ZyPerUHD60 Network Requirements

ZeeVee, Inc.
295 Foster Street, Suite 200
Littleton, MA 01460 USA
February 28, 2023

Table of Contents

Basic elements of ZyPerUHD60 communication

ZyPerUHD60 uses layer 2 / layer 3 IPV4 protocols

IP Address allocation

IP Addresses for the ZyPerUHD60 units can be allocated using any of the following mechanisms:

1. Link-Local – By default the ZyPerUHD60 will automatically assign a Link-Local address in the 169.254.x.x range. This can be manually changed to DHCP or Static address selection.
2. DHCP – If a DHCP server is located on the network the ZyPerUHD60 can be configured to obtain an IP address from this source. Note this selection must be done manually as default is Link-Local.
3. Static – The ZyPerUHD60 units can always be configured manually with a Static IP address.

Ports

The following Ports are used by the ZyPerUHD60 and the ZyPer Management Platform

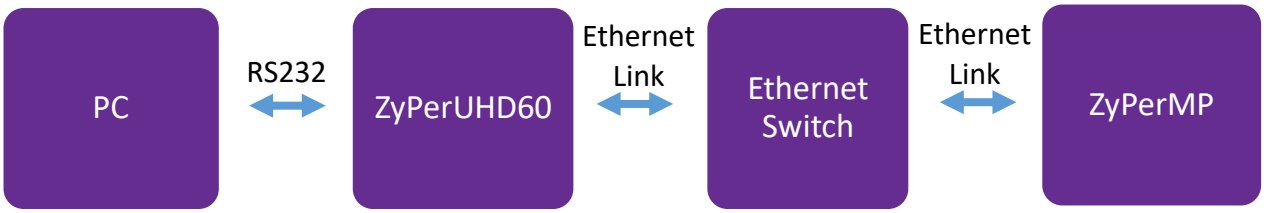
ZyPer Management Platform

Maestro (GUI): TCP ports 80 and 8080
Telnet: TCP port 23
SSH: TCP port 22
FTP: (default) TCP ports 20 and 21
FTP: (passive) TCP ports 21 and some port >1023

Between ZyPer Management Platform and ZyPerUHD60 Units

General communications: UDP port 1234
Discovery: UDP port 3333

Note: The RS232 connection only has “device to server” support. So, the server uses the TCP Port 24 for general communication with the devices and to read the input that was sent on the RS232 to the device.



Video and Audio (multicast)

The focus of ZyPerUHD60 is transporting high resolution video and audio data across 1 Gb Ethernet networks. A typical video data stream consumes twenty megabits per second, depending on its resolution format. In order to manage this bandwidth, the basis of ZyPerUHD60'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 setup 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.

Control: RS-232, IR, CEC (unicast with some optional multicast and broadcast)

ZyPerUHD60 carries various low-speed control communications as well. These signals are typically triggered by a user-facing control system and are used to control things like turning on and off a display. RS-232, IR and CEC signals are included here. These packets are typically sparse, and data rates are in kilobits per second. The data packets are always unicast between the ZyPer Management Platform and ZyPerUHD60 endpoints. Sometimes the communication is directly between endpoints.

Discovery (Broadcast)

ZyPerUHD60 runs its own discovery mechanism. It relies on broadcast communication between the ZyPer Management Platform and all endpoints.

The ZyPer Management Platform transmits a broadcast UDP packet to port 3333 out the video network interface. ZyPerUHD60 devices that receive this packet will send a unicast response. In order to discover the ZyPerUHD60's across VLANs the

user would need to forward broadcast UDP traffic with a destination port of 3333 from the ZMP VLAN to all endpoint VLANS.

Note: Supporting multicast content delivery over multiple VLANs requires an experienced network engineer to configure the switches/network. The information above is provided for information purposes only. ZeeVee can only provide very limited support in configuring such a network. The implementation is almost entirely left to the end customer.

Discovery (Multicast)

As noted above, the default method of discovery is broadcast using UDP port 3333. The system however can be configured to use multicast for discovery. This allows the server to discover ZyPerUHD60 endpoints using multicast across subnets when multicast routing is enabled. When in multicast mode there must be an IGMP querier running – usually that would be the multicast router querier.

The API command to enable multicast discovery is:
set server discoverMode multicast

Note: Supporting multicast content delivery over multiple VLANs requires an experienced network engineer to configure the switches/network. The information above is provided for information purposes only. ZeeVee can only provide very limited support in configuring such a network. The implementation is almost entirely left to the end customer.

Switch selection and network topology

ZyPerUHD60 is compatible with any 1 Gb Ethernet switch that has Layer 2/3 “non-blocking” switching capabilities. Support for multicast, IGMPv2 with IGMP snooping is required. IGMP v2 fast-leave is required. Jumbo Frames (9000 bytes or greater) are also required.

When IGMPv2 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 ZyPerUHD60.

Note: ZyPerUHD60 devices support IGMPv2 but are compatible with IGMPv3 networks. (Routers)

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 ZyPerUHD60, 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 ZyPerUHD60 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. ZyPerUHD60 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 ZyPerUHD60 but like for Stackable switches, bandwidth has to be managed where the limiting factor will be the trunk bandwidth between leaves and spines.

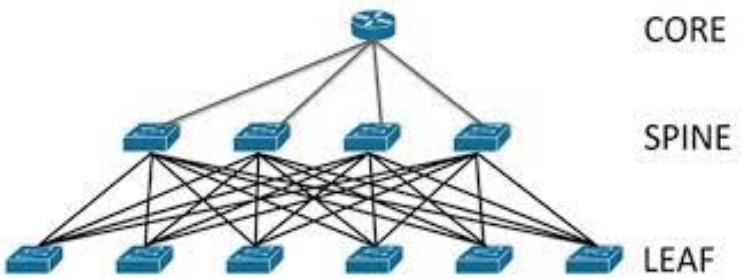


Figure: Illustration of leaf-spine topology

Multicast management

In order to minimize overall bandwidth consumption, ZyPerUHD60 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 ZyPerUHD60 transmitter units will automatically select an available multicast source address. Each transmitter will be assigned up to three multicast source addresses. The addresses and ranges are as shown below:

- Video, including the embedded audio from an HDMI source and downscaled video for preview. 234.0.0.1 to 234.255.255.255

The multicast address cannot be manually changed by the user.

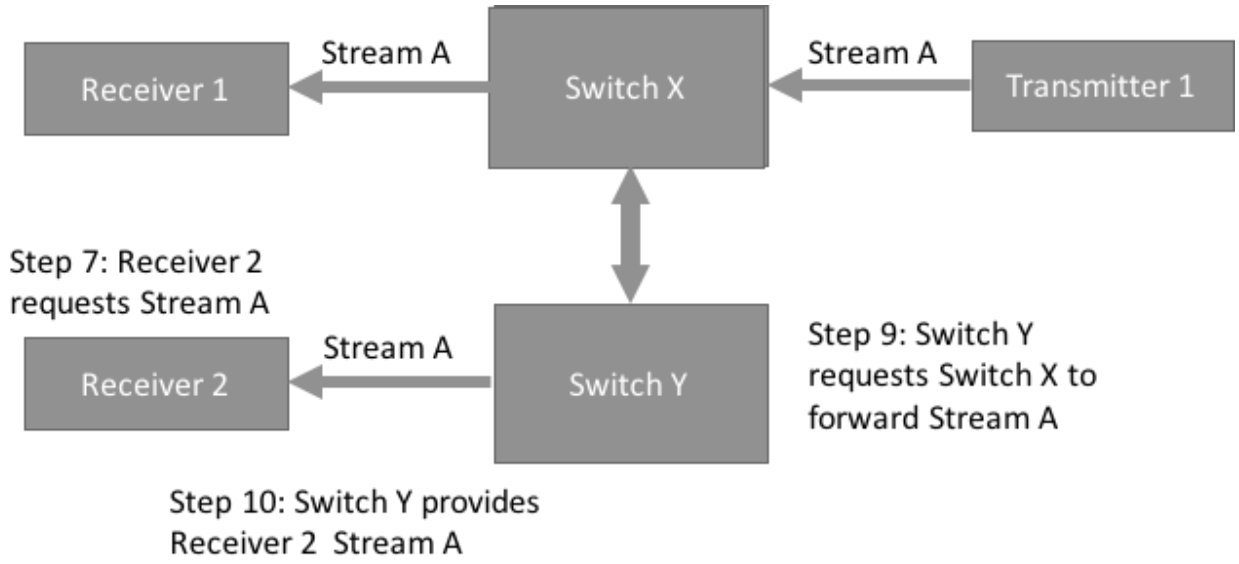
Multicast routing management

In a single switch environment, IGMP suffices to enable the switch to understand which traffic must be routed to which ports. In a ZyPerUHD60 system, the switch will only route a transmitted video to those ports where a ZyPerUHD60 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. ZyPerUHD60 receiver 2 is connected directly to switch Y.
7. ZyPerUHD60 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.

Multicast TTL (Hop Limit)

The TTL (Time to Live) value for video and audio streams is 32.

Network performance issues

Bandwidth management

The ZyPerUHD60 video system has no tolerance for link oversubscription. Lost packets translate to lost pixels on screen. Video data is transmitted via UDP, 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.

USB switching

ZyPerUHD60 products that include USB switching accomplish this over Ethernet through the use USB controller chipset. This chipset uses broadcast, multicast, and unicast communication to create the feature set. As long as the rules for handling ZyPerUHD60 AV traffic are adhered to, then USB will work. There are no special additional rules for USB. However, do consider that USB traffic will also eat into system bandwidth. Complex Ethernet devices can consume hundreds of megabits per second. When a point-to-point link is established between two USB endpoints, the Ethernet communication is unicast.

USB Hop limit

The maximum number of USB Hops allowed is 7. However the ZyPerUHD60 itself counts at 2 Hops making the real Hop limit = 5.

Typical USB Bandwidth

USB devices have instantaneous and operating bandwidths. For example, High Speed devices have an instantaneous bandwidth of 480Mb/s. However, real world throughput of an individual device is never the full transfer rate. USB

devices connected to a PC, must share the available USB bandwidth. Each device does not have an instantaneous bandwidth of 480Mb/s. The typical operating bandwidth of several USB devices are shown in the table below to demonstrate the different bandwidths that might be encountered.

Device	Typical USB Bandwidth Required
Mouse	< 100 Kb/s
Keyboard	17 Kb/s
Flash Drive	80 Mb/s
DVD or CD Writer	80 Mb/s
Camera	80 Mb/s
Interactive White Board	100 Kb/s
Hard Disk	336 Mb/s maximum

Bandwidth Use Summary

The ZyPerUHD60 can transmit AV data from multiple sources simultaneously over the 1 Gb Ethernet port. These sources include: HDMI (Video and Audio), USB, Audio, RS-232 port and CEC data. Maximum bandwidth of each port is shown below:

ZyPerUHD60 Port	Maximum Bandwidth
HDMI (Video + Audio)	900 Mbits/sec (data rate varies between 400Mb/s and 900Mb/s depending on input resolution and frame rate)
RS-232	115 Kbits/sec
USB	480 Mbits/sec (Typically much lower)
Audio	2.3 Mbits/sec (2 channels, 24 bits@48 kHz/channel)
IR	60 Kbits/sec
CEC via HDMI	1 Kbit/sec

Appendix 1: Recommended Switches

The following 1Gbit switches are recommended for use with the ZyPerUHD60. Please note this is not an all-inclusive list. There are many other switches available that will function with the ZyPerUHD60.

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+ (GSM4328PA)	24	PoE+ with four 10Gbit ports
Netgear	M4300-52G-PoE+ (GSM4352PA)	48	PoE+ with four 10Gbit ports
Netgear	M4250-10G2F-PoE+ (GSM4212P)	8	PoE+ with two 1G SFP ports
Netgear	M4250-10G2XF-PoE+ (GSM4212PX)	8	PoE+ with two 10 SFP+ ports
Netgear	M4250-26G4F-PoE+ (GSM4230P)	24	PoE+ with four 1G SFP ports
Netgear	M4250-26G4XF-PoE+ (GSM4230PX)	24	PoE+ with four 10G SFP+ ports
Netgear	M4250-40G8F-PoE+ (GSM4248P)	40	PoE+ with eight 1G SFP ports
Netgear	M4250-40G8XF-PoE+ (GSM4248PX)	40	PoE+ with eight 10G SFP+ ports
CommScope/Ruckus	ICX7150-24P	24	PoE+ with four 10G SFP+ ports
CommScope/Ruckus	ICX7150-48PF	48	PoE+ with four 10G SFP+ ports
CommScope/Ruckus	ICX7550-24P	24	PoE+ with four 10G SFP+ ports and 4 QSFP+ ports
CommScope/Ruckus	ICX7550-48P	48	PoE+ with four 10G SFP+ ports and 4 QSFP+ 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
TP-Link	TL-SG3452P	48	PoE+ with four 1G SFP 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 ZyPerUHD60 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 ZyPerUHD60
    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. Disable IGMP Query (Except on Cisco switches)
7. Disable IGMP Query on VLAN used by ZyPerUHD60
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 ZyPerUHD60
    a. Should be enabled if found
12. Jumbo Frame or (Frame Size)
    a. Enable or set to 9000 bytes or larger
13. 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 either directly connected ZyPerUHD60 units or between the ZyPerUHD60 and a Network Switch.

Cable / Transmission Type	Maximum Distance
Category 5	Not Supported
Category 5e CCA (Copper Clad Aluminum)	Not recommended for PoE devices
Category 5e SCC (Solid Copper Core)	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)
Category 7A	100m (330 ft)

UTP = Unshielded Twisted Pair
STP = Shielded Twisted Pair

Important Note: If using PoE with ZyPerUHD60 units; the ZyPerUHD60 must have a path to the ground. This grounding can be accomplished by using a shielded network cable (F/UTP) or by making sure the ZyPerUHD60 itself or the connected HDMI display is grounded. (i.e. A 3-prong power connector on display)

Disclaimers

ZeeVee has striven to ensure that this document is accurate and represents the described products fully. Although, ZeeVee assumes no responsibility for errors found, should any be found, please contact support@zeevee.com and corrections will be issued as appropriate.

Customers should always consult with qualified Network Engineers regarding all network designs. Design guidance provided by ZeeVee should be considered for reference only. It is up to the customer to validate and implement any network designs. ZeeVee cannot and will not be held responsible for network designs, equipment, cabling or other installation related network items.

ZeeVee hardware designs are property of ZeeVee.

Components, sub-assemblies, and methods utilized in the designs are free of any encumbrances or appropriate licenses and rights have been obtained by ZeeVee for the use in the described products in the intended manner.

ZeeVee software is the sole property of ZeeVee except within the restrictions and guidelines of any open-source or public-license component utilized. ZeeVee represents that normal usage of the product in a typical customer installation is fully within the granted rights and privileges of any licensed component. Visit www.zeevee.com for further details.

The specifications of the described products may change at any time without notice.

ZeeVee forbids unauthorized disassembly, reverse-engineering, duplication, or any other attempt to recreate all or portions of the hardware or software outside of any use explicitly authorized in writing by ZeeVee.

Trademarks

All trademarks are the property of their respective owners.

Copyright