can also be used to access a remote serial port.

After a telnet connection is made to the converter, all data received from the serial port is sent over the Ethernet connection, and all data received from the Ethernet connection is sent to the serial port. With this mirroring of data between the serial port and the telnet connection, the telnet connection becomes an extension of the serial port. An extension to the telnet protocol, described by "RFC 2217 - Telnet Com Port Control Option", allows the configuration of the serial port to be controlled over the telnet connection.

Figure 1 shows a client network node using the serial-to-Ethernet converter to access the serial port on a legacy product.

Figure 1. Serial Port Access on Legacy Product
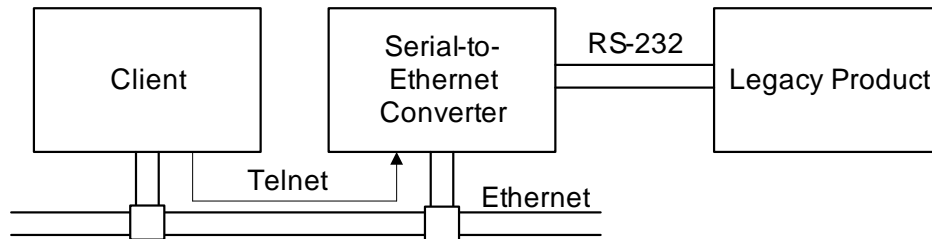
Software Features and Configuration

The serial-to-Ethernet converter software provides telnet access to UART0 and UART1 on the Stellaris Serial-to-Ethernet board, including support for RFC 2217 configuration of the UARTs. The default configuration of the application is performed at compile time but can be changed at run time via RFC 2217 or a simple web interface configuration screen. The lwIP TCP/IP stack that is provided as part of the Stellaris Peripheral Driver Library is used to implement the telnet server that accepts connections on up to two ports (by default, 23 for UART0 and 26 for UART1). Basic Universal Plug and Play (UPnP) is implemented to allow device discovery via the Simple Service Discovery Protocol (SSDP).

The converter software can be configured to use static or automatic IP configuration. When using static IP configuration, the IP address, netmask, and default gateway must all be defined. When using automatic IP configuration, DCHP is first used to retrieve IP configuration from a DHCP server. If this process times out, a link local address (169.254/16) is chosen using the algorithm specified in internet standard RFC3927 which is also known as AUTOIP, IPv4 Link-Local (IPV4LL), Automatic Private IP Addressing (APIPA), or Internet Protocol Automatic Configuration (IPAC). With support for UPnP, static addressing is not required; the device can be automatically discovered on the network. However, in some applications, UPnP may not be available. In this case, effective use of automatic IP configuration requires that an automatic reservation be provided in the DHCP server so that the Serial-to-Ethernet board receives the same IP address each time; otherwise, the converter may get a different IP address each time it is started.

The TCP ports used for the telnet server can be configured, along with the number of seconds to wait before an idle connection is dropped. The default TCP port for UART0 is 23, which is the standard telnet port, and for UART1 is 26. The idle connection time-out defaults to 0, which disables the feature. When the idle connection time-out is enabled, the telnet connection will be dropped after a period of inactivity. The default configuration of the UART is configured at compile time. The software allows rates up to 230400 bps for UART0 and 1 Mbps for UART1. The number of data bits, stop bits, and parity can also be set. In addition, run-time configuration of the UART parmaters are available via RFC2217 running over the telnet protocol.

Configuration of the Serial-to-Ethernet board is also available through a web server that provides status and configuration pages for the serial, telnet, and UPnP parameters of the board. These parameters can be changed and saved in non-volatile memory. Each time the Serial-to-Ethernet board is powered up, the non-volatile parameters will be loaded (if programmed). Otherwise, a default set of configuration parameters will be used. Note that when changing configuration parameters with the web interface, any connections that are established may be reset when the new parameters are saved and take effect.

The complete source code for the serial-to-Ethernet converter is provided in the Stellaris® Firmware Development Package, in the boards/rdk-s2e/ser2enet folder, and is built like any other example application from the package (using either "make" from the command line or the project file for either Keil µVision or IAR Embedded Workbench). The application is designed to run on the Serial-to-Ethernet board, but can be used as a reference for a serial-to-Ethernet application running on any Ethernet-enabled Stellaris device.

Accessing an Ethernet-Based Serial Port as a Legacy Serial Port

In some situations, the legacy product consists of more than just the piece of hardware with a serial port; it may be paired with software on a computer that uses the serial port to configure and control the product. It may not be possible to change this software either, so the legacy product will not be able to make the required telnet connection to use the Ethernet-based serial port. The solution for this problem is a COM port redirector, also known as a virtual COM port.

A COM port redirector creates a virtual device within the operating system of the computer that appears to applications as if it were a real COM port. Instead of sending the stream of characters to a real serial port on the computer, the COM port redirector instead sends that stream to a different location. A common use of COM port redirectors is for USB-based serial ports (such as the USB-based serial port found on the Stellaris evaluation boards). Alternatively, a COM port redirector can use the telnet protocol to connect a virtual COM port on the host computer to the serial-to-Ethernet converter connected to the legacy device.

Figure 2 shows an application on Windows using a COM port redirector to connect to the serial-to-Ethernet converter to access the serial port on a legacy product.

Figure 2. Accesing a Serial Port on a Legacy Product
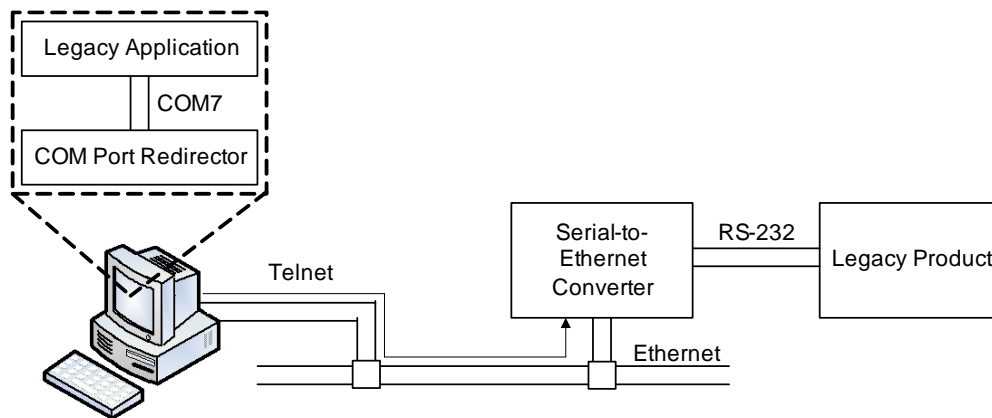
The com0com project, and specifically the com2tcp sub-project, is an open-source project that can be used to provide an appropriate COM port redirector in Windows for use with the serial-to-Ethernet converter. See the com0com web site for details on how to configure and use that software. Other applications, both open and commercial, are available to provide similar functionality. The Stellaris Serial-to-Ethernet RDK also comes with a Windows-based GUI configuration program that works with UPnP and the com0com software to assist in the configuration of the Com0Com serial port redirector.

Conclusion

Through the use of the telnet protocol, a serial port can be easily accessed over the Ethernet using a Stellaris microcontroller. The fully-integrated Ethernet controller in the Stellaris microcontroller enables the design of a very small board for retrofitting a legacy product with Ethernet accessibility. If more functionality is required of that network node, plenty of Stellaris flash space and processing power remains to perform additional tasks.

References

The following documents and source code are available for download at www.luminarymicro.com:

- *Stellaris® LM3Snnnn microcontroller data sheet* (where nnnn is the device number), Publication Number DS-LM3Snnnn
- StellarisWare® Driver Library, Order number SW-DRL
- *StellarisWare® Driver Library User's Manual*, publication number SW-DRL-UG

The following documents are available for download at the given web address:

- RFC 854 - Telnet Protocol Specification: http://tools.ietf.org/html/rfc854
- RFC 2217 - Telnet Com Port Control Option: http://tools.ietf.org/html/rfc2217
- RFC3927 - AUTOIP: http://tools.ietf.org/html/rfc3927
- The com2com project: http://com0com.sourceforge.net

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