

Dual-Homing: Bringing Redundancy to the Edge of the Network

A Technical Brief

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Dual-Homing: Bringing Redundancy to the Edge of the Network

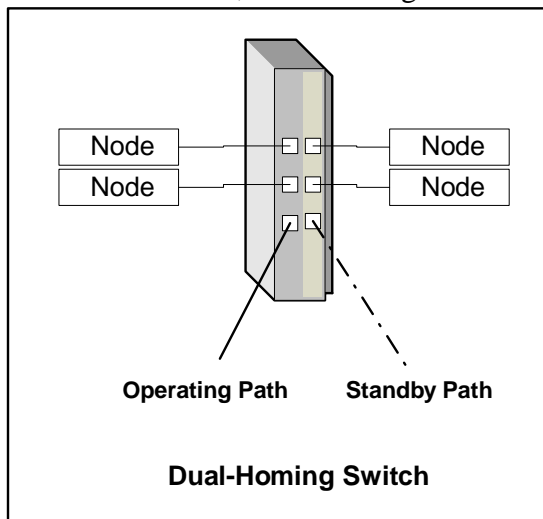
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Designing and implementing high-availability Ethernet LAN topologies in industrial networks can be challenging. The serial field buses that have been traditionally used for industrial control do not offer fault-tolerant options, and industrial systems designers are not accustomed to planning for redundancy for control devices. In the past, the choices for redundancy for edge-of-the-network devices were too limited, too expensive, and too complicated to be considered in most industrial systems.

Today, however, high availability is becoming a key component in many industrial environments. Stopped manufacturing lines, power outages, and other system failures are becoming much too expensive – and visible – to tolerate. While ring and mesh topologies for connectivity are coming into more general use, finding practical ways to provide for recovery from faults for edge devices and nodes has remained difficult. The software required to manage computers and other devices that have dual NICs for redundant connections into the network is complex, and the dual-NIC solutions are costly. Very few manufacturers offer PLCs and IEDs with dual connectivity built in for industrial sensor and controller applications. Dual-homing technology changes all that.

What is Dual-Homing?

In Ethernet LANs, dual-homing is a network topology that adds reliability by allowing a device to be connected to the network by way of two independent connection points (points of attachment). One access point is the operating connection, and the other is a standby or back-up connection that is activated in the event of a failure of the operating connection.



A dual-homing switch, with two attachments into the network, offers two independent media paths and two upstream switch connections. Loss of the Link signal on the operating port connected upstream indicates a fault in that path, and traffic is quickly moved to the standby connection to accomplish a fault recovery.

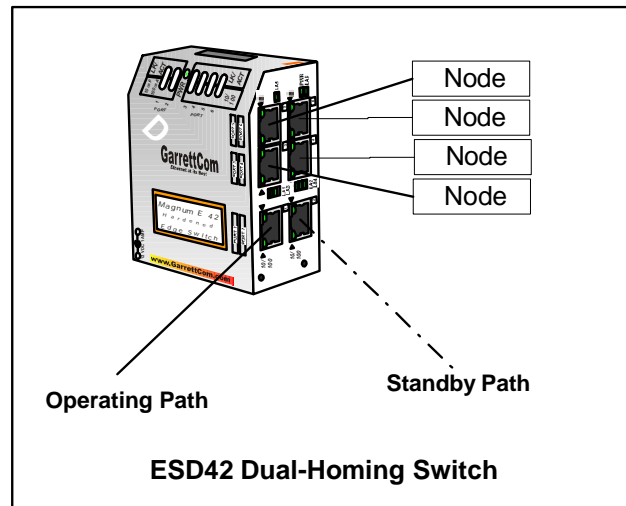
How does Dual-Homing work?

Dual-homing ports are peers. In the case of Garrettcom's ESD42 switch, they occupy ports 1 and 2. When the switch is powered up, port 1 is initially used for operation providing that it can establish a Link signal. All Ethernet traffic upstream to and from the attached nodes then moves

over port 1, the Operating Path, with port 2 in standby mode. Typically, port 2 will be attached upstream and will have Link enabled, ready to go into operation at any time.

When there is a loss of Link on port 1, the switch quickly moves all traffic to port 2, and port 1 becomes the standby port (after the fault is repaired and its Link signal is enabled again). Port 2 will stay in operation indefinitely . . . until it experiences a loss of Link, whereupon the dual homing switch will move all of the traffic to port 1.

The signal for the device to switch its Ethernet traffic to the other dual-homing port is simple: the loss of Link on the Operating Port. There are no configuration variables associated with this type of plug-and-play dual-homing switch. The dual-homing switch-over time is about 300 milliseconds, during which time the device changes the state of its internal address buffers and notifies upstream devices of the connection change of the attached nodes to the new operating port.



Because it takes advantage of Ethernet

standards, the dual-homing redundancy features work with any brands or models of Ethernet switches upstream. GarrettCom has successfully tested its dual-homing switch with a variety of switches including its Magnum Switches, and with the company's standards-based S-Ring™ Redundancy Manager software and Link-Loss-Learn™ (LLL) technology, as well as with industry-standard IEEE 803.1x Rapid Spanning Tree Protocol (RSTP) redundancy software.

Full fault recovery in the overall network is dependent upon the time required by the upstream switches to adjust to the movement of the nodes attached to the switch from one connection port to another. Dual-homing switchover operation is as if the physical media connection for the operating path were manually unplugged from a port on one switch and then quickly plugged into a port of another switch. When tested with a variety of brands of Ethernet switches running industry standard RSTP software, the typical redundant network fault recovery time is less than one second.

Dual-Homing Switch Applications

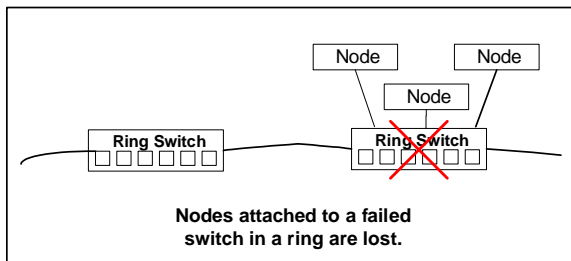
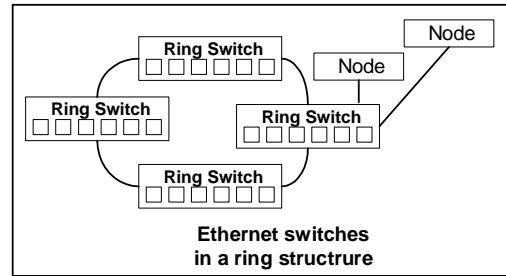
Dual-Homing in Rings

In industrial applications, the most common redundant Ethernet LAN topology is the ring. A ring structure will recover from a media break or the failure of a switch. However, the failure of a switch in the ring takes down the nodes connected into that switch.

Uptime for a critical node can be increased by connecting it to two switches in the ring. Dual-ported nodes or a dual-homing switch can be used to do this. The critical nodes connected to the

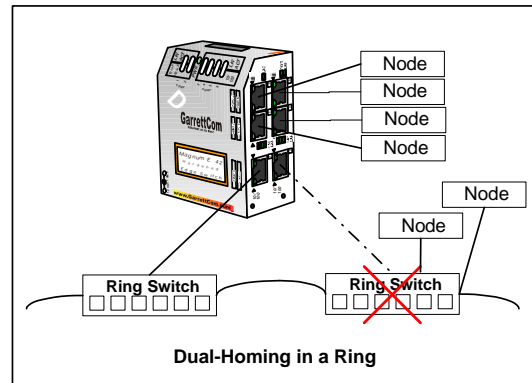
ring through the switch will remain attached to the ring even with one of the two ring switches out of service.

Used in rings, a dual-homing switch improves reliability in two ways. First, it uses two media connections into the ring so that media faults cause less down-time. Second, the MTBF of the simple switch (which is a single point-of-failure for the attached nodes) is much greater than that of a large managed Ethernet switch in the ring.



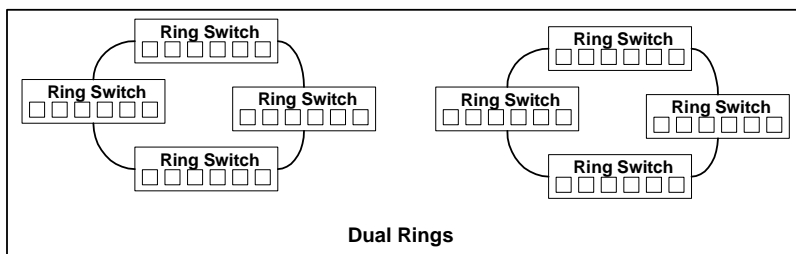
Dual-homing also provides connection flexibility during network maintenance. A switch in the ring may need to be taken out of service temporarily to load new software or to perform a hardware upgrade. During a planned outage,

dual-homing maintains the connection of critical nodes in a redundant LAN to ensure device up-time while permitting service work to be done (typically less expensively) during normal work time.



Dual-Homing in Dual Rings

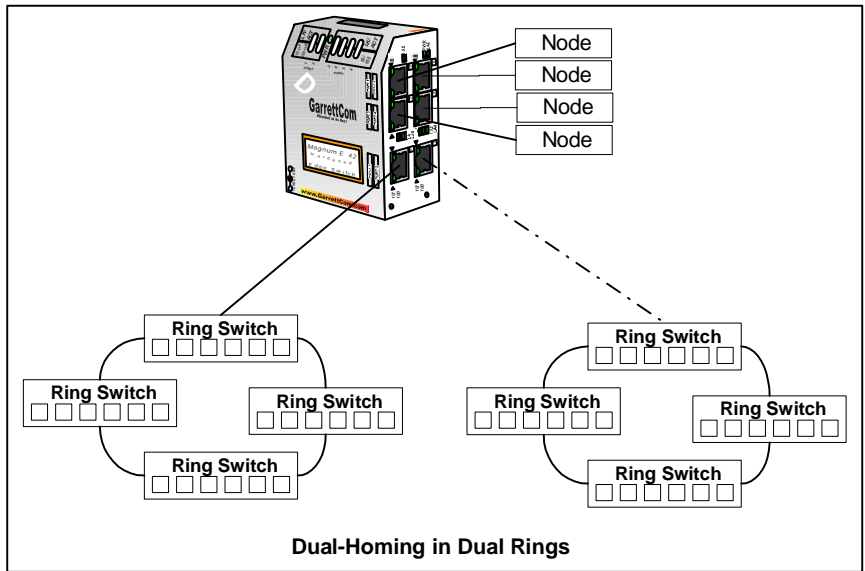
Some LAN designs use two rings for greater redundancy. Single Ethernet rings can recover from only one fault at a time. With two rings, there are two paths for LAN traffic, providing the potential for recovery from more than one fault at a given time. Dual-ring configurations may



sometimes be achieved at little cost increase by breaking up a large ring into two smaller rings.

In a dual-ring topology, uptime requirements typically make cost considerations secondary.

There are a few special-purpose (and expensive) dual-homing PLCs and dual-NIC computers that been installed in complex dual-ring LANs. These new switches now permit any Ethernet-enabled edge device to be installed in a dual-homing configuration easily and reliably.



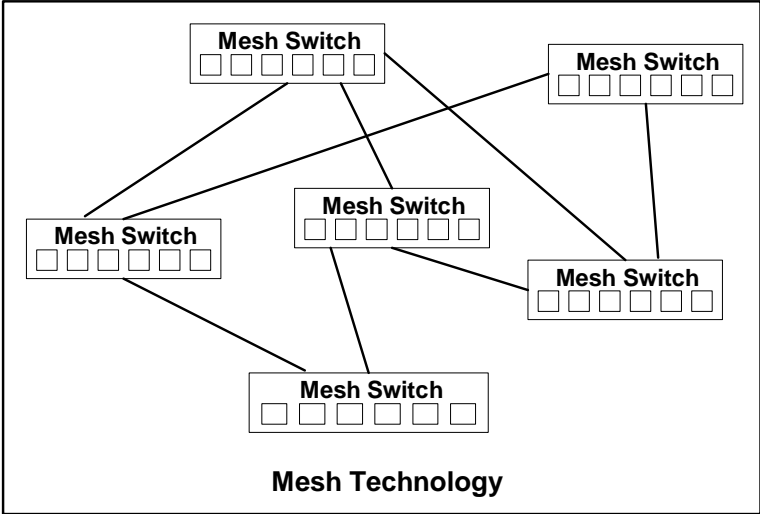
To use this dual-homing switch in a dual-ring LAN, connect Port 1 into any switch in one ring and Port 2 into any switch in the other ring. The same fault-recovery logic in the switch as for single rings is used in handling fault conditions in dual-ring LANs. Loss of Link on the Operating Port causes the dual-homing switch to move all traffic on the upstream connection to the Standby Port, effectively reversing the

order of the Standby and Operating Ports.

Dual-Homing in Mesh Structures

A mesh structure provides an even more robust redundant LAN. Mesh complexity is almost without limit, with multiple interconnects adding to the fault recovery capability even when multiple faults occur. The cost of the Ethernet LAN equipment and cabling used in constructing the mesh rises as the complexity increases, necessitating trade-off calculations by redundant network designers.

Dual-homing switches create another type of redundancy for critical nodes in a mesh. A simple mesh is sufficient to illustrate the principles of meshes for redundancy. The same dual-homing switch fault-recovery logic applies for meshes as for ring configurations.



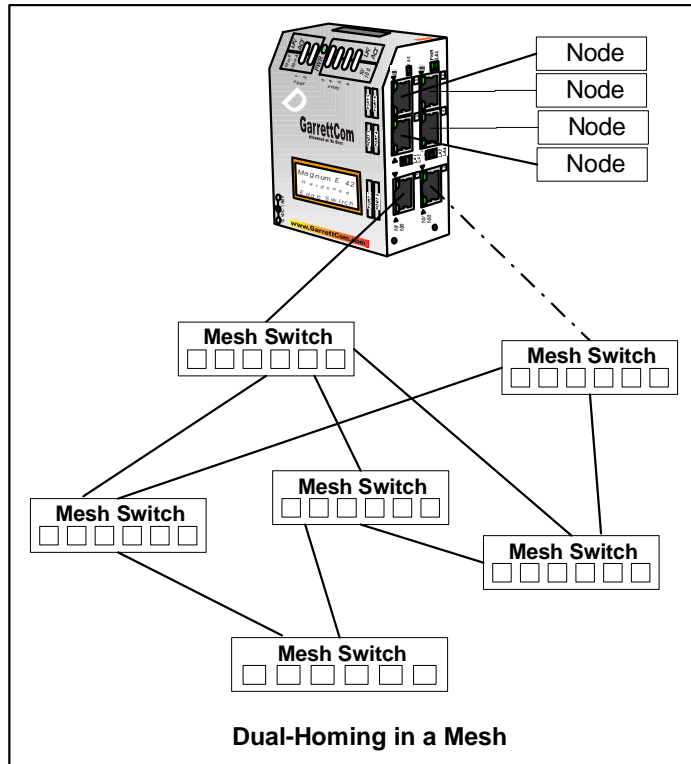
Meshes are complex structures and require managed Ethernet switches running complex software such as STP or RSTP. The mesh operation will vary the forwarding and blocking ports for the mesh switches as the network goes through changes and recovery from a fault or faults. Exactly how the switches will operate to recover from faults cannot always be predicted or tested. The reliability advantage of the dual-homing switch in a mesh is that it is small, simple, and predictable. Because it is inherently a much more reliable device than the typical managed mesh

switch, it is a valuable addition for improving the availability of the most critical network components in meshes.

Dual-Homing for Media Redundancy

A simple but occasionally useful application for a dual-homing switch is to provide for media redundancy. Where there is significant risk of media faults (for example, where the media is attached to a movable device and is flexed during normal operation, or where undependable wireless interconnects are utilized, or where part of the media path is exposed in a high-security situation), media redundancy adds essential connectivity uptime.

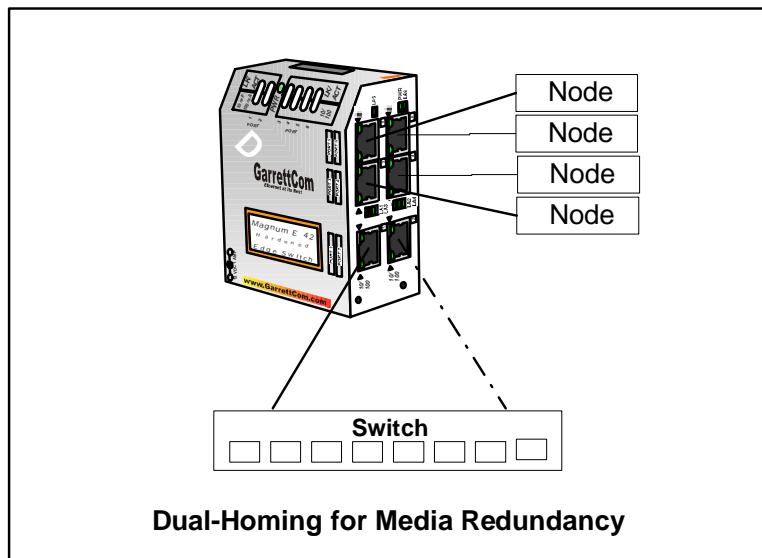
For media redundancy, both ports 1 and 2 (the Operating Port and the Standby Port) are connected to the same switch upstream. Media types for ports 1 and 2 may be either copper or fiber, and each port's media type can be configured independent of the other. Additional media types (such as wireless) may be inserted so long as the Link signal is passed through to provide a reliable signal for switchovers between the Operating and Standby Ports of the dual-homing switch.



Summary

While managed Ethernet Switches for use in redundant LAN structures such as rings and meshes have become increasingly available and popular, redundancy provisions for edge devices in Industrial Ethernet networks has not previously been addressed. The new dual-homing edge switch fills that void and provides a new tool for designers of redundant LANs that is simple and dependable in operation.

A dual-homing Ethernet switch allows the dual-homing function to be moved from the node into a small switch. This enables designers of redundant LANs to increase the reliability and uptime of any industrial control device that has an Ethernet port (not just those



few designed with dual NICs – typically at a cost premium). Redundancy at the edge is now cost-effective and easy.

Creating effective redundant Ethernet LANs is a matter of complex trade-off calculations among up-time, cost, and control device selection.

About the ESD42 Dual-Homing Switch

GarrettCom's Magnum ESD42 Dual-Homing Switch provides a new plug-and-play redundancy tool that opens up LAN design options and expands device choices. Any industrial SCADA device can now be used creatively in redundant LANs to create an installation that is more robust and less complex – at a more affordable price.

Redundancy at the edge of industrial networks is greatly simplified by these new dual-homing Magnum™ ESD42 Switches. These simple, unmanaged switches offer convenient plug-and-play dual connectivity in a physically small package (about the size of a fist), with a choice of three models for office, hardened or premium-rated heavy-duty environments. In addition to the dual-homing feature, ESD42s provide DC and AC power input choices, and a selection of copper and fiber port connector types and distances for the dual-homing ports 1 and 2, and DIN-Rail or panel mounting options. With a MTBF of more than 30 years, they provide high reliability to enable redundancy for nodes at the edge of the network at a low cost.

ESD42 Dual-Homing Switches are part of the Magnum line of Industrial Switches from GarrettCom, Inc. For additional Magnum ESD42 product information, consult the GarrettCom website at www.GarrettCom.com or call 510-438-9071.

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