Redundancy in
# Serial-to-Ethernet Communications

White Paper

Abstract

This paper provides information about redundancy in serial-to-Ethernet communications. It describes technologies from Digi International® that eliminate single points of failure for networked devices while also enabling multiple host connections to a single port.

What is redundancy and why is it important?

It wasn't many years ago that users were ecstatic just to be able to connect a serial device to Ethernet. This technology represented a paradigm shift – information which was previously tethered to a 50-foot RS-232 serial cable could now be made available across TCP/IP Local Area Networks (LANs,) Wide Area Networks (WANs) and even the Internet. However, as users began to depend on access to these islands of information, issues such as connection reliability (uptime) and accessibility became top concerns. Requirements for redundant connections to the serial and Ethernet points raised demand for new features targeting mission-critical applications. Digi International chose to embrace the redundancy needs of users and responded with several new features and products, including:

- Port Sharing – feature which provides the ability for device servers and terminal servers to allow multiple connections to a single serial port
- Multi-master – feature which provides the ability for Industrial Automation (IA) devices to communicate with multiple hosts simultaneously
- Pass-through port – feature which enables the serial port on a Programmable Logic Controller (PLC) or other IA devices to be shared through a device/terminal server
- RS-485 4-wire cable with tri-state mode - extends RS-485 master/slave bus networks over Ethernet

Standard serial-to-Ethernet application
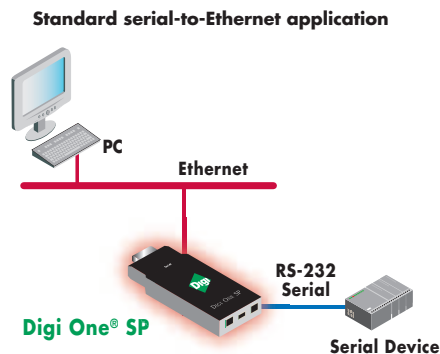
Device server and terminal server overview

Device servers and terminal servers represent the segment of product also known as serial-to-IP converters, which essentially allow any device with a serial port to communicate with an application across an IP network. Applications using TCP Socket or Telnet connections can easily connect to serial devices and communicate with them just as if they were connected locally. Additionally, Digi created RealPort®, a patented COM port redirector which allows an application to communicate with a remote networked serial port as if it were attached locally.

Types of connections to device/terminal servers:

- Raw TCP Socket and Telnet
- User Datagram Protocol (UDP)
- Serial tunnel (uses TCP Sockets to connect one Digi device to another)
- RealPort COM redirector software

Each of these types of connections is fairly standard across many vendors' product lines. Digi decided to take a closer look at each connection point, including the physical ports (serial/Ethernet) and the logical ports (COM redirector/TCP ports), to find out how to increase redundancy. In the process, Digi was also able to increase the accessibility to the ports.

Port Sharing

Port Sharing is a first-of-its kind Digi technology which allows multiple hosts to connect to a single device simultaneously. Digi actually breaks the rules of simple point-to-point TCP sessions in order to allow more than one host to "share" the session. In essence, if two hosts are connected at the same time, both of them have the ability to read from and write to the device. This feature is particularly useful in applications that require failover alternative connections and applications that need to share communications with a particular device.

Serial-to-Ethernet application using Port Sharing

PC

PC

Ethernet

RS-232
Serial

Digi One® SP

Serial Device
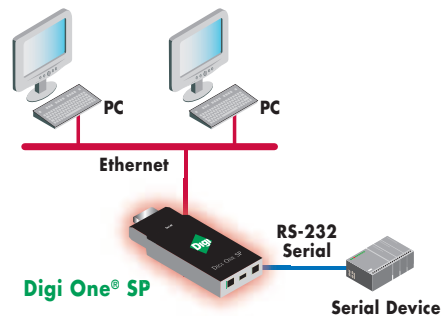
Failover or hot backup application

In applications where failure is not an option, redundancies are put into place to ensure 100% uptime. In a typical IA installation there is generally one host (e.g., a workstation running Human Machine Interface [HMI] software) communicating with one device (e.g., a PLC). A single TCP session is set up between the host application and the serial-to-IP device server. In order to create a redundant solution, a second host application is often set up, ready to "take over" the session in the case there is a problem with the primary host. However, if a serial port connection is not closed properly (e.g., the host application locks up), then a second connection to the device cannot be established without waiting for a timeout to close the session.

Digi's Port Sharing technology actually allows the backup host application to keep an open session (or connection) with the device at the same time the primary device is connected. This means that even if the primary host locks up, the secondary host can instantly take over communication with the device. The end result is little or no downtime associated with a failure of the primary host. This failover application actually means that the backup (secondary) host is completely silent until the primary host fails. They never communicate at exactly the same time.

Digi offers another means of providing a failover connection using a feature called "fast failover" which actually does not use Port Sharing at all. It uses a time-out feature which sends "keep-alive packets" to a connection and closes a session after a period of time without a response. Fast failover would allow a backup application to "take-over" in the case the primary application failed to communicate. Fast failover works with any Digi device/terminal server.

Device sharing

Another use for Port Sharing is in applications where multiple hosts need access to a single device at the same time. This differs from failover in that device sharing actually requires that multiple hosts have read access to the device, but only one host at a time can read and write. Collaboration in console management is a common application for device sharing. Ordinarily, multiple users are not able to be logged into a single server at the same time. However, there is a common request for users to collaborate for training or validation purposes. Device sharing enables multiple users to read and write to a single port simultaneously.

Digi products that support Port Sharing:

- PortServer® TS 1/3 M MEI (N release)
- PortServer TS 1/2/4 H MEI (N release)
- PortServer TS 1/2/4 MEI (N release)
- PortServer TS 1/2/4 W MEI (N release)

- PortServer TS 8/16 MEI (J release)
- Digi One® SP (December 2004)
- PortServer TS 8/16 (J release)

Multi-master

Another redundant form of serial to Ethernet communication is the multi-master connection. Multi-master is typically associated with the IA market and is generally used with well known request/response protocols.

The multi-master feature is truly unique because it violates point-to-point serial communications by allowing multiple masters (or host devices) to simultaneously communicate to a single serial device by queuing requests from each host. Digi's multi-master technology allows the device server to act like a "traffic cop" by allowing traffic from multiple hosts to communicate with the serial slave device.

Take, for example, a PLC that is being monitored by HMI software across a network. The HMI requests data periodically from the PLC (through the Digi One IAP device server). Occasionally the PLC program needs to be updated and an engineer who is likely in a different location does the update. Now, the PLC configuration can be changed without taking down the connection to the HMI software.

Multi-mastering allows multiple IA masters to send a request to a single slave at the same time
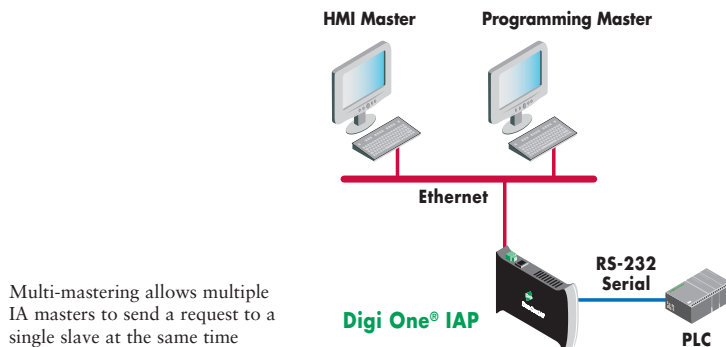
Digi One IAP supports multi-master technology for a variety of popular industrial serial and IP protocols including Modbus, Modbus/TCP, Allen-Bradley DF1/AB Ethernet, EtherNet/IP and several Omron protocols.

Pass-through port

Digi One IAP also employs another form of redundancy called the pass-through port, which is actually an additional serial port with special functionality. The pass-through port also utilizes multi-master technology, but instead of just allowing multiple network masters to communicate to a single serial device, it allows a local serial master to communicate as well. Generally, Digi One IAP is used for connecting serial devices such as PLCs to Ethernet. However, most PLCs only have one serial port, so when connected to Digi One IAP they essentially lose the ability to connect additional serial devices into that serial port because it is already occupied.

A common application includes an HMI panel or local PC which is used to program the PLC without interrupting the network masters already connected to the PLC. The pass-through functionality eliminates the need to unplug the serial port from Digi One IAP to connect the HMI panel to the PLC.

RS-485 4-wire with tri-state mode

In contrast to the typical RS-232 communications that only allows point-to-point connections, there is also an RS-485 bus which allows communications between multiple devices. RS-485 supports two different modes of operation. In 2-wire mode, all devices share one pair of wires for send and receive and each of the devices can communicate with each other. Using this architecture, one can create a redundant connection by normally connecting two Digi device/terminal servers to a 2-wire RS-485 bus.

Digi supports a special scenario in the 4-wire RS-485 tri-state scenario (PortServer TS 8/16 only), where one device is the master, owning one pair for transmit and the other devices are the slaves sharing the other pair of wires for transmission. This feature allows multiple masters to exist on a single RS-485 network.

Special intelligence called tri-state mode is built into the Digi device/terminal server. It carefully observes particular data flow over key pins to allow users who would like to create their own RS-232 Y-cable to have this option using a "smart-wire" type technology. This feature allows two hosts to listen on a single connection, while only one can read and write.

Digi products that support RS-485 4-wire with tri-state mode:

- PortServer TS 8 MEI
- PortServer TS 16 MEI

Summary

Creating redundancy in serial-to-Ethernet connectivity instantly increases reliability, uptime and accessibility for mission-critical enterprise applications. Products and technology from Digi International deliver failsafe device networking by eliminating single points of failure and enabling multiple connections to a single host or device.