ZyPerMX4 / **ZyPer**MX2

Network Requirements

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Basic elements of ZyPerMX2/4 communication

ZyPerMX2/4 uses layer 2 / layer 3 IPV4 protocols

IP Address allocation

IP Addresses for the ZyPerMX2/4 units can be allocated using any of the following mechanisms:

1. DHCP (Default) – If a DHCP server is located on the network the ZyPerMX2/4 can be configured to obtain an IP address from this source.
2. Static – The ZyPerMX2/4 units can always be configured manually with a Static IP address.
3. Link-Local – The ZyPerMX2/4 will automatically assign a Link-Local address in the 169.254.x.x range if neither DHCP or Static address selection is used.

Note the IP address of the ZyPerMX4/MX2 can be obtained by looking at the LED panel on the unit.

Video and Audio (multicast)

The focus of ZyPerMX2/4 is transporting high-resolution video and audio data across 1 Gb Ethernet networks. A typical video data stream consumes between 1 and 10 megabits per second as configured by the user. In order to manage this bandwidth, the basis of the ZyPerMX2/4's AV transmission protocol is multicasting. This way, these high data rate streams are only sent through ports across links where they are needed. Some of the most serious considerations for network deployment – especially in multi- switch environments – are around ensuring that the network is configured to handle this properly. Bandwidth management is a key design consideration. Any significant loss of data (due to oversubscription or other reason) will result in visible on-screen problems. Ensuring that high data rate streams are routed *only* where they are needed is critical.

Switch selection and network topology

ZyPerMX2/4 is compatible with any 1 Gb Ethernet switch that has Layer 2/3 "non-blocking" switching capabilities. Support for multicast, IGMP v2 with IGMP snooping is required.

When IGMP v2 fast-leave is configured, when the device receives a leave

message, it immediately stops forwarding to that port.

Most switches' default behavior is to broadcast multicast packets. Watch out for this and make sure to enable multicast and IGMP before trying to use ZyPerMX2/4.

Regarding "stackable switches"

A stackable switch works with other stackable switches to present themselves as one cohesive "single switch." The entire system can be easily configured from a single IP address. This type of system is compatible with ZyPerMX2/4, but note that bandwidth must still be managed. Typically, a system of stackable switches is *not* fully non-blocking, meaning that there will be bottlenecks (often 10 Gb links between switches with 24, 48, or more 1 Gb ports). Bandwidth demands of the ZyPerMX2/4 system must be compared against the user requirements (how much video must be routed over the stacking ports to meet the user requirements) and all this must be considered in the design of the system's connectivity.

Regarding "leaf-spine"

Leaf-spine comes into play when number of endpoints surpasses the size of a single switch. ZyPerMX2/4 devices connect to leaf switches and leaf switches connect to spine switches. Leaf's mesh into spines meaning that every leaf is connected to every spine. This is compatible with ZyPerMX2/4 but, like for Stackable switches, bandwidth has to be managed where the limiting factor will be the trunk bandwidth between leaves and spines.

Figure: Illustration of leaf-spine topology

Multicast management

In order to minimize overall bandwidth consumption, ZyPerMX2/4 relies on multicast routing for distributing audio and video data. The basic idea is to *only* send AV data through switch ports where it is needed.

Important note: the switch must be configured to drop any packets from a multicast stream with no subscribers. Some switches could treat such packets as broadcast and impact the bandwidth and performance of the entire network.

Multicast source addresses

The ZyPerMX2/4 transmitter units will allow the user to manually select an available multicast source address. The addresses and ranges are as shown below:

- Video, including the embedded audio from an HDMI source.
    224.1.1.1 to 239.255.255.255

Note: It is recommended to avoid using multicast addresses starting with 224 and 239 due to potential conflicts with other devices.

Multicast routing management

In a single switch environment, IGMP suffices to enable the switch to understand which traffic must be routed to which ports. In a ZyPerMX2/4 system, the switch will only route a transmitted video to those ports where a ZyPerMX2/4 receiver has requested a particular stream. In a multi-switch environment, higher-level protocols must be employed so that "switch X" can understand which streams are demanded by receivers connected to "switch Y."

The basic communication flow is:

1. Switch X is connected to switch Y via a 10 Gb trunk link. No video traffic is currently passing between them.
2. Transmitter 1 is connected directly to switch X, and sending stream A into that switch.
3. Switch X needs to notify switch Y that stream A exists. Stream A still does not traverse the trunk link.
4. Receiver 1 is also connected directly to switch X, and makes an IGMP request to switch X for stream A.

5. Switch X begins routing stream A to receiver 1, who displays the video signal. Still there is NO video traffic across the trunk port between switches.
6. ZyPerMX2/4 receiver 2 is connected directly to switch Y.
7. ZyPerMX2/4 receiver 2 requests stream A by issuing an IGMP request to switch Y (which receiver 1 is connected to directly).
8. Switch Y realizes that it does not have access to stream A, but switch X has notified switch Y about stream A.
9. Switch Y sends a request to switch X to provide stream A across the trunk link.
10. Switch X complies, begins routing stream A across the trunk link to Switch Y, and switch Y begins providing stream A to receiver 2.
11. Later, if receiver 2 releases his IGMP subscription to stream A (and no other receivers on switch Y have requested stream A), then stream A should be removed from the trunk link.
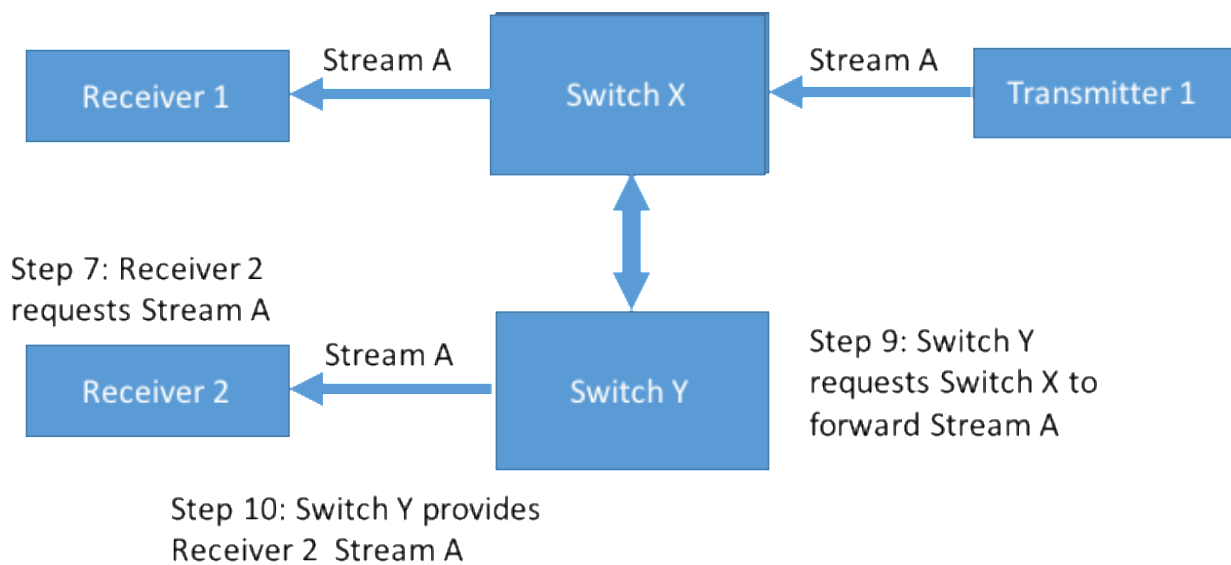
The implementation of these higher-level protocols is vendor specific. One example of such a protocol is Protocol Independent Multicast (PIM), implemented by Extreme Networks and others.

Network performance issues

Bandwidth management

The ZyPerMX2/4 video system has no tolerance for link oversubscription. Lost packets translate to lost pixels on screen. Video data is transmitted via UDP or RTP, so there is no retransmission (since retransmitted packets would be too late anyway). Any significant loss of data will result in significant image problems on screen.

The easiest solution is to design a fully non-blocking network. This is relatively straightforward for smaller systems, with affordable "top of rack" switches ranging to around 100 non-blocking ports. Beyond that size, blade-based systems of non-blocking switches exist, but can be expensive. A spine and leaf architecture may be more affordable, and also may fit more neatly in the physical layout of the network.

To design a cost-efficient system, the video routing use cases must be carefully considered and weighed against bandwidth availability.

Appendix 1: Recommended Switches

The following 1Gbit switches are recommended for use with the ZyPerMX2/4. Please note this is not an all-inclusive list. There are many other switches available that will function with the ZyPerMX2/4.

Manufacturer	Model #	Number of 1Gbit Ports	Notes
Netgear	M4300-28G	24	Includes two 10Gbit RJ45 and two 10Gbit SFP+ Ports
Netgear	M4300-52G	48	Includes two 10Gbit RJ45 and two 10Gbit SFP+ Ports
Netgear	M4300-28G-PoE+	24	PoE+ with four 10Gbit ports
Netgear	M4300-52G-PoE+	48	PoE+ with four 10Gbit ports
Arista	7010T-48	52	Includes four 10Gbit SFP+ ports
Luxul	XMS-7048P	48	PoE+ with two 10Gbit ports
Luxul	XMS-5248P	48	PoE+ with four 10Gbit ports
Luxul	XMS-2624P	24	PoE+ with two 10Gbit ports
Luxul	AMS-2624P	24	PoE+ with two 10Gbit ports
Luxul	AMX-4424P	24	PoE+ with two 10Gbit ports

Luxul Notes: Beware of the raised PoE button on lower left of the XMS-7048P. Hitting this button by accident will disable PoE and all ZyPerMX2/4 units will lose power. You may need to disconnect all non-PoE devices to re-enable PoE on the switch.

Appendix 2: Switch Configuration Options

Some Switches will work directly out of the box with zero configuration required. Nearly all switches however will provide the user some ability to customize the configuration. The list below includes various switch configuration options that ZeeVee has encountered. Look for these or similar options when configuring your switch.

1. Enable IGMP Snooping
   a. Must be enabled
2. Enable IGMP Snooping on VLAN used by ZyPerMX2/4
   a. Must be enabled when all ports default to VLAN1
3. Filter/Drop unregistered Multicast traffic
   a. If not applied, the behavior of the switch will be to broadcast multicast packets if the switch has no known destination for that packet.
   b. Must be enabled if found
4. Unregistered Multicast Flooding
   a. Must be disabled if found
5. Filter Unregistered Multicast (different wording than number 4 above)
   a. Must be enabled if found
6. Enable IGMP Query (*Single switch environment only*)
7. Enable IGMP Query on VLAN1 (*Single switch environment only*)
8. Validate IGMP IP Header
   a. Must be **disabled** if found
9. Set IGMP Version to IGMP V2
   a. Must be set if found
10. Enable FASTLEAVE on port X
    a. Should be enabled, if found
11. Enable FASTLEAVE for VLAN used by ZyPerMX2/4
    a. Should be enabled if found
12. Disable Multicast Storm Control on Netgear ProSafe XS708T. *(Security-Traffic Control-Storm Control-Status=Disable)*

Appendix 3: Maximum Transmission Distance

The table below details the maximum transmission distance between the ZyPerMX2/4 and a Network Switch.

Cable / Transmission Type	Maximum Distance
Category 5	Not Supported
Category 5e	100m (330 ft)
Category 6 UTP	100m (330 ft)
Category 6 STP	100m (330 ft)
Category 6A UTP	100m (330 ft)
Category 7	100m (330 ft)

UTP = Unshielded Twisted Pair
STP = Shielded Twisted Pair

Appendix 4: Frequently Asked Questions

Network

Question: In a Point to Point environment how should the MX2/MX4 and STBi3 be configured?

Answer: First, on the networking front be sure that both the MX2/MX4 and STBi3 are set for static IP with addresses on the same subnet. ZeeVee would recommend RTP for P2P installations. RTP has more timing and synchronization information built into the protocol.

Question: In a network environment how best should the MX2/MX4 and STBi3 be configured?

Answer: In a network environment, the MX2/MX4 should be configured for UDP and multicast.

Question: How does channel beaconing work?

Answer: The ZV channel beacon uses the 239.13.1.19 multicast address. (Port 21217) The MX2/MX4 uses this address to publish its channels across the network. In a single layer 2 network this should always work. In a routed layer 3 network, this multicast address needs to be added to the router's forwarding table explicitly. By default, routers will not forward this address. The actual command to do this varies by router.

Question: What is included in the beacon signal?

Answer: The beacon includes the multicast group, port and source IP address.

Question: What other Network protocols are required to support the ZyPerMX2/MX4 and STBi3

Answer: For an installation of more than a couple of MX streams, the layer 2 Ethernet switch needs to be a smart switch that supports IGMP and multicast traffic management. Again, the actual configuration commands vary by vendor.
(See Appendix 2 for additional switch configuration settings)

Question: Should every MX2/MX4 stream in the system be configured with a different multicast address?

Answer: Each MX2/MX4 stream needs to be configured for a different multicast address for proper stream bandwidth management. Network switches filter based on the IP multicast address only. If multiple MX's are configured with the same multicast address with different ports, all the packets with that multicast address will be forwarded to any STBi3's tuned to any one of those channels. This will overwhelm the Ethernet processing on the STBi3 and cause video artefacts.

Question: What is the range of multicast addresses that can be used by the MX2/MX4?

Answer: The full range of multicast addresses is from 224.1.1.1 to 239.255.255.255

Question: What is the maximum Router hop limit or TTL of a multicast stream?

Answer: The maximum hop limit is 9. Therefore, the TTL = 10.

Miscellaneous

Question: What is the max length of HDMI cable that can be used on the MX2/MX4 before it starts to not detect the source?

Answer: This will depend on the quality of the HDMI cable. ZeeVee has verified functionality with HDMI cables up to 25 feet in length.

Question: What is the recommended Video Bitrate setting for the ZyPerMX2/MX4 when streaming video to STBi3 devices?

Answer: The recommended Video Bitrate in this case is 6000 Kbit/sec (6 Mbit/sec). Settings higher than this will cause unacceptable video breakup with the STBi3. Note that higher bitrates can be used when streaming to some other video decoders.

Question: Can the ZyPerMX2/4 strip out any HDCP encoding?

Answer: Please contact ZeeVee support for additional information about the ZyPerMX2/4.