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AX3660S Series
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ALAXALA Ring Configuration Guide

Edition 1

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ALAXALA Networks Corporation

Preface

This document provides the information about system configuration using Autonomous Extensible Ring Protocol supported by the AX Series (AX3660S, AX2630S, AX2340S), including an overview of protocol operation, tips for system configuration using each model, and considerations.

Related documents

・AX Series product manuals（https://www.alaxala.com/en/techinfo/manual/index.html）

Notes on using this document

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AX3660S	Ver12.1.U
AX2630S	Ver 2.3
AX2340S	Ver 2.4

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Contents

1. What is the Ring Protocol ?

1.1 Overview of the Ring Protocol

The Autonomous Extensible Ring Protocol (Ring Protocol) is an ALAXALA-proprietary Layer 2 network redundancy protocol, which detects failures in a network where switches are connected in rings and performs high-speed path switching in response to the detected failures.

Unlike the Spanning Tree Protocol (STP), which is generally used as a Layer 2 network redundancy protocol but suffers from slow path convergence when failures occur, the Ring Protocol achieves faster path switching. In addition, the Ring Protocol uses a ring topology, which has the advantage of using fewer transmission paths and interfaces than the mesh topology often used for spanning trees.

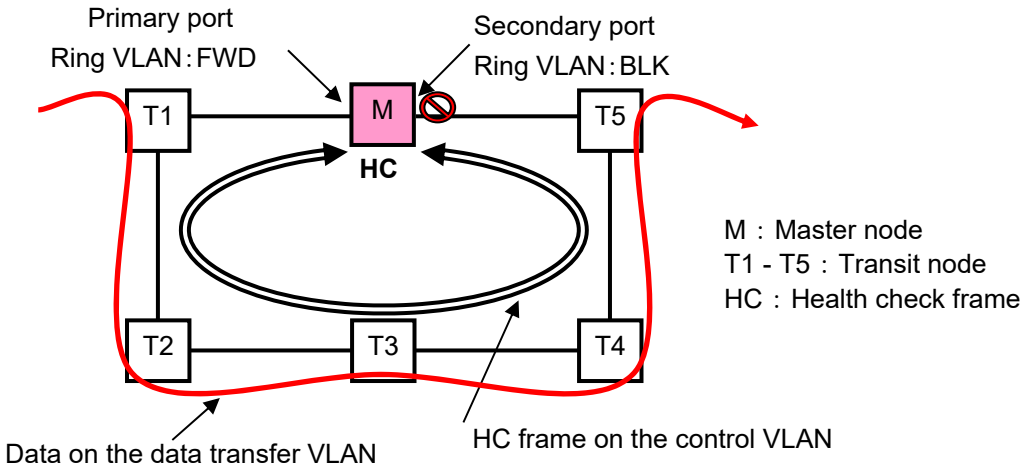


Figure 1.1-1 Ring protocol operation in normal condition

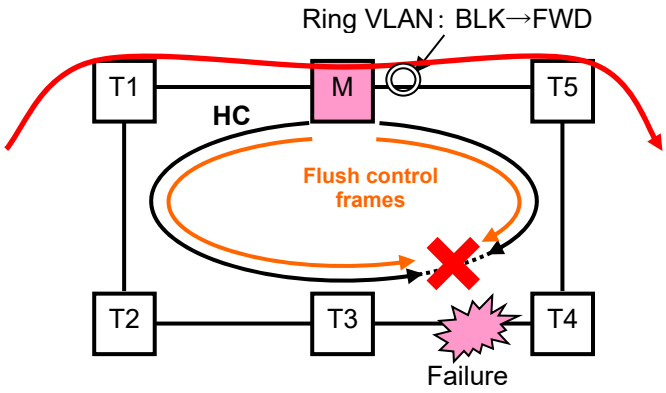


Figure 1.1-2 Ring protocol operation in failure condition

1.2 Features of the Ring Protocol

（1）Ethernet-based ring network

The Ring Protocol is an Ethernet-based Layer 2 network redundancy protocol. Whereas conventional ring networks typically use dual-link fiber optics such as FDDI, you can use the Ring Protocol to build ring networks using Ethernet.

（2）Simple operation method

Networks using the Ring Protocol have a simple configuration consisting of one master node and multiple transit nodes. The master node is mainly responsible for ring status monitoring (for failure detection and recovery) and path switching operations, and the transit nodes perform path switching according to the instructions from the master node.

（3）Control frame

The Ring Protocol uses its own control frames. These control frames are sent from the master node for monitoring the ring status, and for prompting the transit nodes to perform path switching. Unlike typical spanning trees, control frames are sent and received on a dedicated VLAN, which means data frames flow in a different VLAN from the one for control frames. In addition, control frames are processed with a higher priority so that they are not affected by increase in data traffic volume.

（4）Load balancing method

Multiple VLANs used in a ring are aggregated logically by group, and data flow can be set to clockwise or counterclockwise from the master node. This is useful for load balancing and dividing paths by VLAN.

1.3 Glossary

Table 1.3-1 Glossary of the Ring terms

No.	Term	Description
1	Master node	A node that monitors and detects failures and failure recovery in the ring. The master node also controls the logical status (FWD or BLK) of ports in the ring according to the ring status and prevents a loop. Every single ring must have one master node.
2	Transit node	A node that transfers data. Unlike the master node, this node does not monitor failures or failure recovery in the ring.
3	Control VLAN	A VLAN on which control frames are sent and received. Set a unique VLAN ID for each ring. You cannot use the same VLAN for both a control VLAN and a data transfer VLAN.
4	Data transfer VLAN	A VLAN on which data is sent and received. By being associated with a ring VLAN group, data transfer VLANs can be subject to VLAN switchover when a failure has occurred.
5	Ring port	A port connected to a node in the ring. This port sends and receives data frames on a data transfer VLAN and control frames on a control VLAN.
6	Primary port	A ring port of the master node. Its status in a ring VLAN group is set to Forwarding when the ring is in normal condition.
7	Secondary port	A ring port of the master node. Its status in a ring VLAN group is set to Blocking when the ring is in normal condition. Setting the status to Blocking prevents data looping. When a ring failure occurs, the port status is switched from Blocking to Forwarding to form an alternate path.
8	Ring VLAN group	A logical group into which multiple VLANs are aggregated.

		VLAN groups are managed in the ring. A VLAN can only belong to one VLAN group. The ring uses one control VLAN and a maximum of two ring VLAN groups of data transfer VLANs (one for data transmission in the clockwise direction and the other for data transmission in the counter-clockwise direction).
9	Ring VLAN status FWD (Forwarding)/ BLK (Blocking)	The ring VLAN status is either FWD (Forwarding) or BLK (Blocking). Set this status for each ring VLAN group per ring port. A group of data transfer VLANs switches the status between FWD and BLK when a failure has occurred or when a failure recovery has been detected in the ring.
10	Health check frame (HC)	A frame sent by the master node over the control VLAN for a ring normality check.
11	Flush control frame	A frame sent by the master node over the control VLAN when a failure or a failure recovery has been detected in the ring. When a transit node receives the frame, the node clears its MAC address table and forwards the frame to the next node.
12	Single ring	A network in which multiple switches are connected forming a ring. This is a basic configuration for the Ring Protocol.
13	Multi-ring	A network consisting of multiple single rings.
14	Shared link member node (Shared node)	A node on a link shared by multiple rings. Both master and transit nodes can be a shared node.
15	Shared link	A link that connects the shared nodes.
16	Shared link monitoring ring (O-shaped ring)	A ring that monitors a failure and a failure recovery on the shared link.
17	Shared link non-monitoring ring (C-shaped ring)	A ring that does not monitor either a failure and a failure recovery on the shared link.
18	Shared link monitoring master node	The master node in a shared link monitoring ring (O-shaped ring).
19	Shared link non-monitoring master node	The master node in a shared link non-monitoring ring (C-shaped ring).

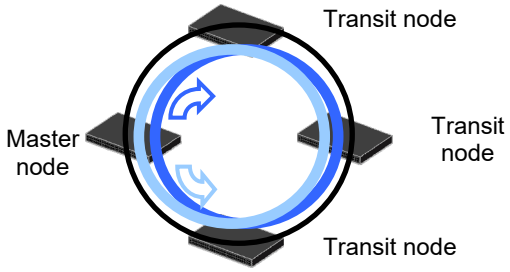
2. Operation of the Ring Protocol

2.1 Network configuration

This section describes the network configurations in which the Ring Protocol is used.

(1) Single ring configuration

A ring configuration consisting of one master node and several transit nodes is called a single ring configuration. The single ring configuration is a basic configuration for the Ring Protocol. Physical ports or link aggregations are specified as ring ports to connect the nodes in the ring. Control frames sent from the master node are circulated on the control VLAN for ring status control. VLANs used to send and receive data frames (so-called data transfer VLANs) are assigned to a logical group called a VLAN group. You can configure a maximum of two VLAN groups for a single ring (one for clockwise circulations from the master node and the other for counter-clockwise circulations). All the nodes in a ring use one same control VLAN and common data transfer VLANs. You can include multiple VLANs in a VLAN group.

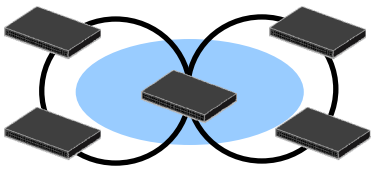


Single ring configuration

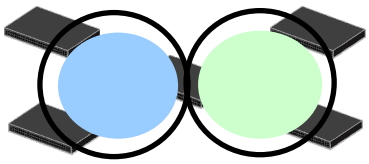
(2) Multi-ring configuration without shared link

A configuration consisting of multiple rings (that is, having multiple physical or logical master nodes) is called a multi-ring configuration.

When neighboring rings are connected by only one node (one contact point), no shared link exists. This means the nodes in each ring run as in an independent single ring, regardless of if the rings use a common VLAN for data frame transfer (shared VLAN) or use separate different VLANs (exclusive VLAN).



Shared VLAN
Multi-ring with shared link

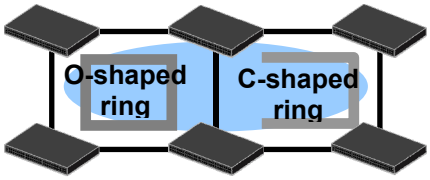


Exclusive VLAN
Multi-ring without shared link

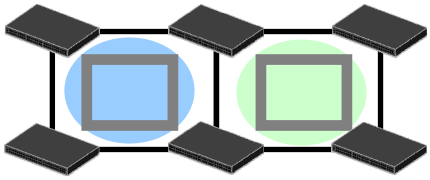
(3) Multi-ring configuration with shared link

When rings are connected by two or more nodes (multiple contact points), the rings share a link. This link is called “shared link”, and a multi-ring configuration with a shared link is called “multi-ring with shared link.”

When rings use separate different VLANs (exclusive VLAN) for data frame transfer, they run as independent single rings. When rings use a common data transfer VLAN (shared VLAN), they perform different failure detection / switching operations from those of a single ring to prevent a super loop (#) when a failure has occurred on a shared link.



Shared VLAN
Multi-ring with shared link

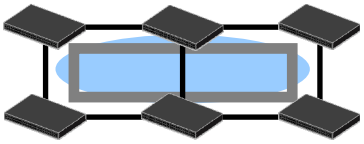


Exclusive VLAN
Multi-ring without shared link

In this VLAN-shared multi-ring with shared link, one ring monitors a failure and a failure recovery on a shared link (shared link monitoring ring, or O-shaped ring), and the other one does not (shared link non-monitoring ring, or C-shaped ring). The nodes at the ends of the shared link are called “shared nodes.” As described here, you can logically configure non-overlap rings to prevent a super loop.

super loop:

This is a loop state across rings. A super loop occurs when the neighboring rings independently perform a failover operation in the same manner as a single ring does, thus connecting themselves together into a single ring without any blocking points.



When each ring on the right and left performs failover operation as if each were a single ring, both rings have no blocking points and thus form a single large loop.

2.2 Operation of the Ring Protocol

This chapter describes the Ring Protocol operation in both normal and failure conditions.

2.2.1 Operation in normal condition

The single ring in normal condition behaves as shown below.

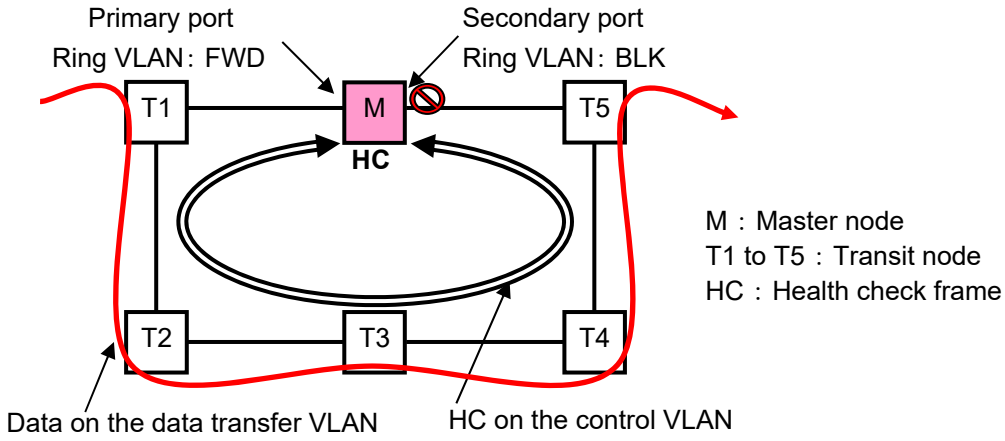


Figure 2.2-1 Single ring operation in normal condition

(1) Master node operation

The master node sends a control frame called health check frame (HC) from its two ring ports (primary and secondary ports) over the control VLAN. Then the master node monitors whether each HC comes back in both directions within a pre-determined time interval. Data frames are sent from the primary port to the data transfer VLAN. The secondary port, which is logically blocked, does not transfer data frames or learn any MAC addresses.

- If the master node does not receive the HC in either direction within the pre-determined time interval, the node determines that a failure has occurred.
- A user can define the time interval.
- After a failure occurs, if the master node receives the HC on one of its ring ports, the master node determines that the failure has been resolved.

The master node monitors whether HCs they sent come back. Even if some packets are lost on the way, the master node keeps its normal ring status as long as it can receive HCs in at least one direction. However, if IEEE802.3ah/UDLD is used, the master node can detect link down events caused by a unidirectional link failure and take actions.

(2) Transit node operation

Transit nodes do not monitor HCs sent by the master node. After a transit node receives an HC, the node transfers it to the next node in the ring via both of its ring ports.

2.2.2 Ring failover

If a failure occurs, the single ring behaves as shown below.

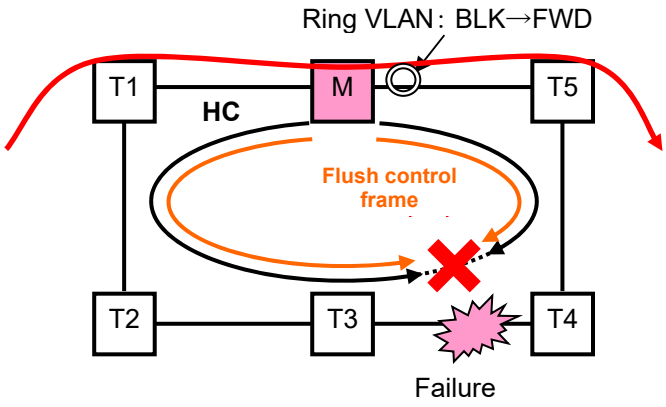


Figure 2.2-2 Single ring operation in failure condition

(1) Master node operation

If the master node detects a failure in the ring, the node takes the following actions:

[1] Changing the status of the data transfer ring VLAN group

After detecting a ring failure, the master node changes the status of its data transfer ring VLAN group as follows:

Ring port (primary) : FWD (not changed)
Ring port (secondary) : BLK => FWD

[2] Sending flush control frames

After detecting a failure, the master node sends a flush control frame from its primary and secondary ring ports. The master node sends a flush control frame several times from each ring port to ensure the propagation of the frame.

[3] Deleting MAC address table entries

To minimize the impact of flooding caused by ring status change, MAC address table entries are not deleted if they are created for destinations other than the ring ports. MAC address table entries are deleted only if they are associated with the VLANs belonging to the data transfer ring VLAN group and their destinations are ring ports.

[4] Discarding flush control frames

Flush control frames are forwarded from one transit node to another and usually discarded at the failure point. Therefore, in general, flush control frames do not come back to the master node. If the master node receives a flush control frame, the node discards it.

[5] Entering the recovery monitoring status

After the master node detects a ring failure, the node exits the failure monitoring status and then enters the recovery monitoring status.

(2) Transit node operation

During a ring failure, a transit node receives several flush control frames on its ring port. A transit node performs steps [1] and [2] below when the first flush control frame arrives. Then, when the transit node receives the subsequent flush control frame during step [2], the node performs step [3]. If the node receives the subsequent frame after step [2] is completed, the node clears the table again.

[1] Forwarding the flush control frame to the next destination

[2] Clearing the MAC address table

The MAC address table entries whose destinations are ring ports are deleted.

[3] Forwarding the flush control frame to the next destination (MAC address table entries are not cleared)

2.2.3 Ring failback

After failure recovery, the single ring behaves as shown below.

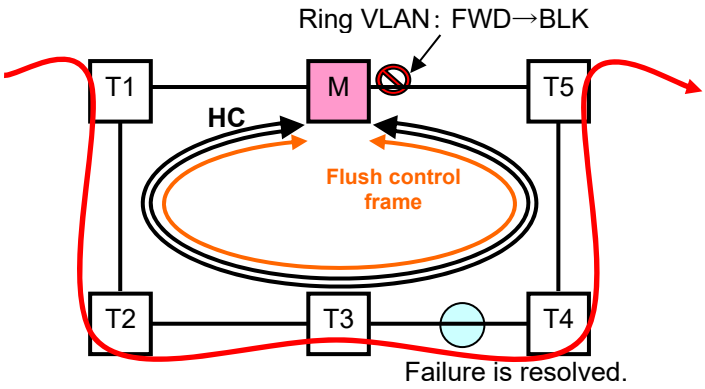


Figure 2.2-3 Failback operation of a single ring

(1) Master node operation

After a failure is resolved in the ring, the master node takes the following actions:

[1] Changing the status of the data transfer ring VLAN group

After detecting a failure recovery, the master node changes the status of its data transfer ring VLAN group as follows:

Ring port (primary) : FWD (not changed)

Ring port (secondary) : FWD→BLK

[2] Sending flush control frames

After detecting a failure recovery, the master node sends a flush control frame from its primary and secondary ring ports. The master node sends a flush control frame several times from each ring port to ensure the propagation of the frame.

[3] Deleting MAC address table entries

MAC address table entries are deleted if they are associated with the VLANs belonging to the data transfer ring VLAN group and their destinations are ring ports.

[4] Discarding flush control frames

After a failure is resolved in the ring, flush control frames are forwarded by transit nodes and finally come back to the master node. The master node discards the returned flush control frames.

[5] Entering the ring failure monitoring status (change of the monitoring status)

After a failure is resolved in the ring, the node exits the recovery monitoring status and then enters the failure monitoring status.

(2) Transit node operation

After a ring failure is resolved, a transit node receives several flush control frames on its ring port. A transit node performs steps [1] and [2] below when the first flush control frame arrives. Then, when the transit node receives the subsequent flush control frame during step [2], the node performs step [3]. If the node receives the subsequent frame after step [2] is completed, the node clears the table again.

[1] Forwarding the flush control frame to the next destination

[2] Clearing the MAC address table

The MAC address table entries whose destinations are ring ports are cleared.

[3] Forwarding the flush control frame to the next destination (MAC address table entries are not cleared)

2.3 Multi-ring operation with Shared Link

2.3.1 Operation in normal condition

In normal condition, if there is a shared link, the Ring Protocol works in multi-ring mode as shown below. If there is no shared link, the Ring Protocol works in single ring mode.

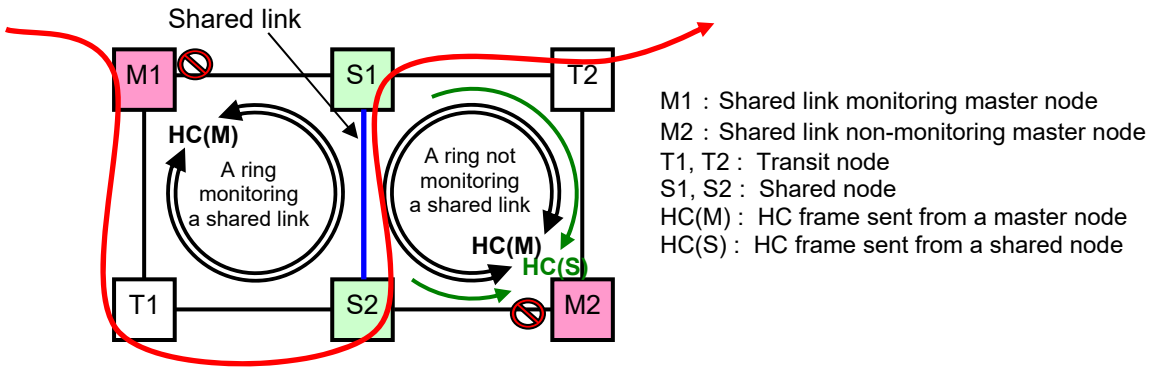


Figure 2.3-1 Multi-ring operation in normal condition

(1) Master node operation

In a multi-ring topology, the master node of each ring (shared link monitoring master node and shared link non-monitoring master node) uses two ring ports as the primary and the secondary (same as a single ring topology). On the secondary port, set the ring VLAN status for data transfer to BLK. The HC(M)s are periodically sent from both the primary and the secondary ports to monitor the ring status.

The shared link monitoring master node monitors whether the HC(M)s come back and determines that the ring status is normal as long as the node receives the HC(M)s. In normal condition, the ring VLAN status for data transfer on the secondary port is BLK, thus data frames arriving on the secondary port are discarded (this prevents a loop).

The shared link non-monitoring master node monitors not only the HC(M)s it sends but also the HC(S)s sent from shared nodes. In normal condition, the ring VLAN status for data transfer on the secondary port is BLK, thus data frames arriving on the secondary port are discarded (this prevents a loop).

(2) Transit node operation

When a transit node has received an HC(M) from the master node or an HC(S) from a shared node, the transit node forwards the received HC frame to the next node (next ring port).

(3) Shared node operation

When a shared node has received an HC(M) from the master node, the shared node forwards the received HC(M) frame to the next node (next ring port).

Also, in the shared link non-monitoring ring, a shared node sends an HC(S) to the master node from its port not belonging to the shared link.

2.3.2 Ring failover

In a multi-ring topology, failures are categorized into three types:
(a) a failure of the shared link monitoring ring (O-shaped ring)
(b) a failure of the shared link non-monitoring ring (C-shaped ring)
(c) a failure on the shared link
When failure (a) or (b) has occurred, the Ring Protocol works in single ring mode.

When failure (c) has occurred, the rings behave as shown below.

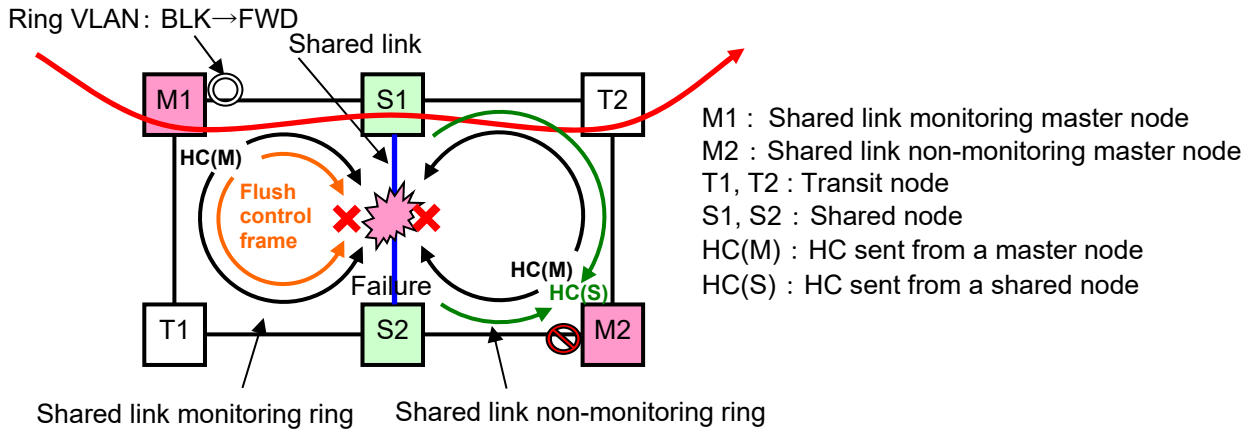


Figure 2.3-2 Multi-ring behavior with a shared link failure

(1) Operation of the shared link monitoring master node

If a failure occurs on the monitored shared link, the shared link monitoring master node behaves in the same manner as in a single ring. That is, if a failure occurs on the monitored shared link, the master node can no longer receive HC(M)s in either direction, and thus determines that a link failure has occurred. The master node performs the same failover operation as in a single ring.

(2) Operation of the shared link non-monitoring master node

The shared link non-monitoring master node cannot receive HC(M)s. However, the master node continues to receive HC(S)s from the shared nodes in both directions, and thus determines that no ring failure has occurred. The master node does not perform failover operation.

(3) Operation of the transit nodes and the shared nodes

The transit nodes and the shared nodes of the shared link monitoring ring (O-shaped ring) perform the same failover operation as in a single ring. The transit nodes of the shared link non-monitoring ring (C-shaped ring) continue to work in normal status because these nodes do not perform failover operation.

2.3.3 Ring failback

In a multi-ring topology, the Ring Protocol starts failback operation in the following cases:
(a) a failure of the shared link monitoring ring (O-shaped ring) has been resolved
(b) a failure of the shared link non-monitoring ring (C-shaped ring) has been resolved
(c) a failure on the shared link has been resolved
For (a) and (b), the Ring Protocol works in single ring mode.

For (c), the Ring Protocol works as shown below.

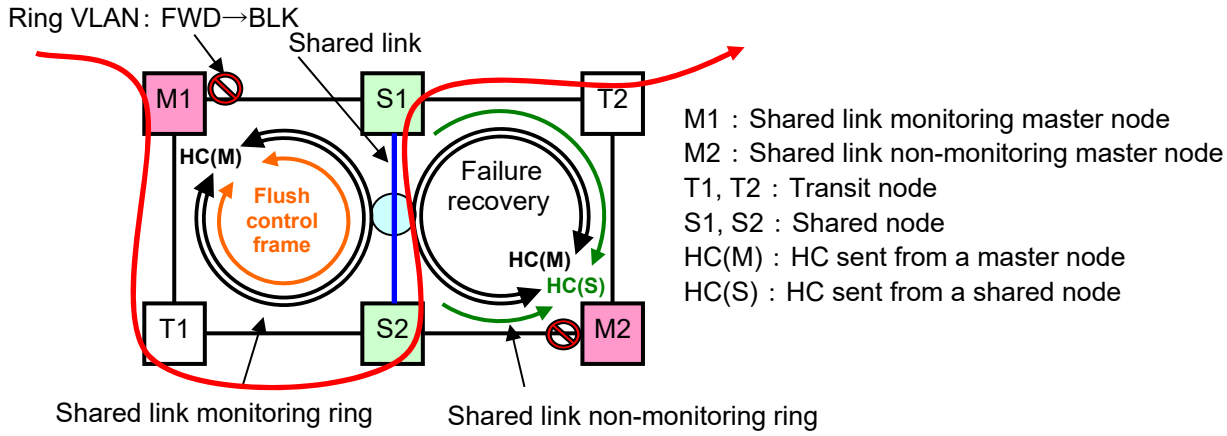


Figure 2.3-3 Multi-ring behavior when a failure has been resolved

(1) Operation of the shared link monitoring master node

The shared link monitoring master node behaves in the same manner as in a single ring. When a failure on the monitored shared link has been resolved, the master node starts to receive HC(M)s on one of its ring ports, and thus detects a failure recovery. The master node performs the same failback operation as in a single ring.

(2) Operation of the shared link non-monitoring master node

The shared link non-monitoring master node does not detect a shared link failure, and thus takes no action when the failure has been resolved. However, the master node starts to receive HC(M)s again.

(3) Operation of the transit nodes and the shared nodes

The transit nodes and the shared nodes of the shared link monitoring ring (O-shaped ring) perform the same failback operation as in a single ring. The transit nodes of the shared link non-monitoring ring (C-shaped ring) continue to work in normal status.

2.4 Unidirectional link failure

In some cases, if the auto-negotiation is disabled in port setting, or if a relay device such as a media converter is connected to the master node or between transit nodes in the ring, a line link-down event does not occur even if there is a line failure in one direction.

With the Ring Protocol, when a line is down in one direction, the master node can receive only either the clockwise or counter-clockwise health-check frames. However, as long as the master node can receive frames in one direction, it determines that a failure has not occurred. This is because if its port in the Blocking state is switched to the Forwarding state due to a failure in one direction, a data loop occurs in the other direction (the direction in which the failure has not occurred).

Therefore, in order not to miss a line failure in one direction in a ring topology, we recommend that you use IEEE802.3ah/UDLD（Uni-Directional Link Detection）.

If you use IEEE802.3ah/UDLD, the link will be down when there is a unidirectional line failure. This means that the master node cannot receive health-check frames in either direction, resulting in a failover operation.

2.5 Supported specifications

Table 2.5-1 below shows the supported specifications of the Ring Protocol.
AX3660S and AX2630S can work as a master node or a transit node. AX2340S works as a transit node only.

2.5.1 Common features

Table 2.5-1 Features of the Ring Protocol

No.	Category	Item	Master / Transit	Transit	Remarks
			AX3660S/ AX2630S	AX2340S	
1	Topology	Single ring	Supported		
2		Mult-ring	Supported (including multi-ring topologies with shared links)		
3	Number of rings	Max. number of rings per device	24		If devices are stacked, this number means the max. number of IDs per stack.
4		Number of nodes per ring	2 or more	2 or more	Depending on the number of ring nodes, adjust the health-check frame transmission interval and monitoring time.
5	Ring port	Number of ports per ring	2		Both physical lines and LA can be specified for a ring port.
6	VLAN setting	Number of control VLANs per ring [Range of available VLAN numbers]	1 [2 to 4094]		A default VLAN cannot be used.
7		Max. number of data transfer VLAN groups per ring	2		You can configure a ring using only one VLAN group.
8		Max. number of data transfer VLAN groups per device	48		(Number of rings per device) x (Number of data transfer VLAN groups per ring)

No.	Category	Item	Master / Transit	Transit	Remarks
			AX3660S/ AX2630S	AX2340S	
9		Max. number of VLANs per data transfer VLAN group	1023 (recommended value) (You can specify 4,093 per configuration, however 1,023 is recommended as a max. number per device. Specify 511 if a ring contains stacked nodes.)		The number of available VLANs is the maximum number of VLANs - 1 (for the control VLAN).
10	Control frame	Format	Proprietary format		The destination MAC address of a control frame is created by adding the multicast bit to the MAC address of the ALAXALA device.
11		Supported control frame	Health-check frame		
12			Flush control frame		
13	Ring failure monitoring method		Monitoring is performed by periodically circulating and receiving health-check frames.		
14		Health-check frame transmission interval	[Initial value] 1,000 ms [Setting range] 200 ms to 60,000 ms	Depending on the master node.	The master and shared nodes send HC frames. The same transmission interval and setting range are applied. For AX3660S, you can set 5 ms or above by using the L3 advanced software license. This license is not applicable when you use the switch in stack mode.
15		Failure monitoring time (Hold time until a failure is detected)	[Initial value] 3,000 ms [Setting range] 500 ms to 300,000 ms	Depending on the master node.	This is the period until the master node determines that a failure has occurred when the node cannot receive a health-check frame. For AX3660S, you can set 15 ms or above by using the L3 advanced software license. This license is not applicable when you use the switch in stack mode.
16	Ring failure recovery monitoring method		Monitoring is performed by periodically circulating health-check frames and checking their arrival. Upon their arrival, failback starts immediately.		
17	Switching method for a node in the ring		Switching is performed by receiving a flush control frame sent from the master node when the node has detected a failure or failure recovery.		
18		Flush control frame	[number of times a frame is sent] Default: 3 Setting range: 1 to 10	Depending on the master node.	If a flush control frame is discarded on the way, communication recovery is not possible. To avoid this, a frame is sent several times to ensure the propagation of a frame.
19	Failure	Determined by ring node type.			This is the period from the

No.	Category	Item	Master / Transit	Transit	Remarks
			AX3660S/ AX2630S	AX2340S	
	recovery time	Failure recovery time	4,000 ms	4,000 ms	time when a ring failure occurs to the time when the MAC address table is cleared (flooding starts) on each node in the ring. This value is based on the test result under the environment described in 3. Examples of Ring Protocol Applications.
20	Load balancing method		Possible when two ring VLAN groups are used.	Depending on the master node.	
21	Master node failover/failback functionality		Supported.	Depending on the master node.	
22	Multiple failures detection functionality		Supported.		
23	Mixed configuration of ALAXALA and third-party nodes		Not supported.		
24	Operating multiple types of nodes by one device		Supported.	Not supported.	If a device belongs to two different rings, the device can perform the master node operation in one ring and the transit node operation in the other.

2.5.2 Compatibility between the Ring Protocol and other functions

The list below shows the compatibility between the Ring Protocol and other functions.

Table 2.5-2 Compatibility between the Ring Protocol and other functions

No.	Function	Compatibility			Description
		AX3660S	AX2630S	AX2340S	
1	Port VLAN	Y	Y	Y	Supported on both Untagged and Tagged ports.
2	Protocol VLAN	Y	Y	Y	Supported on both Untagged and Tagged ports.
3	MAC VLAN	Y	Y	Y	Supported on both Untagged and Tagged ports.
4	Default VLAN	Y	Y	Y	Possible to set a default VLAN as a data transfer VLAN.
5	VLAN tunneling	Y	Y	Y	Supported.
6	MAC learning	Y	Y	Y	Performs normal MAC learning.
7	Link aggregation	Y*	Y*	Y	Supported. Use the Static mode when you apply link aggregation to a ring interface. (*) Operation is limited when the switch is in stack mode.
8	Spanning tree (single)	Y*	Y*	N	Supported only on AX3660S and AX2630S. (*) Operation is not possible when the switch is in stack mode
9	Spanning tree (PVST+)	Y*	Y*	N	Supported only on AX3660S and AX2630S. (*) Operation is not possible when the switch is in stack mode.
10	Spanning tree (MSTP)	Y*	Y*	N	Supported only on AX3660S and AX2630S. (*) Operation is not possible when the switch is in stack mode.
11	GSRP	Y*	Y	Y	Supported. AX2630S and AX2340S support only GSRP aware. (*) Operation is not possible when the switch is in stack mode.
12	LLDP/OADP	Y	Y	Y	Supported.
13	IGMP snooping MLD snooping	Y	Y	Y	Supported.
14	filter / QoS, Shaper	Y	Y	Y	Supported.
15	VLAN with ip （L3 feature）	Y	Y	Y	Supported.
16	VXLAN	P	-	-	Supported only on AX3660S (L3 advanced software license is required). Operable only with VXLAN Network (not VXLAN ACCESS) ports. Not supported on AX2630S and AX2340S.
17	Tag translation	P	P	P	Supported. However, changing the VLAN ID of the control VLAN is not allowed.
18	Port mirroring	Y	Y	Y	Supported.
19	Storm control	Y	Y	Y	Supported.
20	IEEE802.1X	P	P	P	Supported. AX3660S： Not possible to set the per-port authentication or the per-VLAN authentication (static) for a ring port. AX2630S/AX2340S： Not possible to specify a ring port as a port on

					which authentication is performed.
21	WEB-based authentication	P	P	P	Supported. AX3660S: Not possible to set the fixed VLAN mode or the dynamic VLAN mode for a ring port. AX2630S/AX2340S: Not possible to specify a ring port as a port on which authentication is performed.
22	MAC authentication	P	P	P	Supported. Not possible to specify a ring port as a port on which authentication is performed.
23	Uplink redundancy	P	P	P	Supported. This function is not applicable to a ring port.
24	PTP	N	-	-	Not supported on AX2630S and AX2340S.

Y: Coexistence with full Ring Protocol functionality in the device is possible.
P: Coexistence with limited Ring Protocol functionality in the device is possible.
N: Coexistence with the Ring Protocol is not possible.
- : The function is not supported.
* : Operation is limited when the switch is in stack mode. For details, see Pay attention to the functional restriction when you use the switch in stack mode.

3. Examples of Ring Protocol Applications

The Ring Protocol, as it offers a simple configuration and high-speed redundant path switching, matches your needs of simple core network, a network using a redundant path with the least number of ports and links. This chapter provides some examples of practical system applications.

3.1 A building network using a single ring

As an example of a network system using the Ring Protocol features, there is a network system for buildings. In a building network, the Ring Protocol realizes a backbone network that provides inter-floor connection (e.g., connection between the core switch and each access or distribution switch).

(1) Basic configuration

The following figure shows the general wiring when you apply the Ring Protocol to a building network.

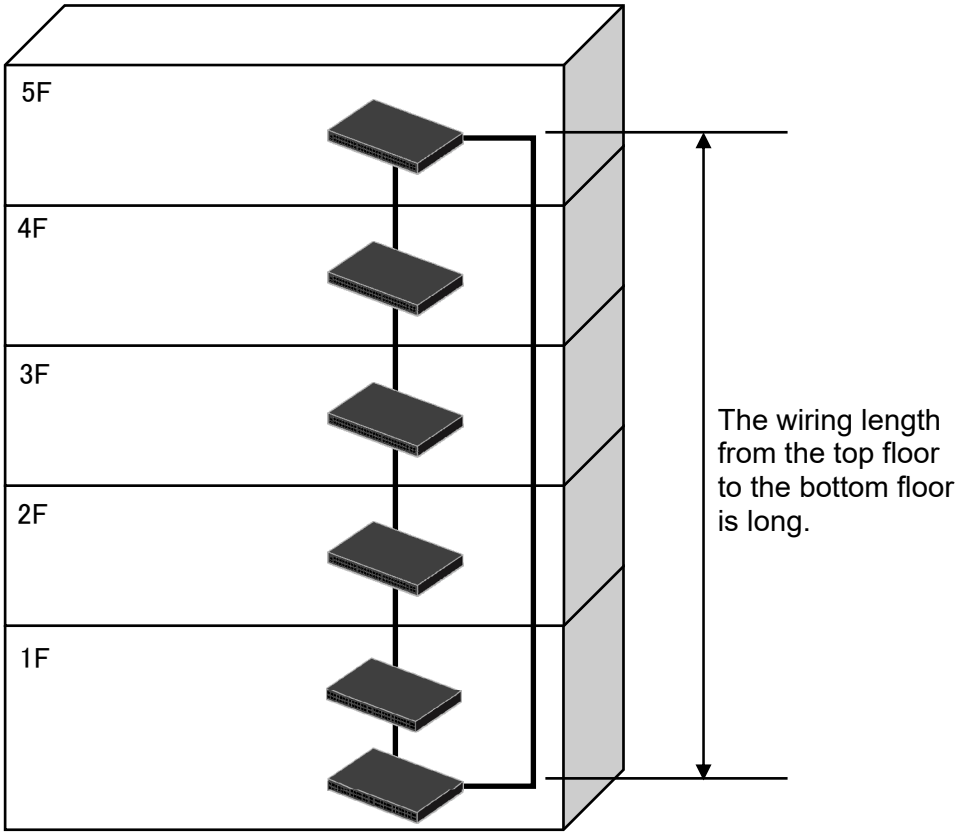


Figure 3.1-1 Basic building network

In this example, a backbone network is configured in a manner that the core switch is connected to each floor's access or distribution switch forming a single ring.

Unlike STP, which often requires complex wiring on each floor, this configuration realizes a simple network with less cables. Also, the core switch uses only two ports, regardless of the number of access or distribution switches on each floor. These advantages help you realize highly cost-effective system.

However, in this configuration, the nodes on the top and bottom floors must be connected to form a ring, which might require a long wiring length. If UTP cables are used for the ring, the length of cables must be considered.

(2) Configuration with less inter-node cable length

Like the basic building network on the previous page, this configuration uses a single ring to connect the core switch to each distribution or access switch. However, it requires less inter-node cable length (only two-floor cable length).

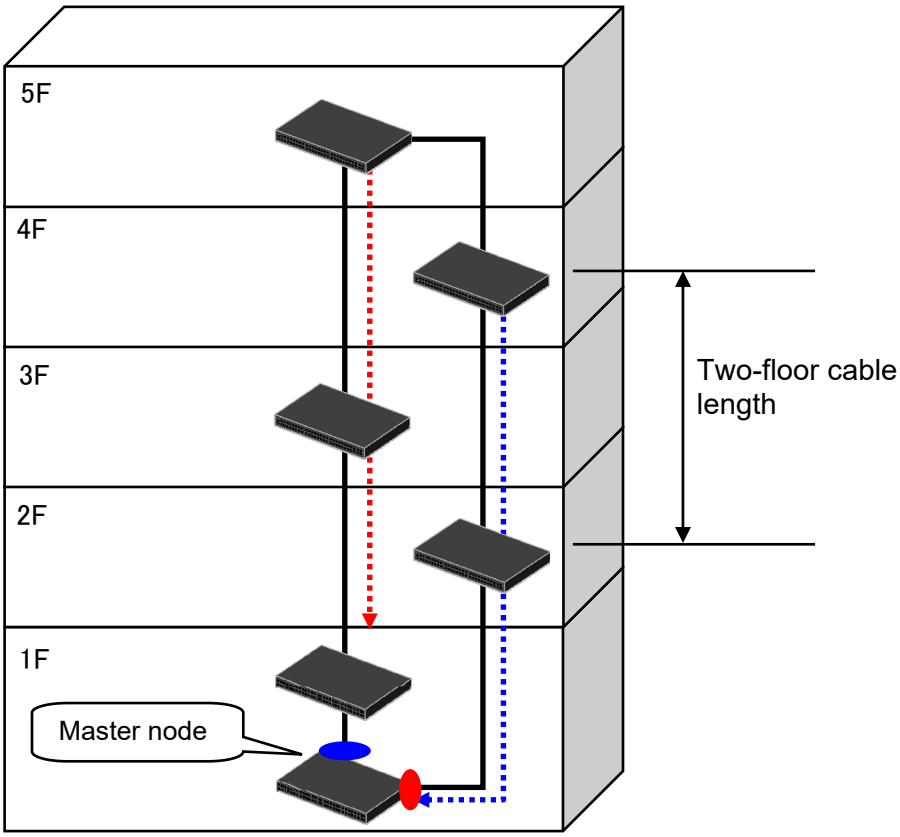


Figure 3.1-2 Building network with less inter-node cable length

In this case, the inter-node cable length is not more than two floors, making it easier to build a ring network with UTP cables.

In addition, another advantage of this configuration is that load balancing is possible between the odd-numbered and even-numbered floor groups by placing the master node on the top or bottom floor.

Notes: Replacement from an STP configuration
Even if the backbone has been made redundant by STP, when the lines are aggregated on the core (in most cases, by using a patch panel), you can use the Ring Protocol by simply changing the wiring on your patch panel.

3.1.1 System configuration based on Layer 2

Figure 3.1-3 below shows a configuration example of a relatively small system. In this example, only box-type devices are used to build a backbone network, and forwarding between access and distribution switches is basically performed by Layer 2.

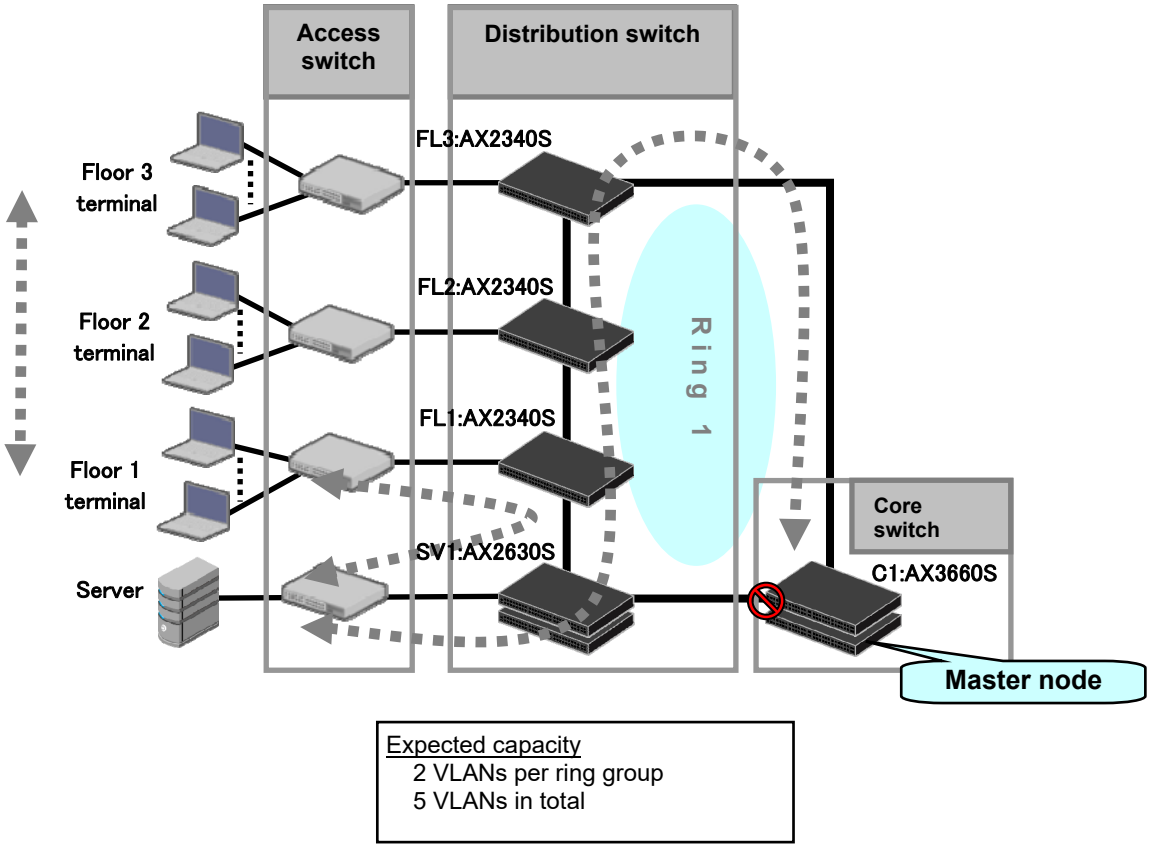


Figure 3.1-3 Configuration with AX3660S / AX2630S / AX2340S

AX3660S is used as a core switch, and AX2630S or AX2340S is used as a floor switch (equivalent to a distribution switch). Further, a server and each floor terminal device belong to the same VLAN; that is, they belong to a same subnet. The difference between the core switch and the other devices is that the core switch works as the master node of a ring.

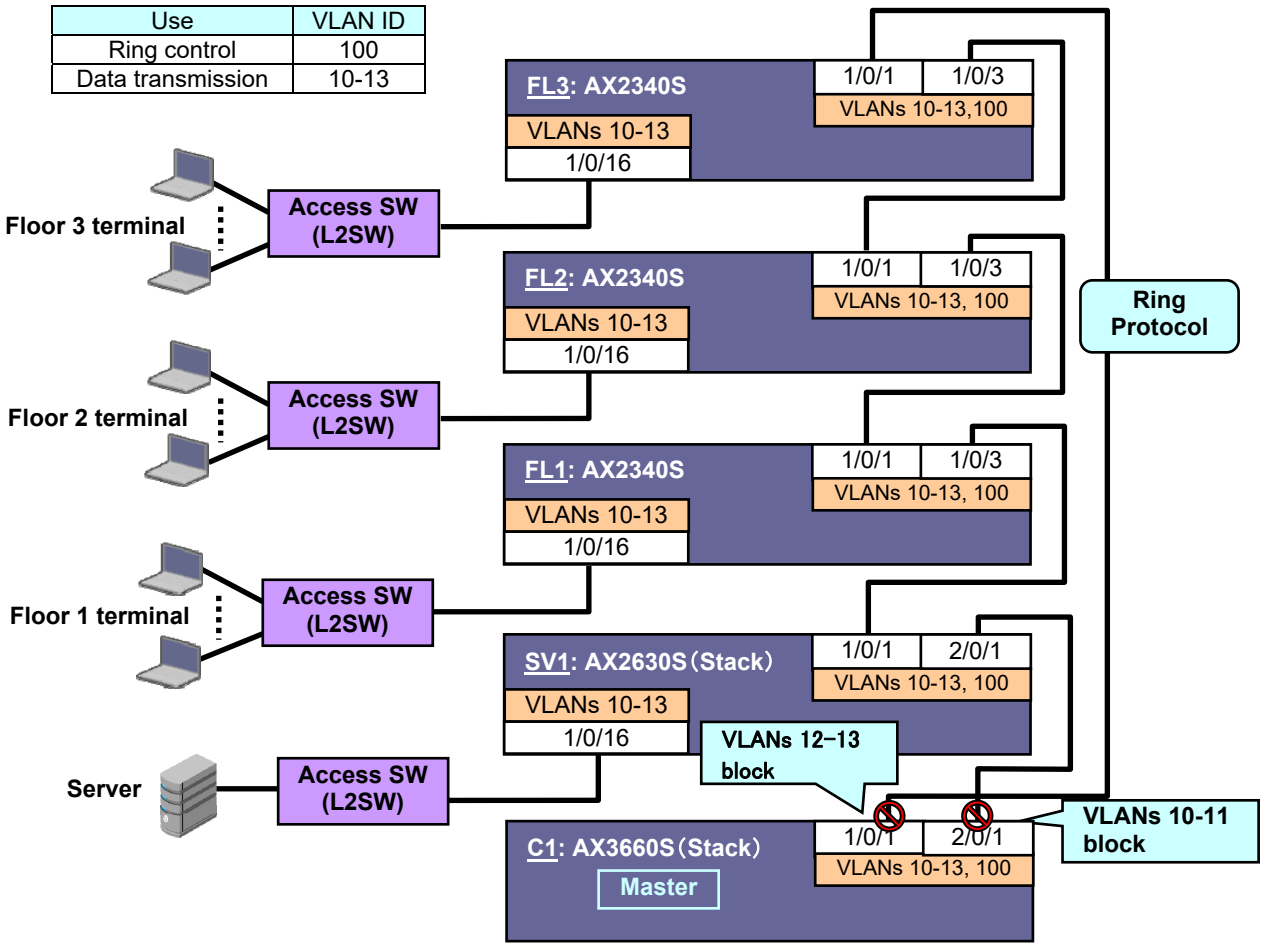


Figure 3.1-4 Ring configuration diagram (a single path)

The ring ports on each device must be trunk ports. The blocking points of the ring must be set on Device C1.

In this configuration, the ports connected via access switches to the floor terminal devices or servers are configured as trunk ports, but you can configure these ports as access ports by assigning a specific VLAN to each of them so that they can directly accommodate terminal devices and servers.

3.1.2 Configuration tips

This section explains the key points for configuring the building network introduced in 3.1.1.

(1) Disable the Spanning Tree Protocol (STP).

On the AX series switches, STP runs using PVST+ by default. However, you need to disable STP because this configuration does not use STP.

(2) Use both a data transfer VLAN and a control VLAN.

In the Ring Protocol, besides VLANs for general data transmission, one VLAN is used exclusively for controlling the ring topology (called “control VLAN”). One control VLAN is required per ring (per ring ID). Therefore, when you assign VLANs, you need to take the control VLAN into account.

(3) Define data transfer VLANs in VLAN mapping.

Define data transfer VLANs used for the Ring Protocol in VLAN mapping.

VLAN mapping simplifies configuration setting (you can specify the same configuration setting for multiple data transfer VLANs at a time) when you achieve load balancing as described in (6) below, which helps you prevent a loop that might occur due to a configuration error.

(4) The secondary port of the master node must be configured as a blocking port.

In normal operation, the secondary port of the master node must be the blocking point of a ring. The ring port of a transit node cannot be a blocking port.

In configuration setting, the secondary port (blocking port) is determined by specifying the primary setting (`axrp-primary-port` command) for the port you do not want to block.

If you omit the primary port setting, the primary port is automatically determined according to the rule below.

For VLAN group #1		
Ring port #1	**Ring port #2**	**Prioritized port**
Physical port	Physical port	(For the box-type master node) The port with the **smaller** port number runs as the primary port.
Physical port	Channel group (aggregated interface)	The physical port runs as the primary port.
Channel group	Physical port	The physical port runs as the primary port.
Channel group	Channel group	The port with the **smaller** channel group number runs as the primary port.
For VLAN group #2		
Ring port #1	**Ring port #2**	**Prioritized port**
Physical port	Physical port	(For the box-type master node) The port with the **larger** port number runs as the primary port.
Physical port	Channel group	The channel group runs as the primary port.
Channel group	Physical port	The channel group runs as the primary port.
Channel group	Channel group	The port with the **larger** channel group number runs as the primary port.

Also, if you want to configure clockwise and counter-clockwise rings by using two VLAN groups, you need to set each different primary port for each VLAN group.

(5) Pay attention to the mode and parameters when you use link aggregation.

When you use link aggregation on the port specified as a ring port, note the following.

(a) Using the static mode is recommended for link aggregation.

There are two link aggregation modes, LACP and static. We recommend that you use the static mode, based on the following reasons:

- Requires less fallback time.
  (In general, compared to the LACP mode, which detects a line failure by monitoring unreachable LACPDUs, the static mode requires less link-down time during failover/failback because the static mode directly monitors the link state to detect a failure. This difference also affects the switching time of the Ring Protocol (for details, see (b)).
- In a local area network, most devices are directly connected each other.
  (If devices are directly connected each other, you can detect a line failure by simply checking the link-down state on the devices).

Also, set the link debounce time for Ethernet ports to the smallest possible value if there is no particular problem (with line quality, for example). Note that links will be unstable if you set less than 2,000 milliseconds (a value automatically given when the link debounce time setting is omitted) for the following interfaces: 10BASE-T, 100BASE-TX, 1000BASE-T, 2.5GBASE-T, 10GBASE-T, 10GBASE-CU, 40GBASE-CR4, and 100GBASE-CR4.

(b) The parameters for the ring must be larger than the fallback/switching time for link aggregation.

If the failure monitoring time for the master node is shorter than the time to complete the fallback or switching operation through link aggregation, the master node mistakenly detects a ring failure and performs path switching in the ring. As a result, a loop might occur.

More specifically, the health-check hold time in Ring Protocol setting must satisfy the following conditions:

i) health-check hold time > health-check interval

ii) health-check hold time > link debounce time + 1,200 (for SFP ports)
health-check hold time > link debounce time + 1,500 (for UTP ports)

(6) Load balancing through VLAN groups is possible.

This is a simple configuration that performs only Layer 2 forwarding. You can achieve load balancing by dividing paths (configuring multiple VLANs).

To achieve this, use either of the following methods:

(a) Configuring two single rings

- The master node can be load-balanced.
- Two ring IDs are used (two control VLANs, the number of control frames doubled)

(b) Configuring a blocking point per VLAN group in a single ring

- One ring ID
- One master node

We recommend that you use method (b) if you do not have a particular need for load balancing of the master node, though the method you select depends on your configuration requirements.

The following table shows the configuration differences between (a) and (b) when a single master node is used.

(a) **Using two single rings**	**(b) Using one single ring**
Configuring the ring port #1 (a port connected to FL3)	
interface gigabitethernet 1/0/1 switchport mode trunk switchport trunk allowed vlan **10-13,100-101** axrp-ring-port 1 axrp-primary-port 1 vlan-group 1 axrp-ring-port 2	interface gigabitethernet 1/0/1 switchport mode trunk switchport trunk allowed vlan **10-13,100** axrp-ring-port 1 axrp-primary-port 1 vlan-group 1
Configuring the ring port #2 (a port connected to SV1)	
interface gigabitethernet 2/0/1 switchport mode trunk	interface gigabitethernet 2/0/1 switchport mode trunk

switchport trunk allowed vlan **10-13,100-101** axrp-ring-port 1 **axrp-ring-port 2** axrp-primary-port **2** vlan-group 2	switchport trunk allowed vlan **10-13,100** axrp-ring-port 1 axrp-primary-port **1** vlan-group 2
Configuring VLAN mapping (common settings)	
axrp vlan-mapping 1 vlan 10-11 axrp vlan-mapping 2 vlan 12-13	
Configuring a ring	
axrp 1 mode master control-vlan 100 vlan-group 1 vlan-mapping 1 **axrp 2** **mode master** **control-vlan 101** **vlan-group 2 vlan-mapping 2** Configure another ring.	axrp 1 mode master control-vlan 100 vlan-group 1 vlan-mapping 1 **vlan-group 2 vlan-mapping 2** Configure two VLAN groups for a single ring.

The following describes how the communication path for each VLAN is configured to achieve load balancing in the ring.

① Transmission path for VLANs 10-11

VLANs 10-11 are included in VLAN group 1 of the ring.
For VLAN group 1, if you configure primary port setting for the interface connected to device FL3 (described as port 1/0/1 in the configuration example above), the normal transmission path is set as follows:

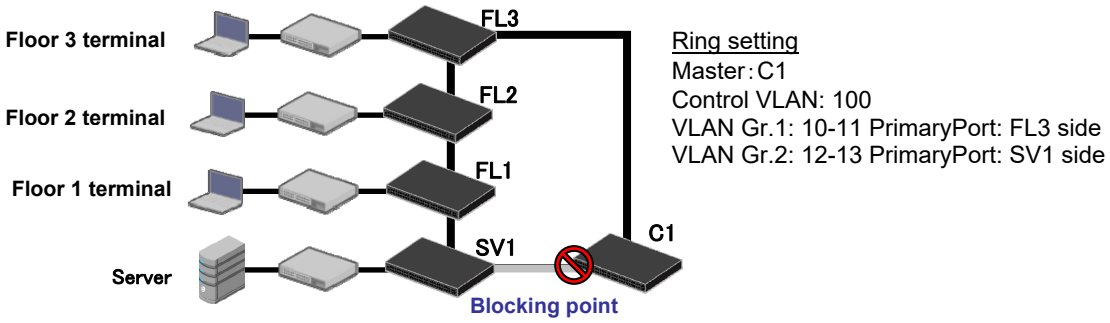


Figure 3.1-5 Transmission path for VLANs 10-11

② Transmission path for VLANs 12-13

VLANs 12-13 are included in VLAN group 2 of the ring.
For VLAN group 2, if you configure primary port setting for the interface connected to device SV1 (described as port 2/0/1 in the configuration example above), the normal transmission path is set as follows:

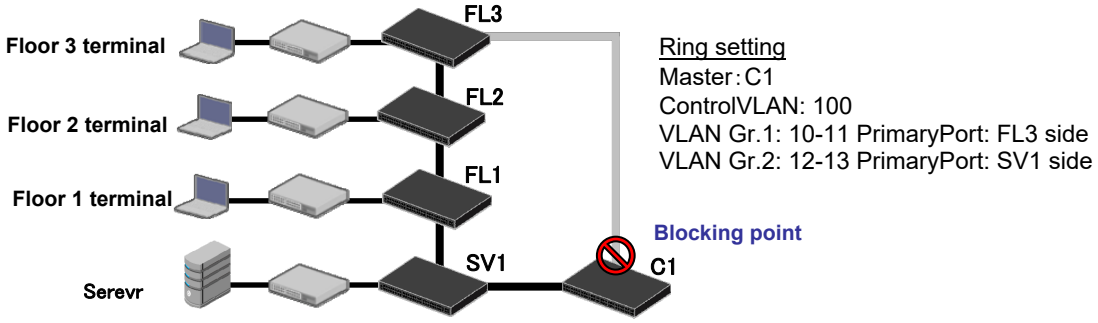


Figure 3.1-6 Transmission path for VLANs 12-13

The above examples are for VLAN assignment per floor. We recommend that you decide how to assign VLANs depending on your requirements.

For example, for a department spanning multiple floors (e.g., terminal devices are located on floor 3 and floor 1), you can achieve load balancing of communication by assigning VLANs 10-11 for transmission between the server and floor 1 devices, VLANs 12-13 for transmission between the server and floor 3 devices, and so on.

(7) Pay attention to the functional restriction when you use the switch in stack mode.

Some functions are not available when the stack function is used with the Ring Protocol. Note the following restrictions when using the switch in stack mode:

(a) If a ring network contains stack member switches, the following functions are not available.
- Spanning tree protocol
- GSRP (GSRP is supported by AX3660S only)
- Virtual link

(b) The following settings are not supported by stack nodes.
- Setting a shared node
- Setting two ring ports for the same stack member switch by using one ring ID
- Setting a link aggregation that spans multiple member switches for a ring port

3.1.3 Configuration example

This section provides the examples for configuration setting on devices C1(master node) and FL1 (transit node) shown in Figure 3.1 4 Ring configuration diagram (a single path). For transit nodes FL2 and FL3, apply the same configuration as for device FL1. For all configurations, see Appendix 1.

(1) Configuring the master node (device C1)

Configuration settings for C1		
Disabling the spanning tree		
(config)# spanning-tree disable		Disable the spanning tree because it is not used. (Configuration tips (1))
Configuring the control VLAN and data transfer VLANs		
(config)# vlan 10-13,100		Set VLANs. Control VLAN 100, data transfer VLANs 10-13 (Configuration tips (2))
Configuring VLAN mapping		
(config)# axrp vlan-mapping 1 vlan 10-11 (config)# axrp vlan-mapping 2 vlan 12-13		Set VLANs 10-11 for vlan-mapping1. Set VLANs 12-13 for vlan-mapping2. (Configuration tips (3))
Configuring the ring ports		
When using a single line	**Configuration for ring port ①**	
	(config)# interface tengigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1 (config-if)# axrp-primary-port 1 vlan-group 1	Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1. Set the ring port as the primary port for vlan-group 1 (RING ID=1). (Configuration tips (4)(6))
	Configuration for ring port ②	
	(config)# interface tengigabitethernet 2/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1 (config-if)# axrp-primary-port 1 vlan-group 2	Set control VLAN 100 and data VLANs 10-13. Set a ring port of RING 1. Set the ring port as the primary port for vlan-group 2 (RING ID=1). (Configuration tips (4)(6))
	Configuration for the ring	
	(config)# axrp 1 (config-axrp)# mode master (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# vlan-group 2 vlan-mapping 2 (config-axrp)# health-check interval 500 (config-axrp)# health-check holdtime 1500	Set RING ID to 1. Set the operation mode as master because this node is the master node. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)(6)) Assign vlan-mapping 2 to vlan-group 2. (Configuration tips (3)(6)) Set the HC transmission interval to 500 ms. Set the HC hold time to 1,500 ms. (Configuration tips (5))
When using link aggregation	**Configuration for port channel ①**	
	(config)# interface port-channel 1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1 (config-if)# axrp-primary-port 1 vlan-group 1	Set port channel 1. Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1. Set the ring port as the primary port for vlan-group 1 (RING ID=1). (Configuration tips (4)(6))
	Configuration for port channel ②	
	(config)# interface port-channel 2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1 (config-if)# axrp-primary-port 1 vlan-group 2	Set port channel 2. Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1. Set the ring port as the primary port for vlan-group 2 (RING ID=1). (Configuration tips (4)(6))
	Configuration for ring port ①	
	(config)# interface range tengigabitethernet 1/0/1-2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# channel-group 1 mode on	To use port 1/0/1-2 for LA, specify 1 for the channel group.
	Configuration for ring port ②	

Configuration settings for C1		
	(config)# interface range tengigabitethernet 2/0/1-2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# channel-group 2 mode on	To use port 2/0/1-2 for LA, specify channel group 2.
	Configuration for the ring	
	(config)# axrp 1 (config-axrp)# mode master (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# vlan-group 2 vlan-mapping 2 (config-axrp)# health-check interval 1200 (config-axrp)# health-check holdtime 3600	Set RING ID to 1. Set the operation mode as master because this node is a master node. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)(6)) Assign vlan-mapping 2 to vlan-group 2. (Configuration tips (3)(6)) Set the HC transmission interval to 1200 ms. Set the HC hold time to 3,600 ms. (Configuration tips (5))

(2) Configuring the transit nodes (devices FL1, FL2 and FL3)

Configuration settings for FL1 (same for FL2 and FL3)		
Disabling the spanning tree		
(config)# spanning-tree disable		Disable the spanning tree because it is not used. (Configuration tips (1))
Configuring the control VLAN and data transfer VLANs		
(config)# vlan 10-13,100		Set VLANs. Control VLAN 100, data transfer VLANs 10-13 (Configuration tips (2))
Configuring the ring ports		
When using a single line	**Configuration for ring port ①**	
	(config)# interface gigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
	Configuration for ring port ②	
	(config)# interface gigabitethernet 1/0/3 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
When using link aggregation	**Configuration for port channel ①**	
	(config)# interface port-channel 1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set port channel 1. Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
	Configuration for port channel ②	
	(config)# interface port-channel 2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set port channel 2. Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
	Configuration for ring port ①	
	(config)# interface range gigabitethernet 1/0/1-2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# channel-group 1 mode on	To use port 1/0/1-2 for LA, specify channel group 1.
	Configuration for ring port ②	
	(config)# interface range gigabitethernet 1/0/3-4 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# channel-group 2 mode on	To use port 1/0/3-4 for LA, specify channel group 2.
Configuring VLAN mapping		
(config)# axrp vlan-mapping 1 vlan 10-11 (config)# axrp vlan-mapping 2 vlan 12-13		Assign VLANs 10-11 to vlan-mapping 1. Assign VLANs 12-13 to vlan-mapping 2.

Configuration settings for FL1 (same for FL2 and FL3)	
	(Configuration tips (3)(6))
Setting a ring network	
(config)# axrp 1 (config-axrp)# mode transit (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# vlan-group 2 vlan-mapping 2	Set RING ID to 1. Set the operation mode as transit because this node is a transit node. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)(6)) Assign vlan-mapping 2 to vlan-group 2. (Configuration tips (3)(6))

(3) Configuring the transit node (device SV1)

Configuration settings for SV1		
Disabling the spanning tree		
(config)# spanning-tree disable		Disable the spanning tree because it is not used. (Configuration tips (1))
Configuring the control VLAN and data transfer VLANs		
(config)# vlan 10-13,100		Set VLANs. Control VLAN 100, data transfer VLANs 10-13 (Configuration tips (2))
Configuring the ring ports		
When using a single line	**Configuration for ring port ①**	
	(config)# interface gigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
	Configuration for ring port ②	
	(config)# interface gigabitethernet 2/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
When using link aggregation	**Configuration for port channel ①**	
	(config)# interface port-channel 1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set port channel 1. Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
	Configuration for port channel ②	
	(config)# interface port-channel 2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set port channel 2. Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1.
	Configuration for ring port ①	
	(config)# interface range gigabitethernet 1/0/1-2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# channel-group 1 mode on	To use port 1/0/1-2 for LA, specify channel group 1.
	Configuration for ring port ②	
	(config)# interface range gigabitethernet 2/0/1-2 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# channel-group 2 mode on	To use port 2/0/1-2 for LA, specify channel group 2.
Configuring VLAN mapping		
(config)# axrp vlan-mapping 1 vlan 10-11 (config)# axrp vlan-mapping 2 vlan 12-13		Assign VLANs 10-11 to vlan-mapping 1. Assign VLANs 12-13 to vlan-mapping 2. (Configuration tips (3))
configuring a ring network		

Configuration settings for SV1	
(config)# axrp 1 (config-axrp)# mode transit (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# vlan-group 2 vlan-mapping 2	Set RING ID to 1. Set the operation mode as transit because this node is a transit node. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)(6)) Assign vlan-mapping 2 to vlan-group 2. (Configuration tips (3)(6))

3.2 Multi-ring campus network

You can use the ALAXALA Ring Protocol to form a campus network, in which networks in buildings are interconnected through the local area backbone network. In this case, configure the network system as a combination of multiple rings. This section provides an example of such a network.

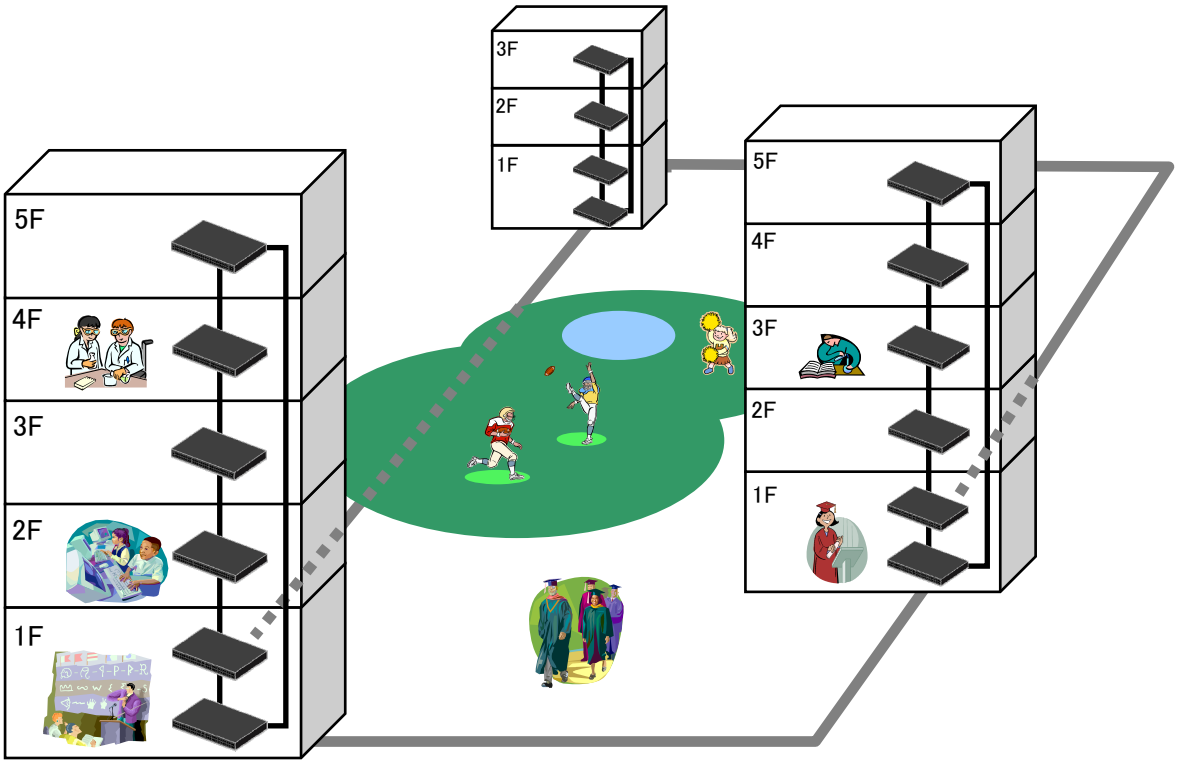


Figure 3.2-1 Image of a campus network

You can use the multi-ring configuration method introduced in 2.1 (2) Multi-ring configuration without shared link or 2.1 (3) Multi-ring configuration with shared link.

The following section introduces a configuration example of the VLAN-shared multi-ring network with shared links.

3.2.1 VLAN-shared multi-ring configuration

The configuration example below shows a multi-ring network, where multiple rings use shared links and common VLANs. This example uses both the shared link monitoring ring and the shared-link non-monitoring ring.

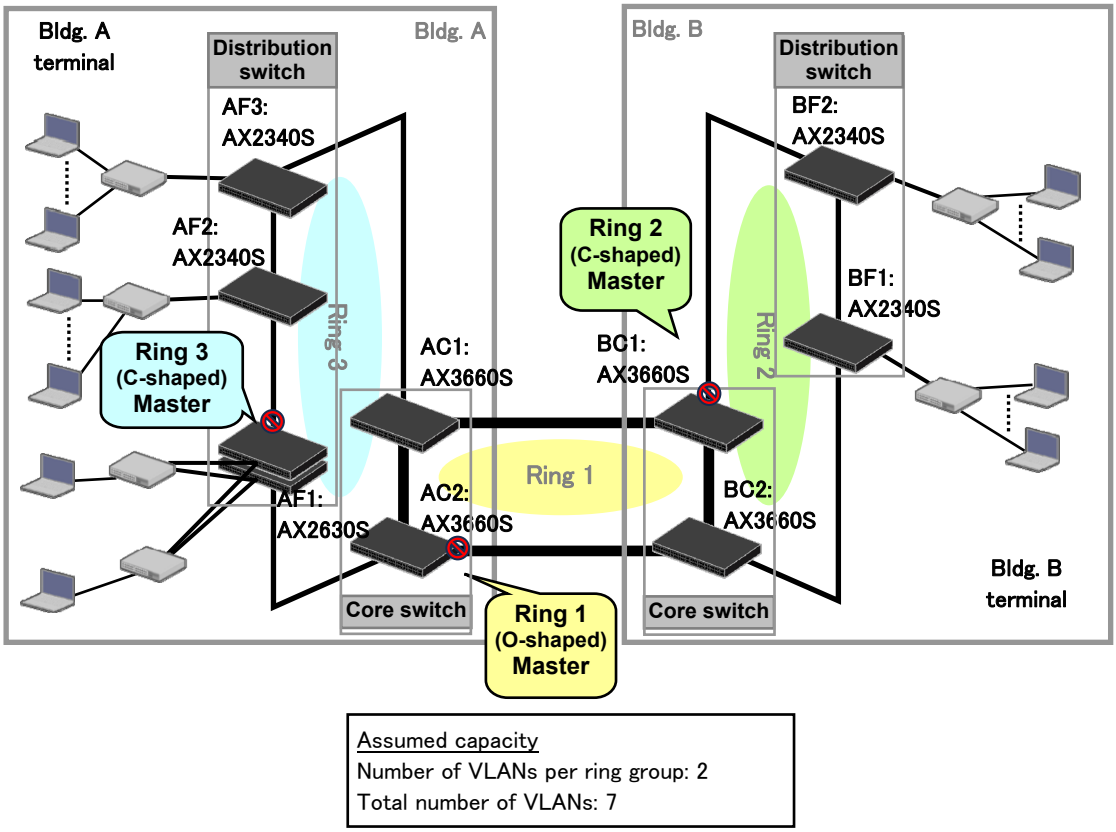
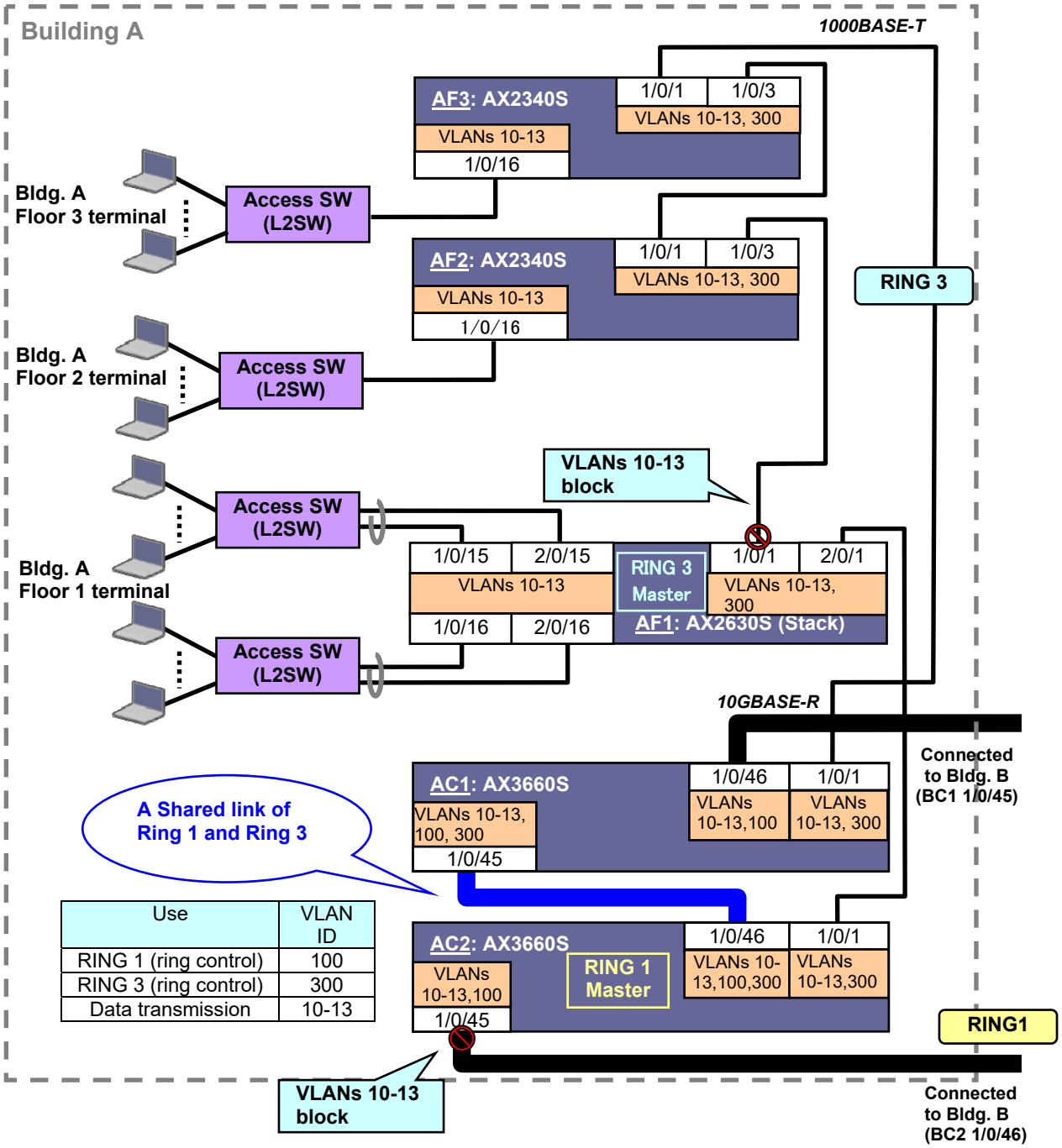


Figure 3.2-2 Multi-ring network using shared VLANs

In each building, AX3660S switches are used as a core switch and AX2630S/AX2340S switches are used as a distribution switch. A backbone ring connects the buildings through the core switches (AX3660S) on each side using 10GBASE-R. This means that the core switches in each building are shared by the backbone ring and the intra-building ring.

Building A logical configuration



Use	VLAN ID
RING 1 (ring control)	100
RING 3 (ring control)	300
Data transmission	10-13

Figure 3.2-3 Network configuration diagram for building A

In Bldg. A, two AX3660S switches (AC1, AC2) are used as a core switch, each connected to AX2630S (AF1) and AX2340S (AF2, AF3) by ring protocol (RING 3). Further, switches AC1 and AC2 are connected to the inter-building network (RING 1), thereby forming a multi-ring network.

In this multi-ring network consisting of RING 1 and RING 3, switches AC1 and AC2 are used as a shared node. RING 1 is a shared link monitoring ring (O-shaped ring), and RING 3 is a shared link non-monitoring ring (C-shaped ring).

Building B logical configuration

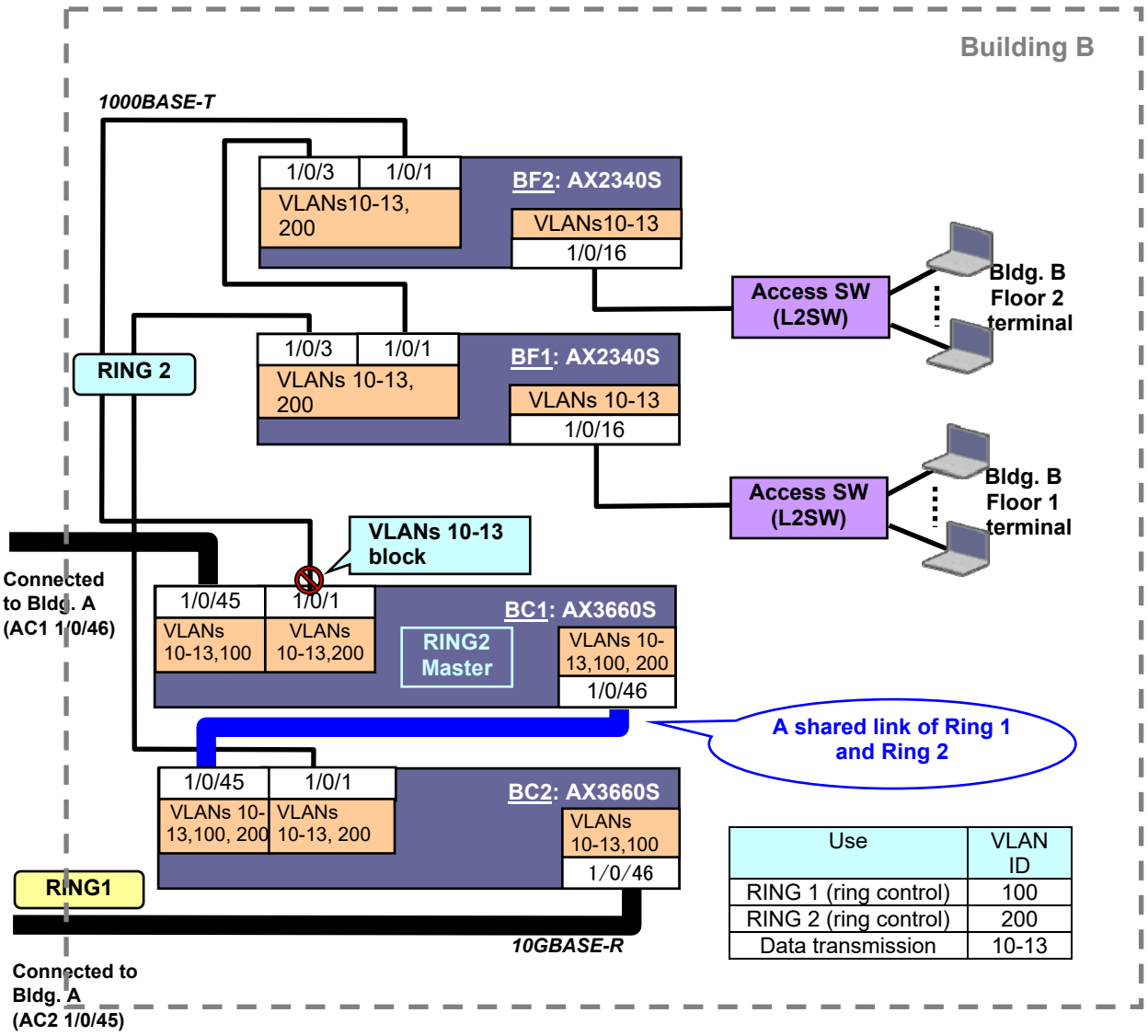


Figure 3.2-4 Network configuration diagram for building B

In Bldg. B, two AX3660S switches (BC1, BC2) are used as a core switch, each connected to AX2340S (BF1, BF2) by ring protocol (RING 2). Further, switches BC1 and BC2 are connected to the inter-building network (RING1).

In this multi-ring network consisting of RING 1 and RING 2, switches BC1 and BC2 are used as a shared node. RING 1 is a shared link monitoring ring (O-shaped ring) and RING 2 is a shared link non-monitoring ring (C-shaped ring).

3.2.2 Configuration tips

(1) Disable the Spanning Tree Protocol (STP).

On the AX series switches, STP runs using PVST+ by default. However, you need to disable STP because this configuration does not use STP.

(2) Use a data transfer VLAN and a control VLAN.

In the Ring Protocol, besides VLANs for general data transmission, one VLAN is used exclusively for controlling the ring topology (called “control VLAN”). One control VLAN is required per ring (per ring ID); that is, a multi-ring topology needs one control VLAN for the shared link monitoring ring (O-shaped ring) and for the shared link non-monitoring ring (C-shaped ring), respectively. Therefore, when you assign VLANs, you need to take the control VLAN into account.

(3) Define data transfer VLANs in VLAN mapping.

Define data transfer VLANs used for the Ring Protocol in VLAN mapping.

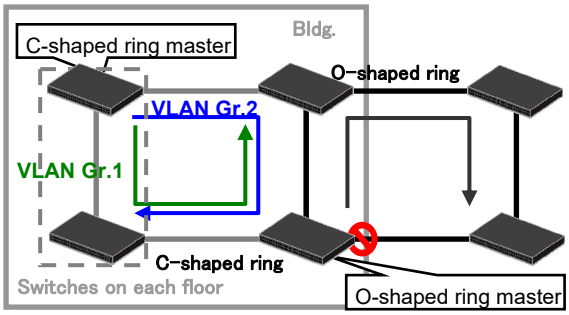
In a VLAN-shared multi-ring network, you must configure multiple rings that use common data transfer VLANs. However, you can simplify configuration setting by VLAN mapping (no need to specify the same VLAN setting one-by-one for each ring), which helps prevent a loop that might occur due to configuration errors or other trouble.

(4) If a shared node is a master, its shared-link port must always be a primary port.

In a ring network consisting of the shared link monitoring ring (O-shaped ring) and the shared link non-monitoring link (C-shaped ring), if the device at the end of the shared link is a master node, its shared link port (a port on the shared link side) must always be a primary port regardless of whether the node belongs to the shared link monitoring ring or to the shared link non-monitoring ring. This means that achieving load balancing by creating multiple VLANs each using a different primary port is not possible.

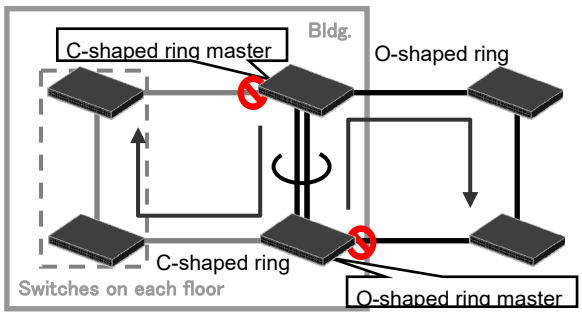
If you want to achieve load balancing, use the following methods.

・Configure a ring network in which a shared node is not used as a master, so that you can change the primary port per VLAN group.



You can load balance the network traffic by aggregating intra-building VLANs as VLAN Gr.1 and inter-building VLANs as VLAN Gr.2.

・To handle increasing network traffic on the shared link, use a load balancing method such as link aggregation (aggregating multiple shared links) to enhance the shared link’s bandwidth.



You can enhance the shared link’s bandwidth by link aggregation or by using a cable of one level higher category (e.g., 1Gbps for a 100Mbps ring, 10Gbps for a 1Gbps ring).

(5) Pay attention to the mode and parameters when you use link aggregation.

When you use link aggregation on the port specified as a ring port, note the following.

(a) Using the static mode is recommended for link aggregation.

There are two link aggregation modes, LACP and static. We recommend that you use the static mode, based on the following reasons:

- Requires less fallback time.
  (In general, compared to the LACP mode, which detects a line failure by monitoring unreachable LACPDUs, the static mode requires less link-down time during failover/failback because the static mode directly monitors the link state to detect a failure. This difference also affects the switching time of the Ring Protocol (for details, see (b)).
- In a local area network, most devices are directly connected each other.
  (If devices are directly connected each other, you can detect a line failure by simply checking the link-down state on the devices).

Also, set the link debounce time for Ethernet ports to the smallest possible value if there is no problem (with line quality, for example). Note that links will be unstable if you set less than 2,000 milliseconds (a value automatically given when the link debounce time setting is omitted) for the following interfaces: 10BASE-T, 100BASE-TX, 1000BASE-T, 2.5GBASE-T, 10GBASE-T, 10GBASE-CU, 40GBASE-CR4, and 100GBASE-CR4.

(b) The parameters for the ring must be larger than the fallback/switching time for link aggregation.

If the failure monitoring time for the master node is shorter than the time to complete the fallback or switching operation through link aggregation, the master node mistakenly detects a ring failure and performs path switching in the ring. As a result, a loop might occur.
More specifically, for the health-check hold time in Ring Protocol setting, at least the following two criteria must be satisfied:

i) health-check holdtime > health-check interval
ii) health-check holdtime > link debounce time + 1200 (for SFP ports)
health-check holdtime > link debounce time + 1500 (for UTP ports)

(6) Pay attention to the functional restriction when you use the switch in stack mode.

Some functions are not available when the stack function is used with the Ring Protocol. Note the following restrictions when using the switch in stack mode:

(a) If a ring network contains stack member switches, the following functions are not available.

- Spanning tree protocol
- GSRP (GSRP is supported by AX3660S only)
- Virtual link

(b) The following settings are not supported by stack nodes.

- Setting a shared node
- Setting two ring ports for the same stack member switch by using one ring ID
- Setting a link aggregation that spans multiple member switches for a ring port

3.2.3 Configuration example

This section provides the examples for configuration setting on devices AC1, AC2, AF1, AF2 and AF3 shown in Figure 3.2 3 Network configuration diagram for building A, and devices BC1, BC2, BF1 and BF2 shown in Figure 3.2 4 Network configuration diagram for building B. For all configurations, see Appendix 1.

(1) Configuring the core node of Bldg. A (device AC1: AX3660S)

Configuration settings for AC1 （running as a shared node of the backbone ring and Bldg. A ring, and as a master node of Bldg. A ring）	
Disabling the spanning tree	
(config)# spanning-tree disable	Disable the spanning tree. (Configuration tips (1))
Configuring the control VLANs and data transfer VLANs	
(config)# vlan 10-13,100,300	Set VLANs. Control VLANs: 100, 300 Data transfer VLANs: 10-13 (Configuration tips (2))
Configuring the ring ports	
Ports on the shared link of Ring 1 and Ring 3	
(config)# interface tengigabitethernet 1/0/45 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100,300 (config-if)# axrp-ring-port 1 (config-if)# axrp-ring-port 3 shared-edge	Set the link debounce time to 0. (Configuration tips (5)) Set control VLANs 100 and 300, and data transfer VLANs 10-13. Set a ring port of RING 1 (RING ID=1). Set a ring port of RING 3 (RING ID=3) as a shared link port.
Ports of Ring 1 (backbone ring)	
(config)# interface tengigabitethernet 1/0/46 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set the link debounce time to 0. (Configuration tips (5)) Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of RING 1 (RING ID=1).
Ports of Ring 3 (intra-building subring)	
(config)# interface tengigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,300 (config-if)# axrp-ring-port 3	Set VLAN 300 and data transfer VLANs 10-13. Set a ring port of RING 3.
Configuring VLAN mapping	
(config)# axrp vlan-mapping 1 vlan 10-13	Set VLANs 10-13 for vlan-mapping1 of the ring. (Configuration tips (3))
Configuring the ring	
(config)# axrp 1 (config-axrp)# mode transit (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config)# axrp 3 (config-axrp)# mode transit ring-attribute rift-ring-edge 1 (config-axrp)# control-vlan 300 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# health-check interval 500	Set RING ID to 1 (Ring 1). Set a transit node of the shared link monitoring ring. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set RING ID to 3 (Ring 3). Set a transit node of the shared link non-monitoring ring (this is also a shared node). Set VLAN 300 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set the HC transmission interval to 500 ms. (Configuration tips (5))

(2) Configuring the core node of Bldg. A (device AC2: AX3660S)

Configuration settings for AC2 （running as a shared node of the backbone ring and Bldg. A ring, and as a backbone ring master）	
Disabling the spanning tree	
(config)# spanning-tree disable	Disable the spanning tree. (Configuration tips (1))
Configuring the control VLANs and data transfer VLANs	
(config)# vlan 10-13,100,300	Set VLANs. Control VLANs: 100, 300 Data transfer VLANs: 10-13 (Configuration tips (2))
Configuring the ring ports	
Ports of the backbone ring (Ring 1)	
(config)# interface tengigabitethernet 1/0/45 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set the link debounce time to 0. (Configuration tips (5)) Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of Ring 1 (RING ID=1).
Ports of the shared link of Ring 1 and Ring 3	
(config)# interface tengigabitethernet 1/0/46 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100,300 (config-if)# axrp-ring-port 1 (config-if)# axrp-ring-port 3 shared-edge	Set the link debounce time to 0. (Configuration tips (5)) Set control VLANs 100 and 300, and data transfer VLANs10-13. Set a ring port of Ring 1 (RING ID=1). Set a ring port of Ring 3 (RING ID=3) as a shared link port.
Ports of Ring 3 (intra-building subring)	
(config)# interface tengigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,300 (config-if)# axrp-ring-port 3	Set control VLAN 300 and data transfer VLANs 10-13. Set a ring port of Ring 3 (RING ID=3).
Configuring VLAN mapping	
(config)# axrp vlan-mapping 1 vlan 10-13	Set VLANs 10-13 for vlan-mapping1 of the ring. (Configuration tips (3))
Configuring the ring	
(config)# axrp 1 (config-axrp)# mode master (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# health-check interval 500 (config-axrp)# health-check holdtime 1500 (config)# axrp 3 (config-axrp)# mode transit ring-attribute rift-ring-edge 2 (config-axrp)# control-vlan 300 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# health-check interval 500	Set RING ID to 1 (Ring 1). Set a master node of the shared link monitoring ring. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set the HC transmission interval to 500 ms. Set the HC hold time to 1,500 ms. Set RING ID to 3 (Ring 3). Set a transit node of the shared link non-monitoring ring (also, set this node as a shared node). Set VLAN 300 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set the HC transmission interval to 500 ms. (Configuration tips (5))

(3) Configuring the distribution node of Bldg. A (device AF1: AX2630S)

Configuration settings for AF1（a server farm node in Bldg. A）	
Disabling the spanning tree	
(config)# spanning-tree disable	Disable the spanning tree. (Configuration tips (1))
Configuring the control VLAN and data transfer VLANs	
(config)# vlan 10-13,300	Set VLANs. Control VLAN: 300 Data transfer VLANs: 10-13 (Configuration tips (2))
Configuring the ring ports	
Configuration for ring port ①	
(config)# interface gigabitethernet 2/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,300 (config-if)# axrp-ring-port 3 (config-if)# axrp-primary-port 3 vlan-group 1	Set control VLAN 300 and data transfer VLANs 10-13. Set a primary port of VLAN group 1 for Ring 3 (RING ID=3).
Configuration for ring port ②	
(config)# interface gigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,300 (config-if)# axrp-ring-port 3	Set control VLAN 300 and data transfer VLANs 10-13. Set a ring port of Ring 3 (RING ID=3).
Configuring VLAN mapping	
(config)# axrp vlan-mapping 1 vlan 10-13	Set VLANs 10-13 for vlan-mapping1. (Configuration tips (3))
Configuring the ring	
(config)# axrp 3 (config-axrp)# mode master ring-attribute rift-ring (config-axrp)# control-vlan 300 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# health-check interval 500 (config-axrp)# health-check holdtime 1500	Set RING ID to 3 (Ring 3). Set a master node. Set VLAN 300 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set the HC transmission interval to 500 ms. Set the HC hold time to 1,500 ms. (Configuration tips (5))

(4) Configuring the distribution node of Bldg. A (device AF2: AX2340S)

Configuration settings for AF2（a ring node of Bldg. A）	
Disabling the spanning tree	
(config)# spanning-tree disable	Disable the spanning tree. (Configuration point (1))
Configuring the control VLAN and data transfer VLANs	
(config)# vlan 10-13,300	Set VLANs. Control VLAN: 300 Data transfer VLANs: 10-13 (Configuration tips (2))
Configuring the ring ports	
Configuration for ring port ①	
(config)# interface gigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,300 (config-if)# axrp-ring-port 3	Set control VLAN 300 and data transfer VLANs 10-13. Set a ring port of Ring 3 (RING ID=3).
Configuration for ring port ②	
(config)# interface gigabitethernet 1/0/3 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,300 (config-if)# axrp-ring-port 3	Set control VLAN 300 and data transfer VLANs 10-13. Set a ring port of Ring 3 (RING ID=3).
Configuring VLAN mapping	
(config)# axrp vlan-mapping 1 vlan 10-13	Set VLANs 10-13 for vlan-mapping 1. (Configuration tips (3))
Configuring the ring	
(config)# axrp 3 (config-axrp)# mode transit (config-axrp)# control-vlan 300 (config-axrp)# vlan-group 1 vlan-mapping 1	Set RING ID to 3 (Ring 3). Set a transit node. Set VLAN 300 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3))

(5) Configuring the distribution node of Bldg. A (device AF3: AX2340S)

Same configuration as (4).

(6) Configuring the core node of Bldg. B (device BC1: AX3660S)

Configuration settings for BC1 （running as a shared node of the backbone ring and Bldg. B ring, and as a master node of Bldg. B ring）	
Disabling the spanning tree	
(config)# spanning-tree disable	Disable the spanning tree. (Configuration tips (1))
Configuring the control VLANs and data transfer VLANs	
(config)# vlan 10-13,100,200	Set VLANs. Control VLANs: 100, 200 Data transfer VLANs: 10-13 (Configuration tips (2))
Configuring the ring ports	
Ports of the backbone ring (Ring 1)	
(config)# interface tengigabitethernet 1/0/45 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set the link debounce time to 0. (Configuration tips (5)) Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of Ring 1 (RING ID=1).
Ports of the shared link of Ring 1 and Ring 2	
(config)# interface tengigabitethernet 1/0/46 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100,200 (config-if)# axrp-ring-port 1 (config-if)# axrp-ring-port 2 shared-edge	Set the link debounce time to 0. (Configuration tips (5)) Set control VLANs 100 and 200, data transfer VLANs 10-13. Set a ring port of Ring 1 (RING ID=1). Set a ring port of Ring 2 (RING ID=2) as a shared link port.
Ports of Ring 2 (intra-building subring)	
(config)# interface tengigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,200 (config-if)# axrp-ring-port 2	Set control VLAN 200 and data transfer VLANs 10-13. Set a ring port of Ring 2 (RING ID=2).
Configuring VLAN mapping	
(config)# axrp vlan-mapping 1 vlan 10-13	Set VLANs 10-13 for vlan-mapping1. (Configuration tips (3))
Configuring the ring	
(config)# axrp 1 (config-axrp)# mode transit (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config)# axrp 2 (config-axrp)# mode master ring-attribute rift-ring-edge 1 (config-axrp)# control-vlan 200 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# health-check interval 500 (config-axrp)# health-check holdtime 1500	Set RING ID to 1 (Ring 1). Set a transit node of the shared link monitoring ring. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set RING ID to 2 (Ring 2). Set a master node of the shared link non-monitoring ring (also, set this node as a shared node). Set VLAN 200 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set the HC transmission interval to 500 ms. Set the HC hold time to 1,500 ms.

(7) Configuring the core node of Bldg. B (device BC2: AX3660S)

Configuration settings for BC2 （a shared node of the backbone ring and Bldg. B ring）	
Disabling the spanning tree	
(config)# spanning-tree disable	Disable the spanning tree. (Configuration tips (1))
Configuring the control VLANs and data transfer VLANs	
(config)# vlan 10-13,100,200	Set VLANs. Control VLANs: 100, 200 Data transfer VLANs: 10-13 (Configuration tips (2))
Configuring the ring ports	
Ports of the shared link of Ring 1 and Ring 2	
(config)# interface tengigabitethernet 1/0/45 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100,200 (config-if)# axrp-ring-port 1 (config-if)# axrp-ring-port 2 shared-edge	Set the link debounce time to 0. (Configuration tips (5)) Set control VLANs 100 and 200 and data transfer VLANs 10-13. Set a ring port of Ring 1 (RING ID=1). Set a ring port of Ring 2 (RING ID=2) as a shared link port.
Ports of the backbone ring (Ring 1)	
(config)# interface tengigabitethernet 1/0/46 (config-if)# link debounce time 0 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,100 (config-if)# axrp-ring-port 1	Set the link debounce time to 0. (Configuration tips (5)) Set control VLAN 100 and data transfer VLANs 10-13. Set a ring port of Ring 1 (RING ID=1).
Ports of Ring 2 (intra-building subring)	
(config)# interface tengigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,200 (config-if)# axrp-ring-port 2	Set control VLAN 200 and data transfer VLANs 10-13. Set a ring port of Ring 2 (RING ID=2).
Configuring VLAN mapping	
(config)# axrp vlan-mapping 1 vlan 10-13	Set VLANs 10-13 for vlan-mapping1. (Configuration tips (3))
Configuring the ring	
(config)# axrp 1 (config-axrp)# mode transit (config-axrp)# control-vlan 100 (config-axrp)# vlan-group 1 vlan-mapping 1 (config)# axrp 2 (config-axrp)# mode transit ring-attribute rift-ring-edge 2 (config-axrp)# control-vlan 200 (config-axrp)# vlan-group 1 vlan-mapping 1 (config-axrp)# health-check interval 500	Set RING ID to 1 (Ring 1). Set a transit node of the shared link monitoring ring. Set VLAN 100 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set RING ID to 2 (Ring 2). Set a transit node of the shared link non-monitoring ring (also, set this node as a shared node). Set VLAN 200 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3)) Set the HC transmission interval to 500 ms.

(8) Configuring the distribution node of Bldg. B (device BF1: AX2340S)

Configuration settings for BF1（a ring node of Bldg. B）	
Disabling the spanning tree	
(config)# spanning-tree disable	Disable the spanning tree. (Configuration tips (1))
Configuring the control VLAN and data transfer VLANs	
(config)# vlan 10-13,200	Set VLANs. Control VLAN: 200 Data transfer VLANs: 10-13 (Configuration tips (2))
Configuring the ring ports	
Configuration for ring port ①	
(config)# interface gigabitethernet 1/0/1 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,200 (config-if)# axrp-ring-port 2	Set control VLAN 200 and data transfer VLANs 10-13. Set a ring port of Ring 2 (RING ID=2).
Configuration for ring port ②	
(config)# interface gigabitethernet 1/0/3 (config-if)# switchport mode trunk (config-if)# switchport trunk allowed vlan 10-13,200 (config-if)# axrp-ring-port 2	Set control VLAN 200 and data transfer VLANs 10-13. Set a ring port of Ring 2 (RING ID=2).
Configuring VLAN mapping	
(config)# axrp vlan-mapping 1 vlan 10-13	Set VLANs 10-13 for vlan-mapping1. (Configuration tips (3))
Configuring the ring	
(config)# axrp 2 (config-axrp)# mode transit (config-axrp)# control-vlan 200 (config-axrp)# vlan-group 1 vlan-mapping 1	Set RING ID to 2 (Ring 2). Set a transit node. Set VLAN 200 as a control VLAN. Assign vlan-mapping 1 to vlan-group 1. (Configuration tips (3))

(9) Configuring the distribution node of Bldg. B (device BF2: AX2340S)

Same as (8).

3.3 Other configuration variations

This section provides other possible configurations using the Ring Protocol.

(1) Access switch redundancy in a building network (multi-ring application ①)

If you use AX3660S as a backbone switch, you can also configure a redundant access network by ring topology using AX2630S/AX2340S as an access switch. As shown below, you can realize a redundant network by configuring multiple rings using a backbone ring.

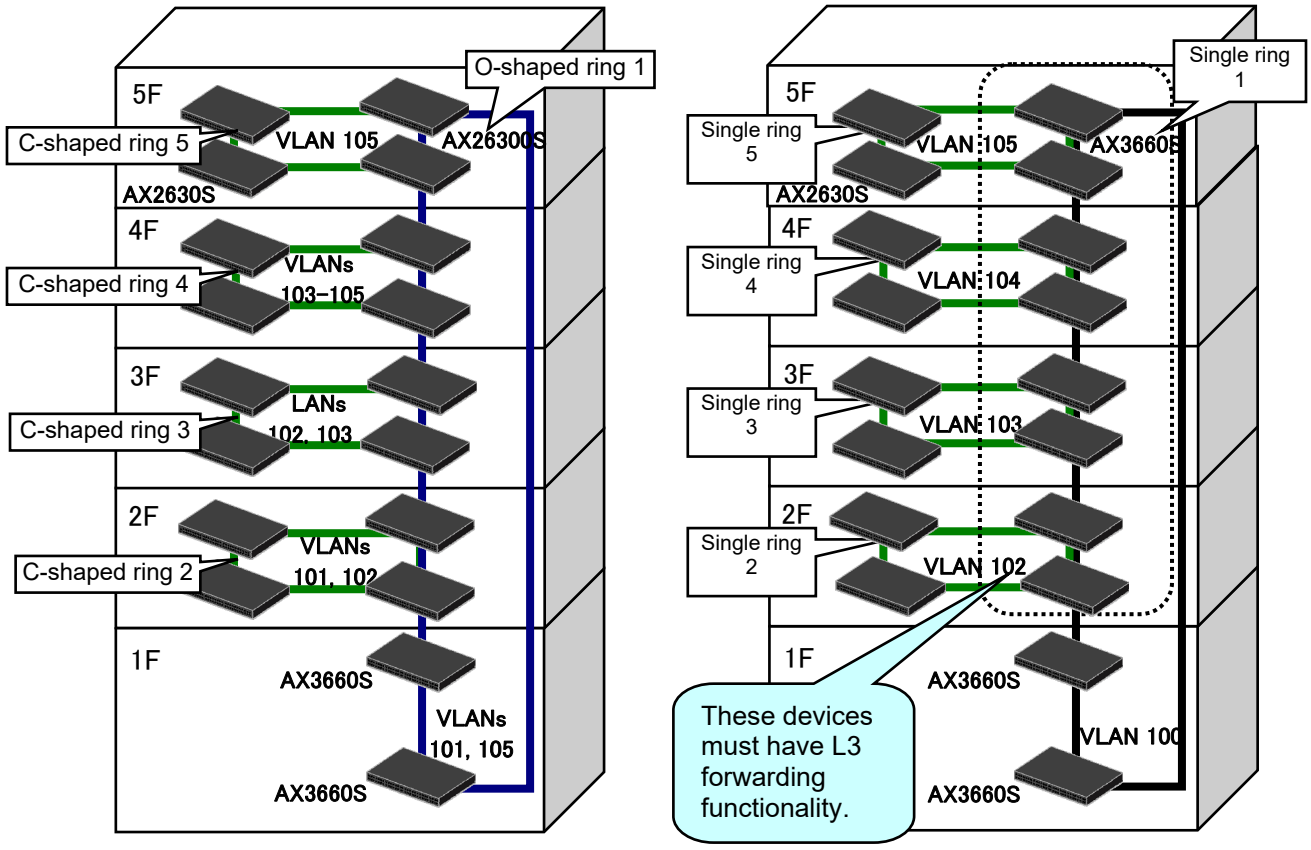
You can configure a multi-ring network in either of the following methods according to the VLAN type you use. For details see Section 2.1.

(a) Multi-ring configuration with shared VLAN

Rings can share and use the same VLAN, but to transfer data between VLANs, data is first forwarded to a switch that has the Layer 3 forwarding functionality. In the example figure below, for communication between floors 4 and 5, data travels to the switch on floor 1.

(b) Multi-ring configuration with exclusive VLAN

Rings must use a separate and different VLAN, and switches at the boundaries between the rings must support Layer 3 forwarding (for example, AX3660S series). However, Layer 2 networks can be localized within each floor, and data is forwarded through Layer 3 over the shortest path in the backbone ring. In the example figure below, for communication between floors 4 and 5, data is passed only between the switches on floors 4 and 5.



(a) Multi-ring configuration with shared VLAN (b) Multi-ring configuration with exclusive VLAN

Figure 3.3-1 Access switch redundancy using multi-ring configuration

(2) Large building network (multi-ring application ②)

The number of nodes in a ring is theoretically unlimited regardless of their device types (AX3660S, AX2630S, AX2340S). Therefore, you can basically increase the number of ring nodes according to the number of floors. However, you can configure a multi-ring network and have multiple network segments by using a combination of rings and VLANs if you want to satisfy the following requirements.

<Requirements>

- For management and security, want to prevent data leak to other departments/floors.
- Want to contain the impact of a failure in a limited network segment.
- Want to reserve device capacity for additional address usage and network traffic.

The following figure shows examples of multi-ring network for large buildings.

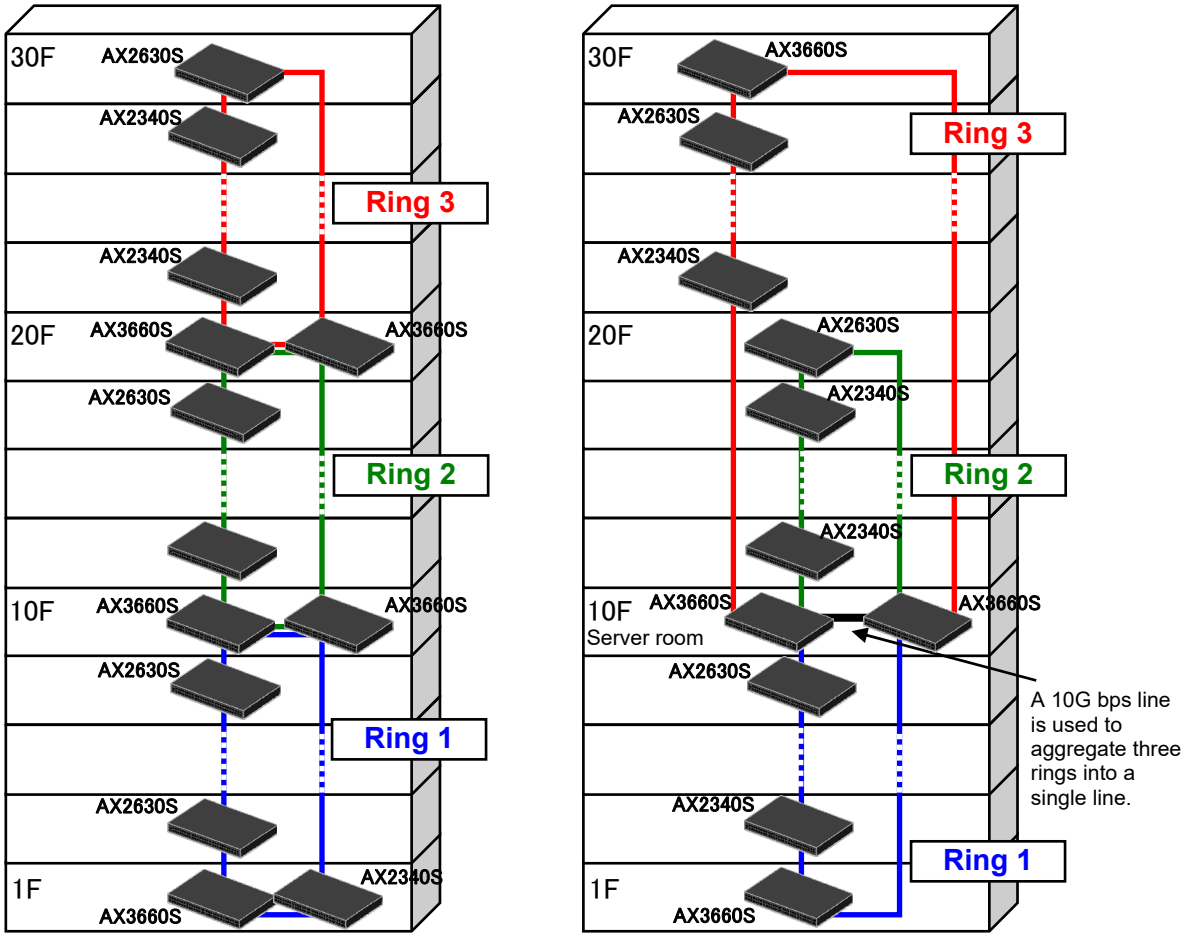


Figure 3.3-2 Example of a ring network applied to large buildings

To configure a multi-ring network for large buildings, use either of the following two configurations, based on how to use VLANs (see Section 2.1) depending on the scale or requirements of your network.

(a) Multi-ring configuration with shared VLAN

Different rings can use the same VLAN. This configuration is suitable when you manage multiple floors as a time.

(b) Multi-ring configuration with exclusive VLAN

Layer 3 forwarding is used to forward frames between rings. This configuration can localize traffic within individual rings and is suitable for the following cases: constructing a large floor network, handling high volume data traffic within a floor, and dividing your network into multiple segments for security reasons.

4. Restrictions and Considerations

4.1 Prohibited ring configurations

(1) Having multiple master nodes in a ring

If one ring has multiple master nodes (Figure 4.1-1), communication might be blocked or a failure might not be detected properly depending on the positions of the logically blocked secondary ports of the master nodes,

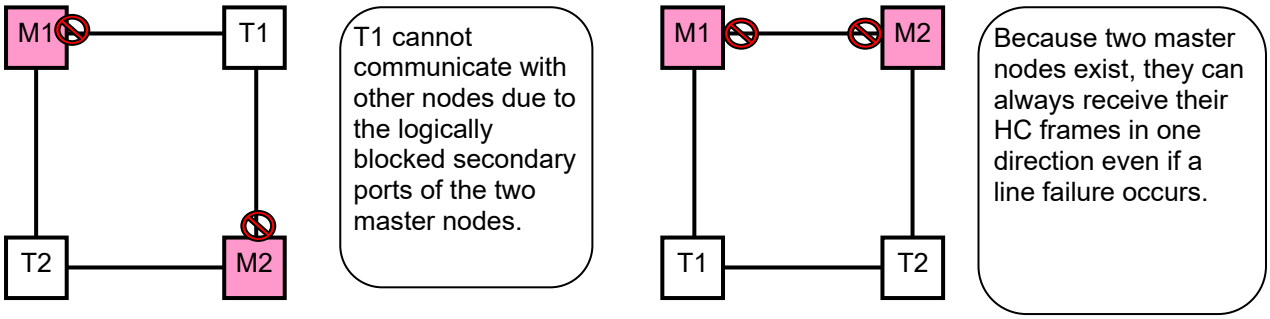
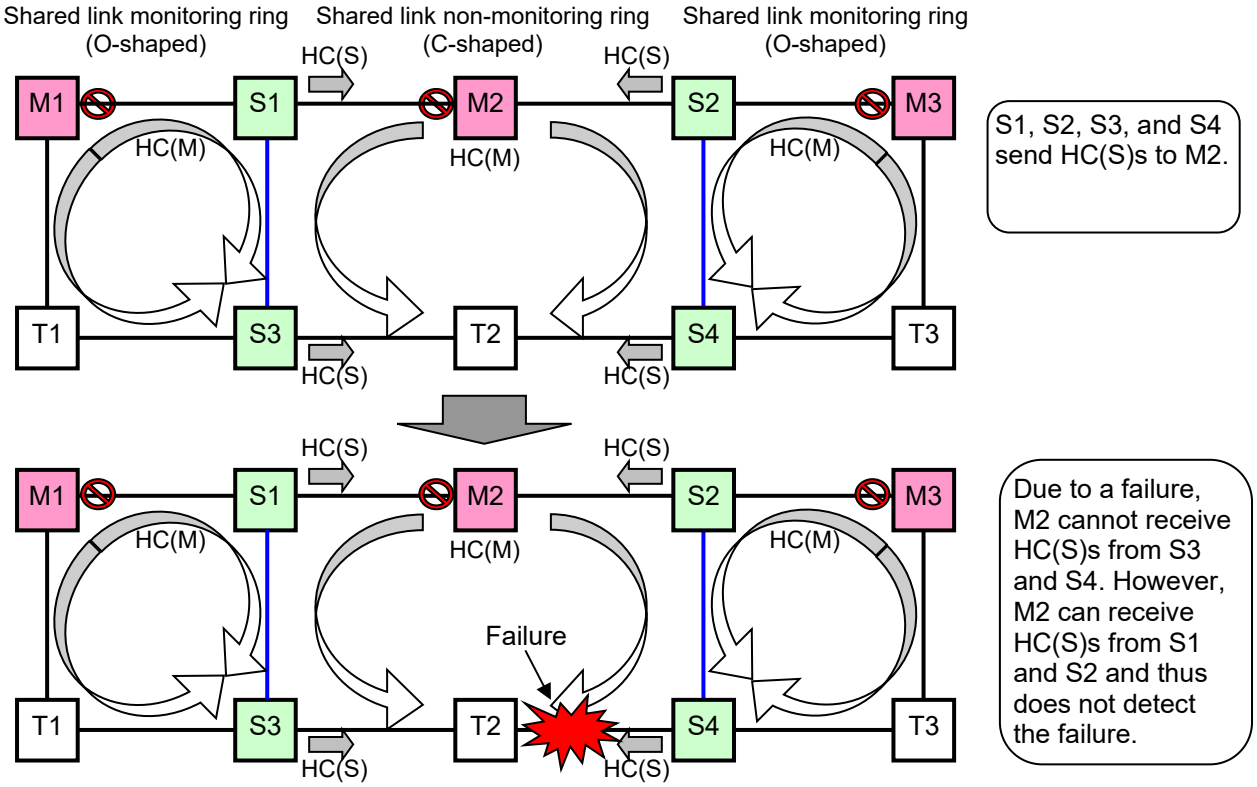


Figure 4.1-1 Configuration with multiple master nodes in a ring

(2) Having multiple shared link monitoring rings in a multi-ring configuration

A multi-ring configuration must have only one shared link monitoring ring (O-shaped ring). Otherwise, a ring failure might not be detected properly as shown in Figure 4.1-2.



M1 - M3: Ring master node, T1 - T3: Ring transit node, S1 - S4: Ring shared node

Figure 4.1-2 Configuration with multiple shared link monitoring rings

(3) Using the master node of the shared link non-monitoring ring as a shared link node

When you configure a shared link consisting of three or more nodes, do not use the shared link non-monitoring master node as a shared link node.

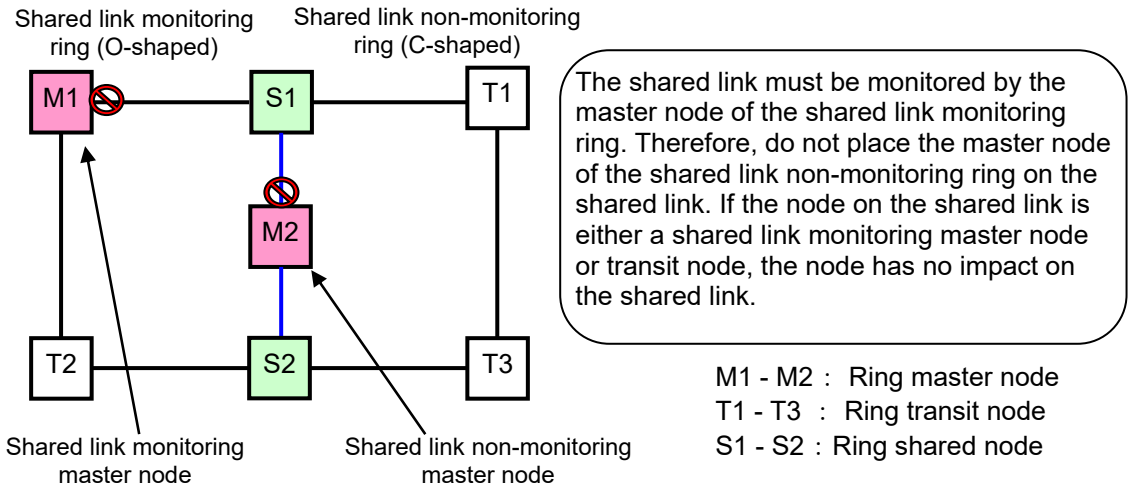


Figure 4.1-3 Shared link having multiple nodes

(4) Ring configuration with a loop

Do not configure a multi-ring network in a way that causes a loop.

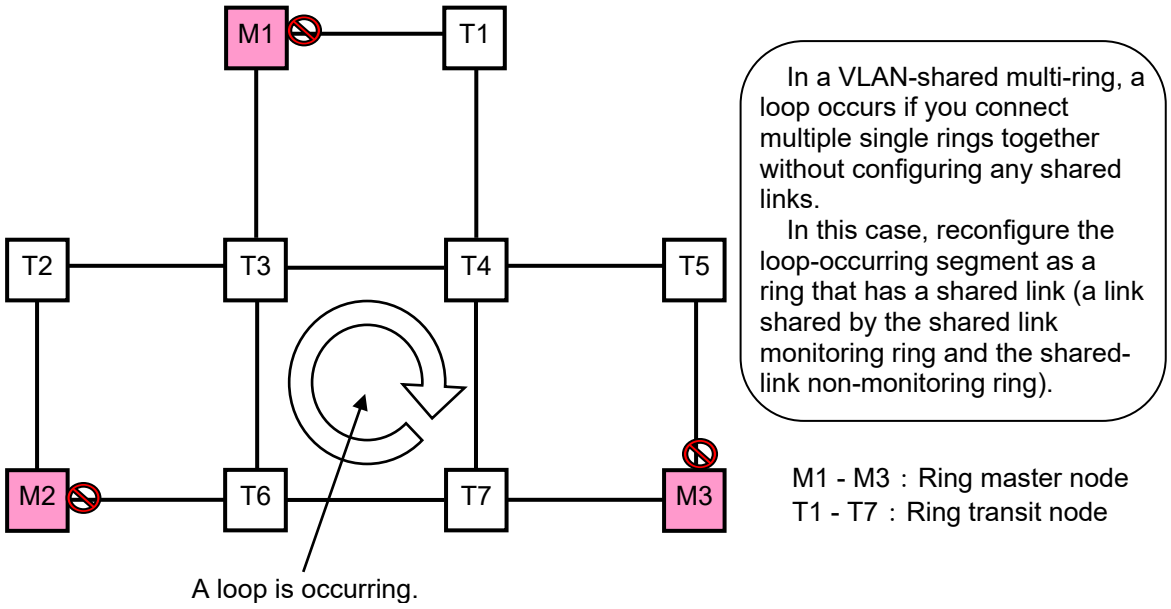


Figure 4.1-4 Ring configuration having a loop

4.2 Notes

When you use the Ring Protocol, reference the related information in the following manuals.

AX3660S Configuration Guide vol.1	28.8 Notes on using Ring Protocol
AX2630S Configuration Guide vol.1	29.8 Notes on using Ring Protocol
AX2340S Configuration Guide vol.1	27.7 Notes on using Ring Protocol

5. Parameters

5.1 Parameter descriptions

You can specify the following parameters when you configure a ring network.

(1) health-check interval

Only for AX3660S and AX2630S.

This parameter specifies the interval for sending health-check frames from the master node or from the terminal shared node of the shared link non-monitoring ring.

200 to 60,000 ms （default：1,000 ms）

Note that for AX3660S, if you use the L3 advanced software license, you will be able to specify the minimum interval value of 5 ms except when the switch is in stack mode. When you set 50 ms or less value, see the following configuration guide for details.

AX3660S Software Manual Ver.12.1 Configuration Guide Vol.1
- 28.7.13 Route switching at 50 milliseconds [SL-L3A]

(2) health-check holdtime

Only for AX3660S and AX2630S.

This parameter specifies the hold time, a time until the master node determines that a failure has occurred after the master node receives the last health-check frame of its own or the one sent from the terminal shared node of the shared link non-monitoring ring.

500 to 300,000 ms （default：3,000 ms）

Also, setting this parameter to a smaller value (that is, closer to the value of the health-check interval) allows you to detect a ring failure earlier. However, setting it to a value less than twice the health-check interval might result in false failure detection if a health-check frame is discarded on the way for some reason. (Recommended value: health-check hold time >= health-check interval x 3).

Note that for AX3660S, if you use the L3 advanced software license, you will be able to specify the minimum interval value of 15 ms except when the switch is in stack mode. When you set 50 ms or less value, see the following configuration guide for details.

AX3660S Software Manual Ver.12.1 Configuration Guide Vol.1
- 28.7.13 Route switching at 50 milliseconds [SL-L3A]」

(3) forwarding-shift-time

This parameter specifies the reception hold time for flush control frames in a transit node. After this time elapses, the transit node clears the MAC address table for ring ports and changes its port status from BLK to FWD even if it does not receive a flush control frame.

1 to 65,535 sec or infinity (default: 10 sec).

When you specify this parameter, you need to set a larger value than the health-check interval set for the master node. Otherwise, a loop might occur because the transit node at both ends of the failed link changes the status of its blocked ring port to FWD during failure recovery operation before the master node changes the status of its open ring port to BLK.
(forwarding-shift-time >> health-check interval).

(4) flush-request-count

Only for AX3660S and AX2630S.

This parameter specifies the number of times the master node sends a flush control frame. The flush control frame prompts the transit nodes in a ring to clear their MAC address tables during failover or failback operation.

1 to 10 (default: 3 times).

If a flush control frame is discarded on the way before it reaches a transit node, the MAC address table of the transit node might not be cleared. A flush control frame must be sent several times.

(5) link debounce

This parameter specifies the link-down detection time, a time until a link-down event occurs after a link failure is detected.

0 to 10,000 ms (default：2,000 ms)

When you configure LA on a ring port, you can change the time interval until a link failure is detected by adjusting the link debounce value. Therefore, when you configure LA on a ring port, you need to set an appropriate health-check holdtime value by considering the link debounce time value and the fallback time of LA. If the health-check holdtime value is small, the Ring Protocol might erroneously detect a failure even on an aggregated link in fallback state.

For the following interfaces, a link might be unstable if you set 2,000 ms (default value) or less for the link debounce time.

- 10BASE-T, 100BASE-TX, 1000BASE-T, 2.5GBASE-T, 10GBASE-T, 10GBASE-CU, 40GBASE-CR4, 100GBASE-CR4

6. Operation Management

This chapter describes operation management, including operation commands used when you build a network with the Ring Protocol and how to isolate a faulty part of a network.

6.1 Operation command

You can use the following operation commands for the Ring Protocol:

- `show axrp`
  Shows statistics such as the ring status and ring port status.
- `clear axrp`
  Clears ring statistics.
  Only for AX3660S and AX2630S.
- `restart axrp`
  Restarts the Ring Protocol.

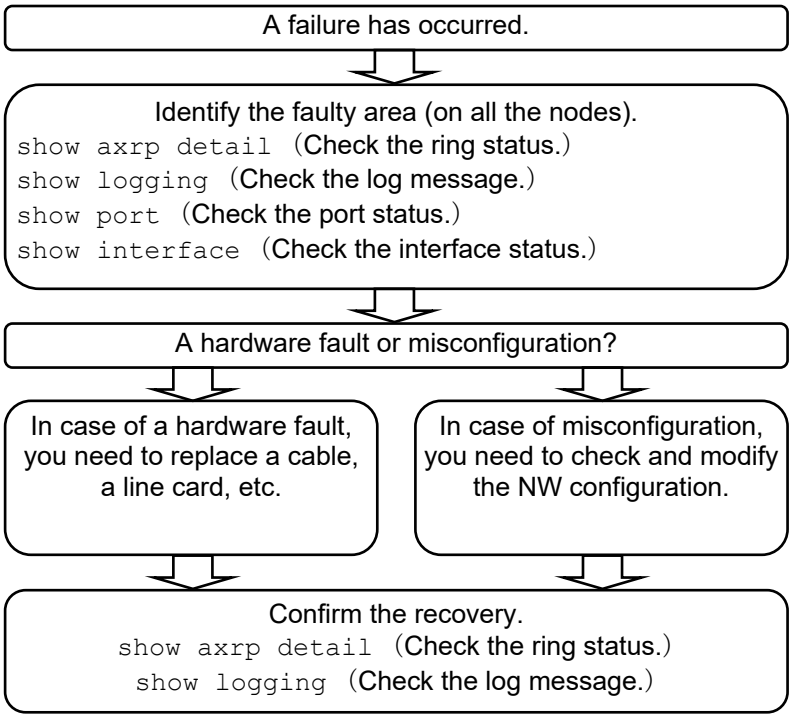
The following operation commands are also used frequently.

- `show running-config`
  Shows the running configuration.
- `show logging`
  Shows the log entries recorded by a device.
- `show port`
  Shows the port status and statistics.
- `show interfaces`
  Shows the interface status and statistics.
- `show vlan`
  Shows the VLAN status and statistics.
- `show channel-group statistics`
  Shows link aggregation statistics.

For details on the above and other operation commands, see the manual *Operation Command Reference*.

6.2 Isolating a faulty part of a ring network

If a failure occurs in the Ring Protocol, a log message appears, indicating that a failure has occurred and a failover operation has started. Another log message appears after the failure is resolved, indicating that the failback operation has started. You can also obtain master node's monitoring status as MIB information and use a trap to check failover/failback operation.



＜Status check by `show axrp detail`＞

You can execute this command on a node to check the status of the primary and secondary ports for the ring ID to which the node belongs. You can also execute the command on the master node to check various ring settings.

When path switching has occurred in a ring following a failure, the Fault Counts value of the master node is incremented. This indicates that the master node detected the failure and switched the path by failover operation. When the ring has recovered from the failure, the Recovery Counts value is also incremented. If the status is changed, the date and time of the last status change is also displayed.

＜Status check by `show logging`＞

This command shows a variety of events including ring failures. When a ring fails and then recovers, the master node displays an event indicating the start of failover operation and then the start of failback operation. On the other hand, transit nodes receive flush control frames and display an event indicating that they have cleared their MAC address tables.

When other events occur, they are all logged. So, if you run this command on all the nodes, you can determine which device has a failure.

Appendix : Sample Configuration Files

Shown below is a list of sample configuration files for the devices used in the network configuration diagrams in Chapter 3. They are provided in text files. (To see these files, you need Adobe Acrobat 5.0 or later or Adobe Reader 6.0 or later.)

3.1 Single ring for a building network

3.1.1 System configuration based on Layer 2

	Device name	File name
(1) Ring configuration with a single link	C1 (AX3660S-48)	3-1-1_BN_L2_UL_C1.txt
	FL1 (AX2340S-16)	3-1-1_BN_L2_UL_FL1.txt
	FL2 (AX2340S-16)	3-1-1_BN_L2_UL_FL2.txt
	FL3 (AX2340S-16)	3-1-1_BN_L2_UL_FL3.txt
	SV1 (AX2630S-48)	3-1-1_BN_L2_UL_SV1.txt
(2) Ring configuration with link aggregation	C1 (AX3660S-48)	3-1-1_BN_L2_LA_C1.txt
	FL1 (AX2340S-16)	3-1-1_BN_L2_LA_FL1.txt
	FL2 (AX2340S-16)	3-1-1_BN_L2_LA_FL2.txt
	FL3 (AX2340S-16)	3-1-1_BN_L2_LA_FL3.txt
	SV1 (AX2630S-48)	3-1-1_BN_L2_LA_SV1.txt

3.2 Multi-ring campus network

3.2.1 VLAN-shared multi-ring configuration

	Device name	File name
(1) Devices in building A	AC1 (AX3660S-48)	3-2-1_CN_SLMR_AC1.txt
	AC2 (AX3660S-48)	3-2-1_CN_SLMR_AC2.txt
	AF1 (AX2630S-48)	3-2-1_CN_SLMR_AF1.txt
	AF2 (AX2340S-16)	3-2-1_CN_SLMR_AF2.txt
	AF3 (AX2340S-16)	3-2-1_CN_SLMR_AF3.txt
(2) Devices in building B	BC1 (AX3660S-48)	3-2-1_CN_SLMR_BC1.txt
	BC2 (AX3660S-48)	3-2-1_CN_SLMR_BC2.txt
	BF1 (AX2340S-16)	3-2-1_CN_SLMR_BF1.txt
	BF2 (AX2340S-16)	3-2-1_CN_SLMR_BF2.txt

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