

# **ZyPer4K Network Requirements & Security Considerations**



**Intelligent AV Distribution**

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## Basic elements of ZyPer4K communication

ZyPer4K uses layer 2 / layer 3 IPV4 protocols

### IP Address allocation

IP Addresses for the ZyPer4K units can be allocated using any of the following mechanisms:

1. DHCP – If a DHCP server is located on the network the ZyPer4K can be configured to obtain an IP address from this source.
2. Static – The ZyPer4K units can always be configured manually with a Static IP address.
3. Link-Local – The ZyPer4K will automatically assign a Link-Local address in the 169.254.x.x range if neither DHCP or Static address selection is used.

**Note:** When the ZyPer4K is equipped with an optional USB or Dante Transmitter module, the USB/Dante module itself will have a unique IP Address. This address is always acquired via DHCP or Link-Local mechanism. It is important that a DHCP server has a pool of addresses large enough to account for these USB/Dante IP Addresses as well as the ZyPer4K IP Address. The USB module cannot be assigned a Static address. The Dante Transmitter can be assigned a Static address.

### Ports

The following Ports are used by the ZyPer4K and the ZyPer Management Platform

#### ZyPer Management Platform

ZMP (GUI): TCP port 80

Telnet: TCP port 23

SSH: TCP port 22

FTP: (default) TCP ports 20 and 21

FTP: (passive) TCP ports 21 and some ports >1023

#### Between ZyPer Management Platform and ZyPer4K Units

General communications: UDP port 6969 and 6970

RS232: UDP ports 10001 to 10004

USB: UDP port 6137 (Note USB support is optional)



## Video and Audio (multicast)

The focus of ZyPer4K is transporting high resolution video and audio data across 10 Gb Ethernet networks. A typical video data stream consumes three to nine gigabits per second, depending on its resolution format. In order to manage this bandwidth, the basis of ZyPer4K'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: IR, RS-232 (unicast with some optional multicast and broadcast)

ZyPer4K 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. Infrared signals and RS-232 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 ZyPer4K endpoints. Sometimes the communication is directly between endpoints.

## Discovery (Broadcast)

ZyPer4K runs its own auto-discovery mechanism. It relies on broadcast communication between all endpoints and the ZyPer Management Platform.

## The 1 Gb utility port

The ZyPer4K units include built-in Ethernet switching capability, in order to provide 1 Gb connectivity that can be piped through the 10 Gb link.

## USB 2.0

Some ZyPer4K products include the capability to distribute and switch USB traffic across the 10 Gb Ethernet network. In general, this USB functionality is compatible with any type of USB device. However, the consumption of Ethernet



bandwidth by the USB devices must be considered in the system design.

## Switch selection and network topology

ZyPer4K is compatible with any 10 Gb Ethernet switch that has Layer 2/3 “non-blocking” switching capabilities. Support for multicast, IGMP v2 with IGMP snooping and IGMP v2 fast-leave 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 packets. Watch out for this and make sure to enable IGMP Snooping before trying to use ZyPer4K.

It is critical that the Network does not contain a multicast router. The presence of a multicast router will cause fatal errors to the ZyPer4K multicast delivery system.

The Network should also not contain an IGMP Querier as this will also cause fatal errors to occur with the ZyPer4k multicast delivery system. Note that in a single Switch solution that IGMP Query can be enabled on the Switch without causing any issues.

## Regarding trunk ports

QSFP ports can usually be configured as single 40 Gb trunk port or as four independent 10 Gb ports. If you intend to use the port as a high bandwidth link to another switch, be sure to configure it as a 40 Gb trunk port. Otherwise you’re just adding extra 10 Gb ports to your switch, and if you connect them all to the same switch, you made a loop, and 3 ports will get shut down, leaving you with only 10 Gb between the switches.

## 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 ZyPer4K, 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 40 Gb links between switches with 24, 48, or more 10 Gb ports). Bandwidth demands of the ZyPer4K 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. ZyPer4K devices connect to leaf switches and leaf switches connect to spine switches. Leafs mesh into spines meaning that every leaf is connected to every spine. This is compatible with ZyPer4K but like for Stackable switches, bandwidth has to be managed where the limiting factor will be the trunk bandwidth between leaves and spines.

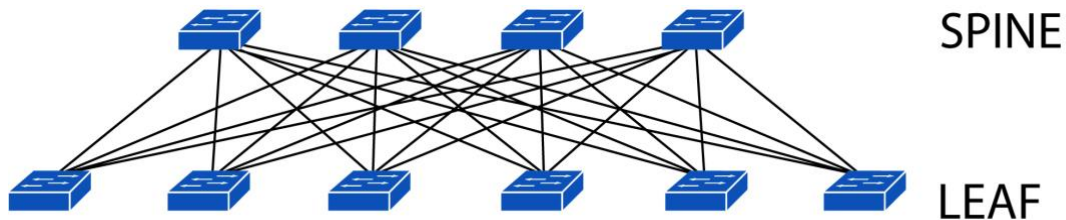


Figure: Illustration of leaf-spine topology

### Multi Subnet Networks (Port Forwarding)

It is strongly recommended that the ZyPer4K system be deployed on a single dedicated video network. This allows the endpoint discovery system to easily find and identify encoders and decoders in the system. It is possible however to deploy the ZyPer4K on a multi subnet network. In this case steps must be taken to ensure that the devices can all be discovered and managed by the ZyPer Management Platform (ZMP).

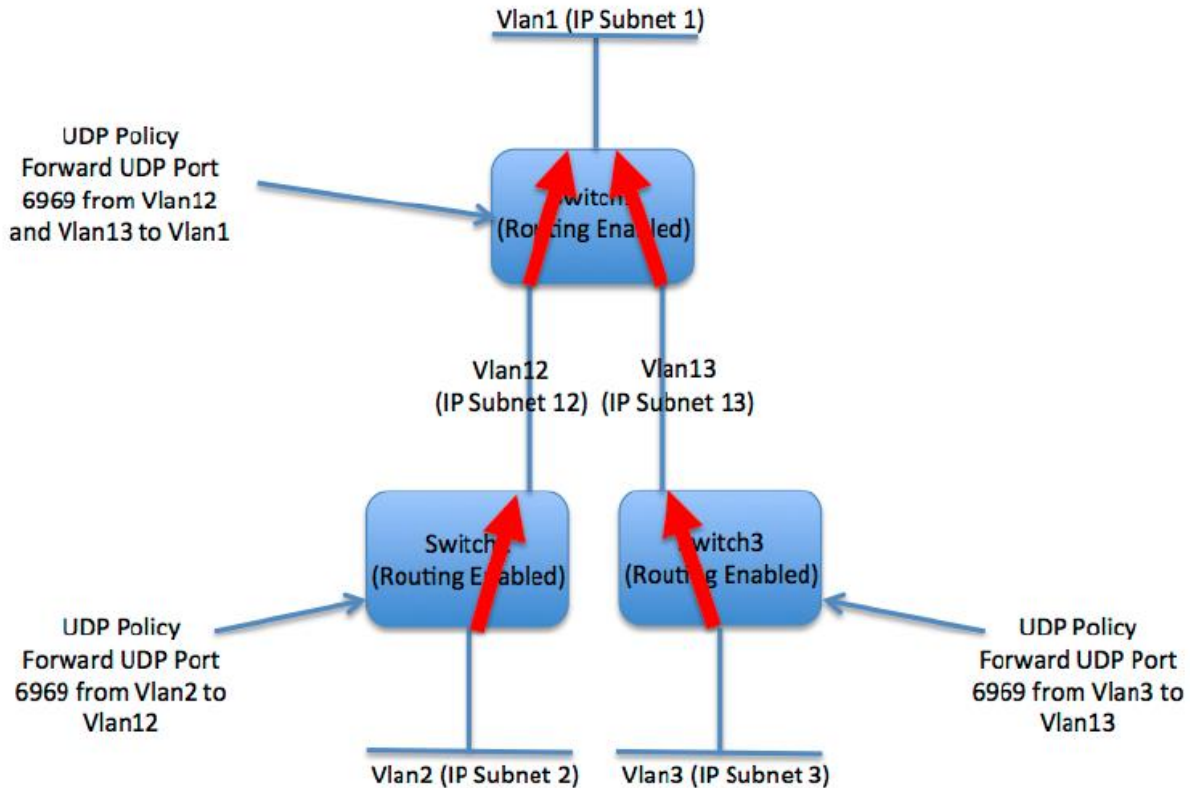
**Note:** The instructions below involve advanced network configuration and management concepts. A qualified network engineer should be involved in making these configuration updates and the network switch provider may need to be consulted to ensure support of needed features.



The ZyPer4K encoders announce themselves to the ZyPerMP management platform using a UDP allnets broadcast packet (destination 255.255.255.255). These announcement packets will typically not pass through a network router since they are an IP broadcast. Therefore, in order for the ZyPer Management Platform to successfully discover the ZyPer4K devices, they are required to be in the same broadcast domain (or VLAN).

In order to allow the ZeeVee Management Platform to discover the ZyPer4K encoders and decoders we utilize a feature called UDP port forwarding on the switches. In a standard configuration the routing switches will not forward an IP broadcast packet received on one VLAN to other VLANs. UDP port forwarding will be configured on the switches in order to forward specific UDP broadcast packets received from the VLANs where the encoders and decoders are placed to the VLAN where the ZMP is located. Once this is done, the ZMP is able to successfully discover and manage the encoder and decoder devices. ZyPer4K Encoders and Decoders send UDP packets on port 6969 in order to advertise themselves to the ZMP. By creating UDP port forwarding policies on the routing switches, we can arrange for those packets to be delivered to the ZMP to allow it to discover and manage them.

The diagram in the figure below shows how the UDP policies are configured to forward the advertisement packets to the ZyPer Management Platform on VLAN1.



**Special Note:** ZyPer4K endpoints that contain USB need to also have UDP port 6137 forwarded from the ZMP to all endpoint VLANs.

### Multi Subnet Networks (Manual Device Additions)

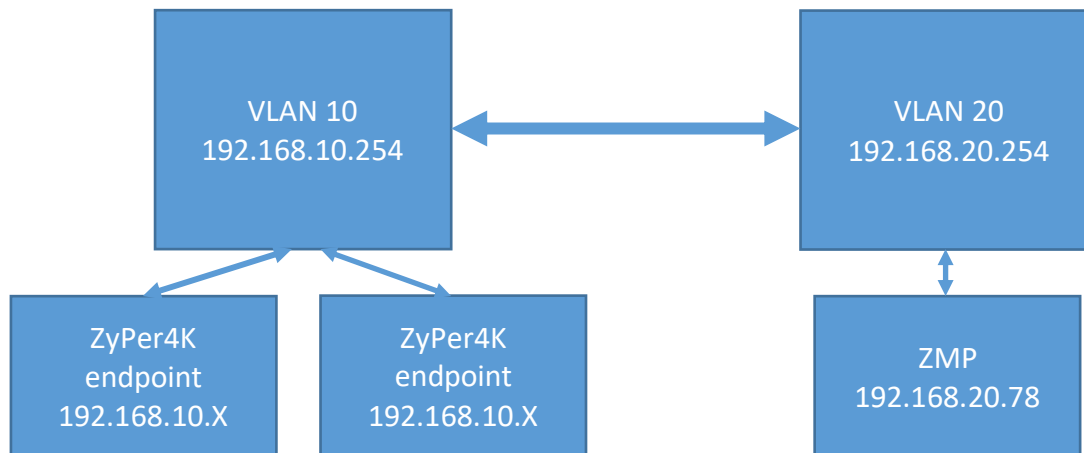
It is strongly recommended that the ZyPer4K system be deployed on a single dedicated video network. This allows the endpoint discovery system to easily find and identify encoders and decoders in the system. It is possible however to deploy the ZyPer4K on a multi subnet network. In this case steps must be taken to ensure that the devices can all be discovered and managed by the ZyPer Management Platform (ZMP).

**Note:** The instructions below involve advanced network configuration and management concepts. A qualified network engineer should be involved in making these configuration updates and the network switch provider may need to be consulted to ensure support of needed features.

It is possible to manually tell the ZyPer Management Platform the IP Address of ZyPer4K devices that are located on a different VLAN/Subnet than the ZMP itself.



The example below is a case with two different VLANs/Subnets.



The ZyPer4K Endpoints are located on VLAN 10 and the 192.168.10.X subnet.  
The ZyPer Management Platform is on VLAN 20 and the 192.168.20.X subnet.

The ZMP will automatically discover any ZyPer4K endpoints located on VLAN 20.  
The ZMP will NOT automatically discover any ZyPer4K endpoints located on VLAN 10. However, given the proper circumstances, the ZyPer4K endpoints on VLAN 10 can be manually added to the ZMP for control.

For this to work, the network MUST be configured to route traffic between VLAN 10 and VLAN 20. How to configure the network to allow routing between VLANs is beyond the scope this document and should be done by a qualified network engineer. A simple test to confirm routing is that a device in VLAN 10 can ping a device in VLAN 20.

The ZyPer4K endpoints need to have a known IP Address. The IP Address should either be assigned by a DHCP server or assigned statically.

Once this is done, the user needs to log into the ZMP Command Line Interface (CLI). Example: telnet 192.168.20.78 based on the drawing above.

The ZMP configuration is shown below:

`Zyper$ show server config`



```
server(192.168.20.78);
  server.gen; autoEdidMode=enabled, redundancy=enabled
  server.ip-server-address; mode=static, address=192.168.20.78,
mask=255.255.255.0, gateway=192.168.20.254
  server.ip-management-address; mode=none, address=NA
  server.encoder-defaults; hdmi-audio-format=force-pcm
  server.data-transfer; telnet=telnet-handshake-mode
  server.logging; level=1
Success
```

Now use the “add device” command to manually add the ZyPer4K endpoints.

```
Zyper$ add device ip-address 192.168.10.81
Success
```

In the above example, the IP Address of a ZyPer4K endpoint located in VLAN 10 is 192.168.10.81

ZyPer4K endpoints need to be added one at a time.

You can get a listing of all “user added” devices with the “show device user-added” command.

```
Zyper$ show device user-added
device(d8:80:39:eb:1c:ee);
  device.gen; model=Zyper4K, type=encoder, name=London, state=Up,
uptime=0d:18h:32m:36s, lastChangeld=55
  device.ip; address=192.168.10.79
device(d8:80:39:59:f1:ff);
  device.gen; model=Zyper4K, type=decoder, name=Right, state=Up,
uptime=0d:18h:32m:36s, lastChangeld=52
  device.ip; address=192.168.10.81
device(d8:80:39:59:af:be);
  device.gen; model=Zyper4K, type=decoder, name=Left, state=Up,
uptime=0d:18h:30m:5s, lastChangeld=56
  device.ip; address=192.168.10.82
device(d8:80:39:5a:69:a9);
```



```
device.gen; model=Zyper4K, type=encoder, name=Laptop, state=Up,  
uptime=0d:18h:32m:36s, lastChangeId=70  
device.ip; address=192.168.10.96  
Success
```

Note that for ZyPer4K endpoints to stream audio/video between VLAN 10 and VLAN 20 the network must be configured to pass multicast traffic between the VLANs. That is another topic beyond the scope of this document.

## Multicast management

In order to minimize overall bandwidth consumption, ZyPer4K 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. **IGMP Snooping must be enabled.** As few as two video streams at 4K can oversubscribe a 10 Gb link, so getting multicast right is critical.

***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 ZyPer Management Platform is responsible for assigning multicast source addresses to transmitters. Each transmitter will be assigned three or four source addresses. Separate source addresses are used for:

- Video, including the embedded audio from an input video source
- Scaled video, including the embedded audio from an input video source
  - Note: This feature provides video/audio for Multiview windows
- Audio that has been extracted from the input video source stream
- Audio brought into the transmitter via I2S (e.g., analog audio input)

ZyPer4K encoders must be assigned multicast addresses in the range of 224.1.1.1 to 239.255.255.255. (Must have API version 2.0 or greater installed.) You can assign a specific range to not conflict with other multicast devices on the network.

Note that addresses 224.1.1.253 and 224.1.1.254 are reserved.



Multicast addresses for each encoder must be assigned manually by the user. This can be accomplished all at once with a single command:

*Set All API command example:*

```
set device encoders send-ip-mcast-range 224.1.2.1 224.1.3.255
```

**Note:** This feature/command is enabled in API version 1.4 and above.

The above command will set all 3-4 multicast addresses for every encoder

- Video, including the embedded audio from an input video source
- Scaled Video, including the embedded audio from an input video source
  - Note: This feature provides video/audio for Multiview windows and is only supported with ZyPer4K units with HDMI 2.0 capability
- Audio that has been extracted from the input video source stream (Downmix audio)
- Audio brought into the transmitter via I2S (*e.g.*, analog audio input)

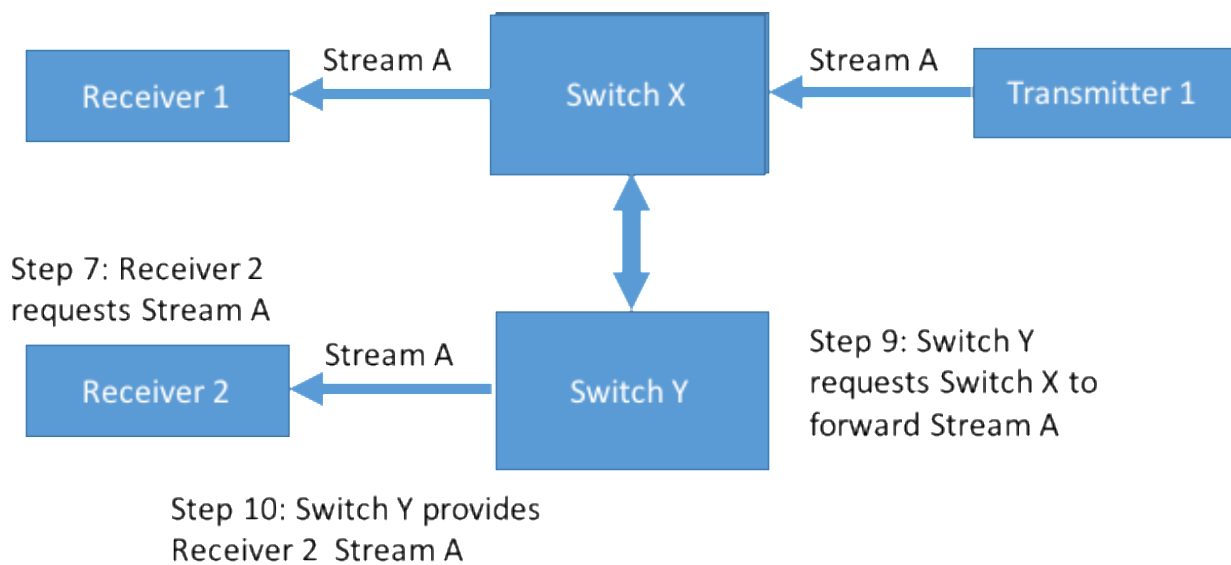
### Multicast routing management

In a single switch environment, IGMP suffices to enable the switch to understand which traffic must be routed to which ports. In a ZyPer4K system, the switch will only route a transmitted video to those ports where a ZyPer4K 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.” If this is not carefully managed, trunk links can easily be oversubscribed by multiple (dozens or more) streams of 8 Gb video.

The basic communication flow is:

1. Switch X is connected to switch Y via a 40 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. ZyPer4K receiver 2 is connected directly to switch Y.
7. ZyPer4K 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 Management Warnings

It is critical that the Network does not contain a multicast router. The presence of a multicast router will cause fatal errors to the ZyPer4K multicast delivery system.



The Network should also not contain an IGMP Querier as this will also cause fatal errors to occur with the ZyPer4k multicast delivery system. Note that in a single Switch solution IGMP Query can be enabled on the Switch without causing any issues.

## Network performance issues

### Bandwidth management

The ZyPer4K 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). There is intelligence built in to mask small errors (by filling in surrounding or previous pixels, *etc.*), but 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.

The following table gives a summary of how much data a ZyPer4K video stream consumes. The data rate does scale up and down with video format (resolution, frame rate, *etc.*). It is critical that the network is designed to handle the worst-case routing scenario demanded by the use cases. Special attention must be paid to the bottlenecks – the 40 Gb trunk ports between 10 Gb switches.



Resolution	Frame Rate	Bit Depth	Chroma	Ethernet bandwidth consumed (Gbps)	Notes
1280x720	60p	8-bit	4:4:4	1.6	
1920x1080	60p	8-bit	4:4:4	3.4	
1920x1080	60p	8-bit	4:2:2	2.2	
3840x2160	30p	8-bit	4:4:4	6.4	
3840x2160	60p	8-bit	4:4:4	8.7	Compressed from 13 Gbps
Multiview Window	30p	8-bit	4:4:4	9.5	Maximum bandwidth at Decoder for all streams in multiview

### The ZyPer4K 1 Gb port

ZyPer4K products include a 1 Gb “courtesy port” whose traffic is piped back through the main 10 Gb AV port of the endpoint. The ZyPer4K units include an Ethernet switch built in, which is how this traffic is connected back to the 10 Gb network.

A few notes on this port:

- The 1 Gb port does not support jumbo packets
- There is no VLAN or priority assigned to the 1 Gb port
- ZyPer4K does not implement any form of STP or loop protection. The 1 Gb port must *never* be looped back to the same switch as the 10 Gb port.

Because there is no priority assigned to this port, keep in mind that traffic from this port may trigger an oversubscription condition and cause video failures. This can be especially bad through trunk links. Consider a 48-port 10 Gb switch with a single 40 Gb uplink. Potentially 48 ZyPer4K endpoints could be connected, each



with some Ethernet device on the 1 Gb port. If all of these devices were to maximize their bandwidth consumption (1 Gb each), that would be 48 Gb consumed without a single video link in place. Use of the 1 Gb port must be very carefully considered in complex multi-switch Ethernet networks.

### USB switching

ZyPer4K products that include USB switching accomplish this over Ethernet through the use of a USB controller chipset. This chipset uses broadcast, multicast, and unicast communication to create the feature set. As long as the rules for handling ZyPer4K 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 (webcams, data storage 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.

### Typical USB Bandwidth

USB devices have instantaneous and operating bandwidths. For example, High Speed devices have an instantaneous bandwidth of 480 Mb/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 480 Mb/s. The typical operating bandwidths 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
Low Resolution / High Compression Web Camera	80 Mb/s
DVD or CD Writer	80 Mb/s
Interactive White Board	100 Kb/s
Hard Disk	336 Mb/s maximum





## Bandwidth Use Summary

The ZyPer4K can transmit AV data from multiple sources simultaneously over the 10 Gb Ethernet port. These sources include: HDMI (Video and Audio), 1 Gb Utility port, USB 2.0 port, Analog audio, RS-232 port, IR port. Maximum bandwidth of each port is shown below:

ZyPer4K Port	Maximum Bandwidth
Primary AV input (HDMI, DisplayPort, HDSDI, Analog)	13 Gbits/sec (3840x2160, 4:4:4 @ 60 Hz) (will be compressed to approximately 8.7 Gbits/sec maximum)
1 Gb Ethernet	1 Gbit/sec
USB 2.0	480 Mbits/sec
Analog Audio	2.3 Mbits/sec (48k x 24 bits x 2 channels)
RS-232	115 Kbits/sec
IR	60 Kbits/sec

## Security

The ZyPer4K system with companion management platform implement several different security related features.

In an AV over IP system you can provide a level of security by keeping the video traffic private from the main network. This can be done as simply as adding a new VLAN for the AV equipment. Many customers create a dedicated AV network that is physically disconnected from the main network. The available Enterprise class management platform provides for two independent network interfaces to more easily separate the AV network from the corporate network.

Customers with highly secure networks will run vulnerability scans on all network devices. One of the tools that can be used is Nessus from Tenable. Please contact ZeeVee for a detailed analysis of Nessus scans of the ZyPer Management Platform.



## Encryption between endpoints

All AV traffic between ZyPer4K encoders and decoders uses an Advanced Encryption Standard (AES-128). This level of encryption is sufficient to protect U.S. Government classified information up to the SECRET level. AV traffic encrypted with AES-128 includes Audio, Video, RS-232, USB and IR communications.

## High-bandwidth Digital Content Protection

High-bandwidth Digital Content Protection (HDCP) is a form of digital copy protection developed to prevent copying of digital, audio & video content as it travels across connections. The system is meant to stop HDCP-encrypted content from being played on unauthorized devices or devices which have been modified to copy HDCP content. Before sending data, a transmitting device checks that the receiver is authorized to receive it. If so, the transmitter encrypts the data to prevent eavesdropping as it flows to the receiver.

ZyPer4K units support High-bandwidth Digital Content Protection (HDCP 2.2) from end to end. This feature cannot be disabled and provides a 100% assurance of HDCP compliance.

## Management Platform

Direct from ZeeVee, the Control System has a basic level of security. Access to the management platform either via the ZMP GUI (via JSON) or the API (via Telnet or SSH) is password protected to prevent unauthorized access.

Note that starting with release 2.1 of the API, Telnet access to the management platform can be disabled. See the Management Platform User Guide for details.

## USB Ports

The ZyPer4K USB ports can be filtered to disable unauthorized access.

Filter options include:

- None – Allows any USB compatible device to interface over ZyPer4K
- HID – Allows only Human Interface Devices (Mouse/Keyboard)
- Storage – Allows any USB compatible device except Mass Storage



## 1Gb Ethernet utility port

The 1Gb Ethernet utility port found on the ZyPer4K encoders and decoders provides a convenient means of accessing the network. For security reasons these ports can be disabled via the API.

The API command is as follows:

```
set device <device:mac|name> ethernet-management-port enabled|disabled
```

## Port Based Access Control

The ZyPer4K family of products support 802.1X MAC-address Authentication or MAC Address Authentication Bypass (MAB)

802.1X MAC-address Authentication Bypass is an authentication mechanism that lets devices authenticate to the network using their MAC address as an identifier

- A list of authorized MAC addresses of device's NICs is maintained on the RADIUS server for MAB purpose
- MAB can be configured on a per-port basis on the switch
- When a device tries to connect, the switch sends the MAC address of each client to the authentication server
- The RADIUS server checks the MAC address of the client NIC against the list of authorized addresses
- The RADIUS server returns the access policy and VLAN assignment to the switch for each client

Practically speaking, you just have to enter the list of your ZyPer4K TX and RX devices MAC addresses into the RADIUS server and enable on the network.

MAC Address Authentication or MAB is supported by all the major switch vendors including Arista, Cisco, Dell, Extreme, HP, Netgear and Ruckus.

## 10Gb Security

The fact that ZyPer4K is on a 10Gb network and uncompressed video traffic is always greater than 1Gb provides a level of security to "remote data theft". External (Internet) access to any 10Gb AV over IP system will be conducted using a link with 1Gb or much less bandwidth. For example; it is a physical impossibility



to steal uncompressed AV traffic with a bandwidth of 6.5Gb/sec via a 1Gb/sec link.



## Appendix 1: Recommended Switches

The following 10Gbit switches are recommended for use with the ZyPer4K. Please note this is not an all-inclusive list. There are many other switches available that will function with the ZyPer4K.

Manufacturer	Model #	Number of Ports		Notes
		Copper	Fiber	
Netgear	ProSafe XS708T	8	2 (shared)	Disable Multicast Storm Control
Netgear	ProSafe XS712T	12	2 (shared)	Smart Switch
Netgear	ProSafe XS716T	16	2 (shared)	Smart Switch
Netgear	M4300-8x8F	8	8	Fully Managed Switch
Netgear	M4300-12x12F	12	12	Fully Managed Switch
Netgear	M4300-16X	16	0	Fully Managed Switch
Netgear	M4300-24X	24	4 (shared)	Fully Managed Switch
Netgear	M4300-24XF	2 (shared)	24	Fully Managed Switch
Netgear	M4300-24x24F	24	24	Fully Managed Switch
Netgear	M4300-48X	48	4 (shared)	Fully Managed Switch
Netgear	M4300-48XF	2 (shared)	48	Fully Managed Switch
Netgear	M4300-96X	96	96	96 Max Ports. Configurable as mix of Copper/Fiber.
Netgear	M4500-48XF8C	0	48	Included 8 100Gb uplink ports for connection to spine switch
Netgear	M4500-32C	0	32	32-port 100G fiber spine switch
Extreme	X670-G2-48x-4q	0	48	4x 40Gb QSFP+ ports
Extreme	X690-48x-2q-4c	0	48	2x 40Gb QSFP+ ports
Extreme	X690-48t-2q-4c	48	0	2x 40Gb QSFP+ ports
Arista	7050TX-48	32		
Arista	7050TX-64	48		
Arista	7050TX-128	96		
Arista	DCS-7504E	192		Linecard based
Arista	DCS-7508E	384		Linecard based
Arista	DCS-7512E	576		Linecard based
Arista	7150S-24		24	
Arista	7150S-52		52	
Arista	DCS-7504N		576	Linecard based
Arista	DCS-7508N		1152	Linecard based
Arista	DCS-7512N		1728	Linecard based
Dell	X4012		12	
Dell	S4048-ON		48	Up to 72 10GbE ports with breakout cables.
Ruckus	ICX7500	48	4	
Ruckus	ICX7750-48F		54*	48 10GbE SFP+ ports and 6 40 GbE QSFP+ ports



Ruckus	ICX7750-48C	48	6	Fiber ports are 40 GbE QSFP+ ports
Cisco	Nexus 2348TQ	48	48	
Cisco	WS-C3580-48XS		48	48 10GbE SFP+ ports and 4 40GbE QSFP+ ports
Cisco Meraki	MS425-16		16	2x 40Gb QSFP+ ports
Cisco Meraki	MS425-32		32	2x 40Gb QSFP+ ports
Huawei	S6720-30C-EI-24S		24	24 10GbE SFP+ ports and 2 40 GbE QSFP+ ports
Huawei	S6720-54C-EI-24S		48	48 10GbE SFP+ ports and 2 40 GbE QSFP+ ports



## 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 ZyPer4K system
  - a. Must be enabled when all ports default to VLAN used by ZyPer4K system
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
7. Disable IGMP Query on VLAN used by ZyPer4K system
8. Set IGMP Version to IGMP V2
  - a. Must be set if found
9. Enable FASTLEAVE on port X
  - a. Should be enabled, if found
10. Enable FASTLEAVE for VLAN used by ZyPer4K system
  - a. Should be enabled if found
11. Disable Multicast Storm Control on **Netgear switches**. (*Security-Traffic Control-Storm Control-Multicast Storm Control = Disable*)



## Appendix 3: Maximum Transmission Distance

The ZyPer4K product is offered in both Fiber and Copper Ethernet versions. The table below details the maximum transmission distance between either directly connected ZyPer4K units or between the ZyPer4K and a Network Switch.

Cable / Transmission Type	Maximum Distance
850nm Multi-mode Fiber (MMF) OM3/4	300m (990 ft)
1310nm Single-mode Fiber (SMF) 9/125	10km
1550nm Single-mode Fiber (SMF) 9/125	40km
Category 5	Not supported
Category 5e	55m (180 ft)
Category 6 UTP	55m (180 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

**Note:** To achieve maximum distances with Fiber cable it is critical to ensure use of proper Fiber Optic Transceivers and cable types.

ZeeVee Part #	Description	Distance
Z4KSFP10G85-3M	Fiber Optic Transceiver, SFP+ 10Gbps 850nm MMF	300m
Z4KSFP10G31-10K	Fiber Optic Transceiver, SFP+ 10Gbps 1310nm SMF	10km