

Unmask Ethernet Direct Industrial Redundancy Technologies

Importance of Redundancy in Industrial Ethernet

In order to provide the right Industrial Ethernet Solutions to the industry, Ethernet Direct offers a broad range of Industrial Managed Ethernet products designed specifically with multi-levels of redundancy to ensure a reliable and secured industrial network. There are several redundancy mechanisms in existence in Ethernet Direct's Industrial Ethernet Switch Solutions. Each redundancy design serves different redundancy purpose. In an industrial network, downtime is measured in terms of the cost per minute of lost production. For this reason, deploying an Industrial Ethernet Switch with effective redundancy strategies is crucial in industrial applications where a failure could result in catastrophe. Ethernet Direct's especially-designed switches deliver the highest accessibility to ensure profitability.

Levels of Redundancy

Essential features are incorporated in Ethernet Direct's industrial managed switches in order to perform multi-levels of redundancy. **Power redundancy** means the ability to connect to an alternative power supply in case a power failure occurs. A relay output will trigger an alarm when pre-defined events happen. **Ring redundancy** provides a back-up path in an event that any part of a network is disrupted. Ethernet Direct's X-Ring is designed for mission-critical industrial networks. X-Ring can deactivate one of the links in the ring to data traffic while simultaneously monitoring that the link is functioning. In case one of the links in the ring fails, the deactivated link will be "activated" within milliseconds. Finding ways to provide recovery from faults in nodes connected to critical devices has been made easy by Ethernet Direct. Further to ring redundancy, switches should be able to be configured with dual network nodes in the form of Dual Homing technology. This **Network node redundancy** adds reliability by allowing a device to be connected to the Ethernet network by having two independent connection points – one as operating connection and the other as back-up connection. Hence, **Entire system redundancy** is reliable only when multi levels of redundancies can be achieved. It minimizes data loss by providing fast recovery time once unexpected network disruption occurs.

Ring Redundancy Explained

The use of a ring for redundancy or failure recovery is conventional in industrial network deployment. Since there is no IEEE or IETF standard, each supplier has a slightly different scheme and thus, proprietary method. For this reason, many customers are not selecting ring redundancy - it would lock them into a particular supplier. Those customers choose Rapid Spanning Tree - it is another redundancy scheme and is an IEEE standard that can be used for most applications. Ring Redundancy must be configured in managed switches using, according to the vendor, pre-defined ports, and one switch must be defined as the 'ring manager'. Ethernet Direct switches allow any ports to be used as 'ring' ports.

Rapid Spanning Tree Protocol Explained

RSTP, short for Rapid Spanning Tree Protocol, allows a back-up path to be put in a standby mode and activated upon failure of the primary path. The network topology can be in a ring similar to Ring Redundancy. Different switch vendors that support RSTP in their managed switches can be used in the same network segments since RSTP is an IEEE standard. Users must configure RSTP in managed switches - defining various aspects of the configuration.

The most common redundancy called Spanning Tree Protocol has been developed into Rapid Spanning Tree Protocol (RSTP), which reconfigures in less than one second. However, this is based on switch limitation in a ring. In an industrial application, a ring may need to support 20 to 30 switches.

X-Ring From Ethernet Direct

X-Ring is an advanced industrial redundant technology introduced by Ethernet Direct. When compared with the commercial standard redundant technologies like STP or RSTP, the X-Ring can effectively reduce the recovery time to less than 300ms. In order to successfully apply this technology, the Ring Topology must be applied to all the connected switches.

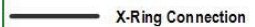

When all switches are connected in Ring Topology with X-Ring function enabled, one of the switches will be appointed as "Ring Master", and this ring master will monitor the ring's health to make sure the ring is working properly. Once a failure is detected by the ring master, the ring master will activate the blocked backup path within milliseconds to replace the faulty primary transmission path to make sure the ring will continue to work. In addition, there are multiple Ring Masters allowed in the ring connections.

With the launch of the new industrial gigabit Ethernet switches, the X-Ring recovery time was successfully reduced to less than 10ms, and with its gigabit transmission speed plus the new switch fabric technology applied, the switch's CPU calculation capability was extensively increased. Therefore, the new gigabit Ethernet switches became the trends of the major buying options.

The following is an example of connection diagram of X-Ring deployment:

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X-Ring Connection Diagram

-  X-Ring Connection
-  X-Ring Backup Path

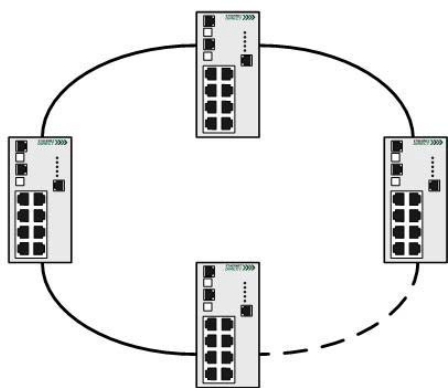


Figure-1: The sample of the X-Ring Connection Diagram

X-Ring Recovery Time Architecture

As network expands by connecting many devices together, Ethernet redundancy becomes more critical to ensure non-stop connection. X-Ring can accommodate as many as 50 switches in a ring. The maximum number of switches is typically suggested to be 30 to 50 switches in order to easily manage the network.

Ring recovery time for HME & HWE series

Number of Switches	30	40	50
Recovery Time	300ms	450ms	500ms

Note:

If the number of switches is less than 30 switches, the recover time will still be equal to 300ms.

Ring recovery time for HMG series

Number of Switches	30	40	50
Recovery Time	10ms	15ms	20ms

Note:

If the number of switches is less than 30 switches, the recover time will still be equal to 10ms.

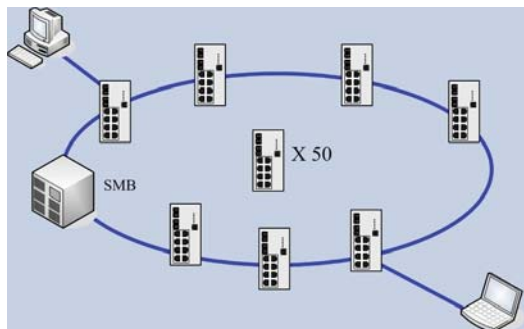


Figure-2: Ring Architecture

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Couple Ring

In the real world implementation, there are cases that require two X-Ring groups to be connected together to ensure redundant protection. Therefore, the "Couple Ring" technology was introduced by Ethernet Direct. The following is a sample of connection diagram showing how Couple Ring is implemented within the two X-Ring groups. With Couple Ring function, each X-Ring group will need to assign two switches with 2 extra ports to achieve the structure. Hence, the total switches needed for the Couple Ring to work will be four switches, and each switch is assigned with four ports for completing a Couple Ring (including the two X-Ring ports per switch). In some applications, for some reasons, configuring all devices to create a huge redundant ring might be convenient. In order to address this kind of network design wherein some devices could probably be located in a remote site, Ethernet Direct provides the "Ring Coupling" technology.

Ring Coupling allows network engineers to set up a versatile and fault-tolerant network by separating distributed devices into different and smaller redundant rings. In this kind of configuration, the smaller rings would still be able to communicate with each other. One of the two switches act as the "Master" activates the coupling line to the other ring while the other switch acts as the slave.

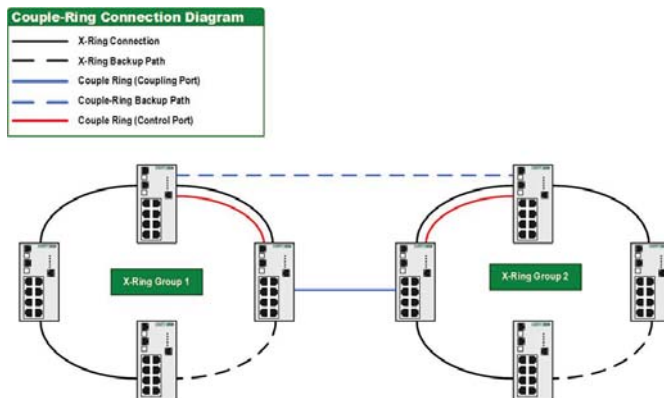


Figure-3: The sample of Couple Ring Connection Diagram

Dual Homing

Despite the fact that Managed Ethernet switches are used in redundant LAN structures, redundancy for edge devices on the network are not quite familiar. Ethernet Direct unveils the Dual Homing technology in Industrial Ethernet switches. Traditionally, the industrial Ethernet applications focus more on Edge implementation, which means the de-centralized management technology is applied to the industrial environment. But there are cases that the users from the industrial environment need to connect their switches to the backbone core switches, and the backbone core switch suppliers are vendors like Cisco or HP... etc. These backbone switches are mostly commercial switches and commonly they only support "RSTP" as their redundant technology.

Dual Homing provides an advanced redundancy network solution by connecting switches running in different redundant protocols such as IEEE 802.1w Rapid Spanning Tree Protocol and X-Ring to extend the network redundant coverage. Dual Homing feature can ensure two X-Ring groups with redundant backup when connected to a backbone switch. Hence, Ethernet Direct Industrial Managed Switches can set Back-up Masters in X-Ring to ensure the most secure network. Redundancy is achieved by connecting two ports from two separate switches using X-ring Ring protocol with two ports of managed switches using other redundancy protocol. An active link where data is transmitted is connected with one port in the switch. The other port connected with another switch is a hot standby link. The hot standby link is being constantly monitored and it will be switched over within seconds once the active link is disconnected or breaks. This approach can open up LAN design options and expand device choices. For example, it can permit any industrial SCADA devices to be part of a resilient network.

By default the RSTP and X-Ring are not meant to exist in the same network segment, but considering the needs for the redundancy, the Dual Homing technology is therefore introduced. With the implementation of Dual Homing feature, the X-Ring group will be allowing to connect to these backbone core switches and without sacrificing its redundant protections. Below, we show the sample of connection diagram on how Dual Homing can be connected with 1 or 2 X-Ring groups.

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Dual Homing Connection Diagram

- X-Ring Connection
- X-Ring Backup Path
- Dual Homing Connection
- Dual Homing Backup Path

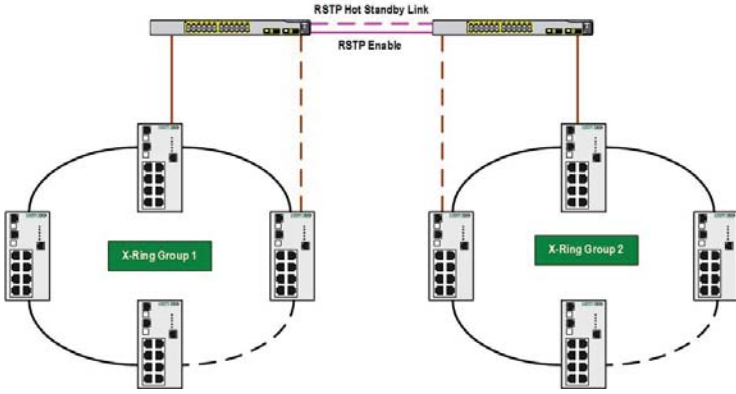


Figure-4: The Sample of Dual Homing with 2 X-Ring Groups Connection Diagram (Straight Through Connection Method)

Dual Homing Connection Diagram

- X-Ring Connection
- X-Ring Backup Path
- Dual Homing Connection
- Dual Homing Backup Path

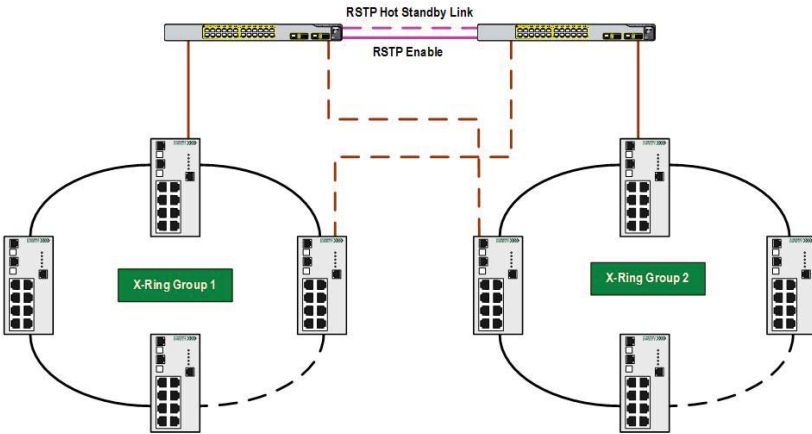


Figure-5: The Sample of Dual Homing with 2 X-Ring Groups Connection Diagram (Cross Through Connection Method)

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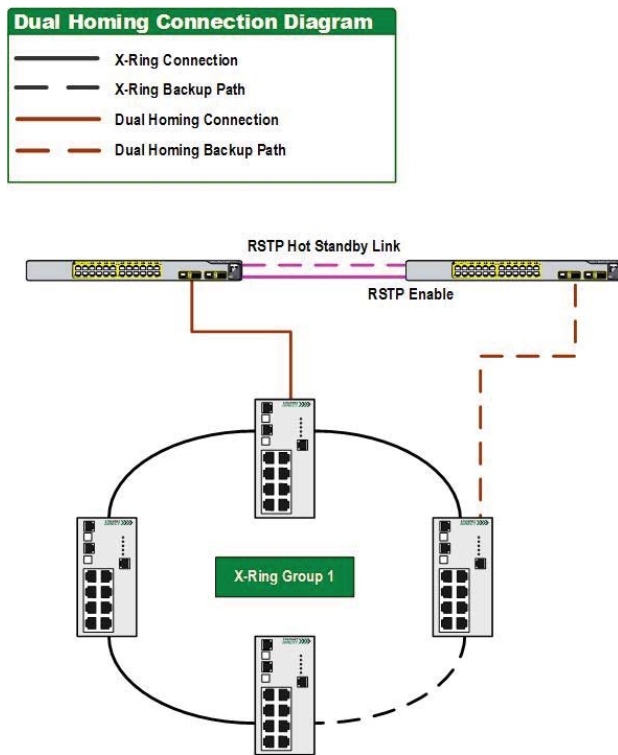


Figure-6: The Sample of Dual Homing with Single X-Ring

Dual Ring & Central Ring

Although Ethernet Direct provides the Dual Homing technology for the industrial customers who may need to connect their switches from field environment to the centralized backbone, some users may not deploy Cisco or HP switches. In some applications cases, customer would like their backbone switches to be the same as those switches in their field environment equipped with industrial-grade protection and yet serve as the backbone network. Considering the needs, Ethernet Direct released new redundant technologies called “Dual Ring” and “Central Ring”.

The Dual Ring and Central Ring are similar in the connection concepts. The only different is that the Dual Ring is recommended when the concern is “cost” or small projects with lesser amount of switches. Dual Ring allows the connection up to two ring groups to the central backbone and the configuration will only exist in those switches with minimum 8 ports availability.

As for the Central Ring, the configuration will only exist in a 16-port gigabit Ethernet switch, and it allows the connection up to five ring groups. Below, we show the sample of connection diagram on how these rings can be applied.

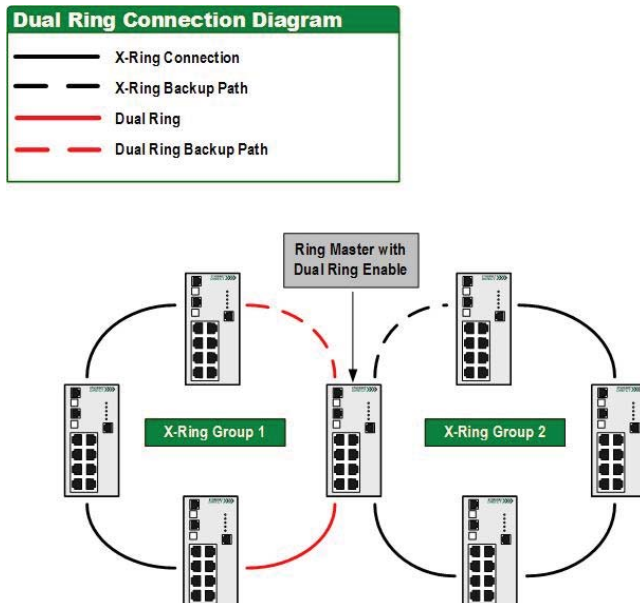


Figure-7: The Sample of Dual Ring Connection Diagram

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Central Ring Connection Diagram

- X-Ring Connection
- - X-Ring Backup Path
- Central Ring
- - Central Ring Backup Path

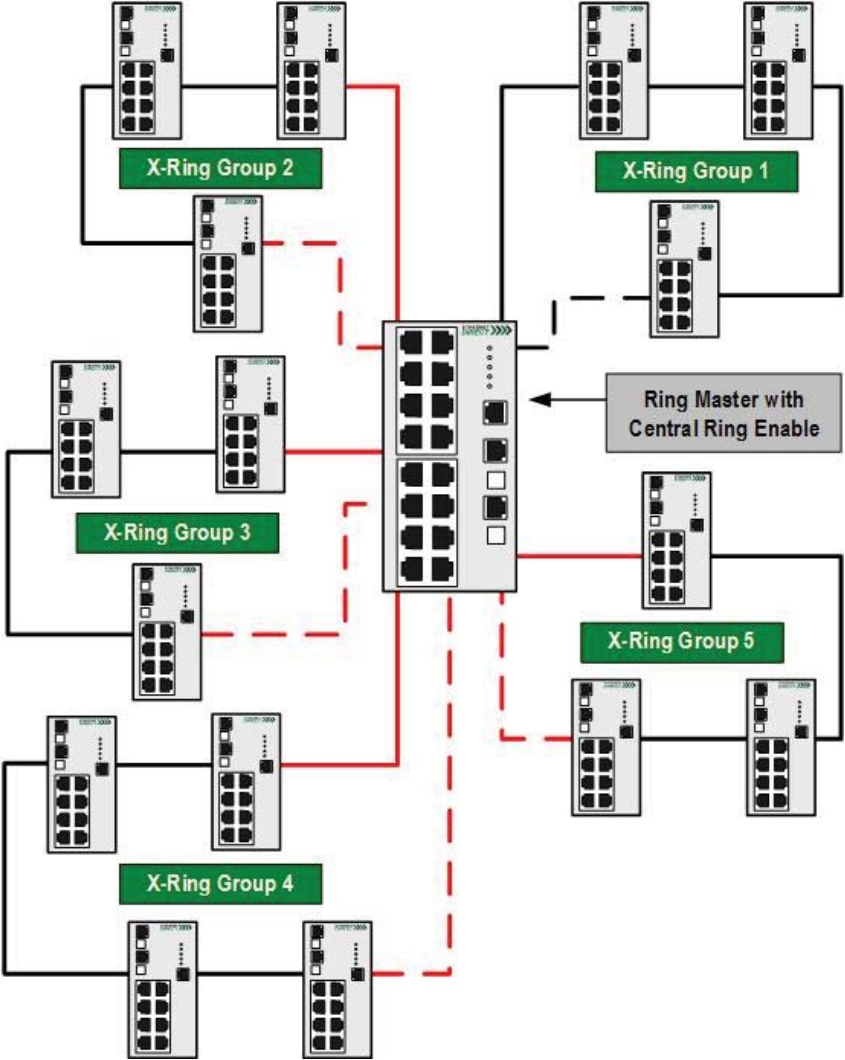


Figure-8: The Sample of Central Ring Connection Diagram

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Double Ring

The Double Ring technology was introduced by Ethernet Direct when the implementation environments require redundant solutions for all the connected devices and not only limited to the network switches.

The diagram shows that the Ethernet Direct Double Ring solution not only takes care of the Ethernet switches but also helps to provide the redundancy for the connections between the edge devices and the switches.

In this kind of implementation, the edge devices are required to have at least two network interfaces for the redundant connections needed, and those devices without the multiple network interfaces may not be applicable to this technology.

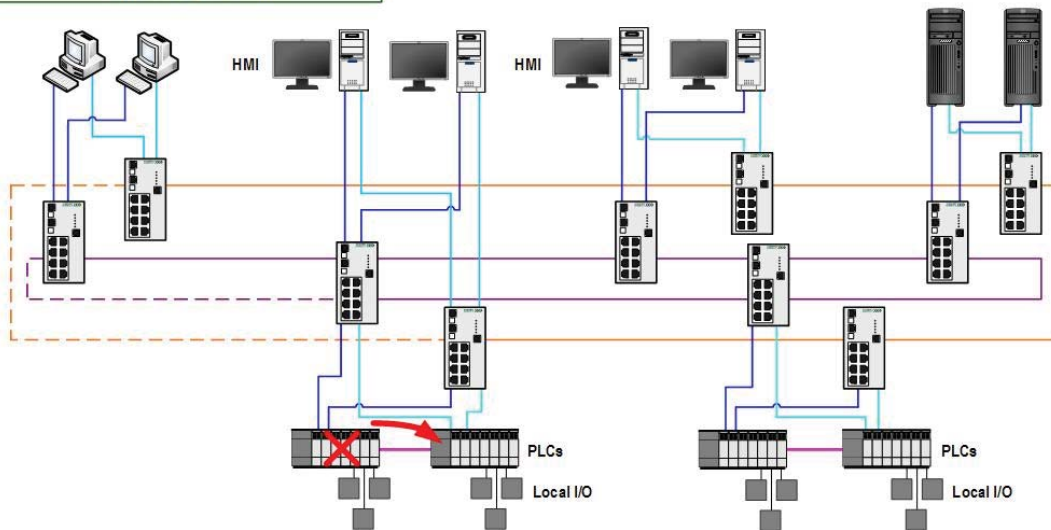


Figure-9: The Sample of Double Ring Connection Diagram

Unmask Ethernet Direct Industrial Redundancy Technologies

X-RSTP

To further fulfill more advanced redundancy scheme, Ethernet Direct launched the newest redundant technology named "X-RSTP", and is a pioneer in the Industrial Ethernet arena. This technology combines the advantages of both X-Ring and RSTP.

X-RSTP has inherited the RSTP's flexibility in its implementation and it also inherits the advantage from the X-Ring for its fast recovery time. X-RSTP's recovery time is approximately less than 100ms. Although it's still far away from the X-Ring's 10ms standard, but it has extensively been improved compared to the traditional RSTP. By implementing the X-RSTP, the installation cost can be reduced, and the multiple ring connections to the backbone can be fulfilled with needs of the redundant protections.

X-RSTP Connection Diagram

— X-RSTP Connection

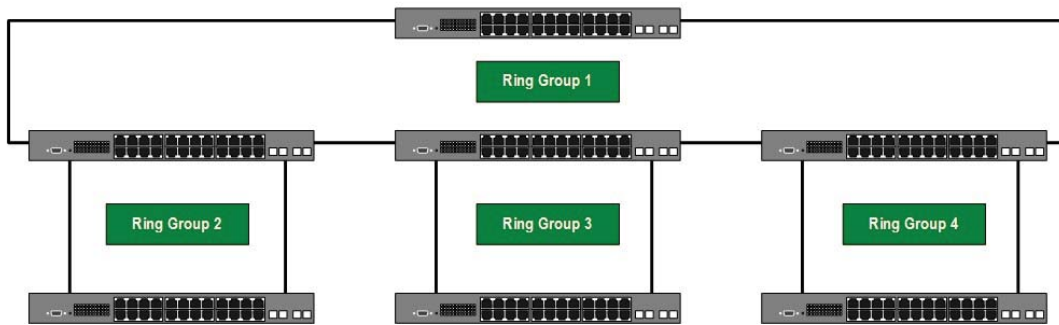


Figure-10: The Sample of X-RSTP Connection Diagram

Conclusion

Ethernet Direct offers numerous redundant technologies depending on any given architecture or applications. As an emerging leader in the Industrial Ethernet technology, Ethernet Direct promises security and stability in industrial Ethernet applications.