ATEN KVM over IP Matrix System Implementation Guide

Optimizing Your Network for the KVM over IP Matrix System

KVM over IP Extenders with the CCKM KE Matrix Management Software

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1. Introduction

The ATEN KVM over IP Matrix System is a solution that combines KVM over IP Extenders with the KE Matrix Management Software (CCKM) to extend, control and monitor access to computers, across a network, in a multitude of ways. The purpose of this guide is to ensure that installation project managers and site administrators are aware of ATEN's best practice guidelines for appropriate network structure and configuration for use with the KVM over IP Matrix System. The key elements and recommendations for success, including our suggestions for selecting a suitable network switch, will optimize your installation experience with our products and reduce potential problems.

2. KVM over IP Matrix System Components

The KVM over IP Matrix System lets you set up a matrix of workstations that access computers across a network, with the flexibility to control and configure each connection.

KVM over IP Extenders

The KVM over IP Extenders (Transmitters and Receivers) are installed at computers/workstations, and are configured via the KE Matrix Management Software (CCKM) to create connections between them over a LAN. This allows Extenders to bridge a connection between the workstation and the remote computer they access across a network. Extender setups can be configured for one-to-one, one-to-many, many-to-one, and many-to-many workstation-to-computer connections.

KVM over IP Transmitters
The KVM over IP Transmitters facilitate the secured transmission of A/V data over the network by connecting to source components (computers, set-top boxes, media players, etc.) and converting the source device input into encrypted network packets for delivery over the LAN. Depending on the model, source input can be VGA, DVI, DisplayPort or HDMI up to 4K.

KVM over IP Receivers
The KVM over IP Receivers are connected to display devices (monitors, TVs, projectors) and receive the IP transmissions from the network. Receivers decrypt the data and then convert the signals back to their original format so the A/V content can be displayed at its optimum resolution on the connected display.

KE Matrix Management Software

The KE Matrix Management Software (CCKM) allows you to define connections and manage, customize and control KVM over IP Extender pairings in a matrix configuration with features such as auto-detection of KVM over IP Extenders, username/password authentication, switching and sharing of connections, scheduling, permissions and more. Whether you're extending computer access for monitoring, broadcasting, editing or workstation setup, the KVM over IP Matrix System gives you the flexibility and control to manage one or hundreds of extended connections.

3. General Recommendations

The following general recommendations for installing the KVM over IP Matrix System on a network have been provided here for easy reference. For more details, please follow the individual cross-references and refer to Part 4. Network Design.

Design a simple network layout
Please keep your network installation as simple as possible. A general rule of thumb is to adopt a flat structure – a basic line cascade is recommended, not a pyramid or tree cascade. Please refer to 4.1 Planning Network Architecture

Select suitable cable
It is recommended to use ATEN 2L-2901 Shielded Digital Video Extension Cable to support long distances while safeguarding transmission quality.

Keep distances between switches as short as possible
The distances between the switches should be as short as possible; distances between KVM over IP Extenders should be no more than 100 m (330 ft.)

Ensure that the bandwidth is sufficient
In order to prevent bottlenecks, make sure that there is enough bandwidth between switches. Please see 4.3 Choosing a Network Switch

Choose a high-performance network switch
Please note that a high-performance network switch is essential for long-term, stable KVM over IP Matrix System operation, and it is strongly suggested that you deploy one of the recommended models. Please refer to 4.3 Choosing a Network Switch and 6.2 Recommended Network Switches and Example Models

Try to avoid adapters
To prevent possible noise throughout the installation, avoid using adapters (such as VGA-to-DVI, HDMI-to-DVI). If this cannot be avoided, be sure to use a high quality model (such as ATEN 2A-127G or 2A-128G)

Ensure Firmware is current
Make sure that all the switches and extenders in the installation are up-to-date with the latest firmware.

4. Network Design

4.1. Planning Network Architecture

Build Strategies

For optimum performance, the KVM over IP Extenders require high amounts of data to be transferred across a network; therefore we recommend the following strategies to setup the KVM over IP Extenders. Using our suggestions will provide better performance and the highest video resolutions possible. Use each of the keys to ensure the best transmission of data and the highest throughput possible. Prior to setup we recommended laying out the plans for your KVM over IP Extender installation using the following performance guide

Build a Network Diagram
To build an effective KVM over IP Extender installation, start by mapping out the layout. Create a diagram with the KVM over IP Extenders, computers and routers along with how they will be connected across the network. It also helps to write out how the devices will interact. Use the diagrams below as the framework as you decide what devices to purchase and how to build the network effectively for the best data throughput.

Considerations:

- If possible, create a private network for the KVM over IP Extenders
- Use the same switch model throughout
- Use a flat cascaded layout
- Avoid a tree or pyramid structure
- Limit cascades to two levels
- Install network switches near each other
- Minimize the distance of connections
- Install KE Matrix Management Software (CCKM) computer and KVM over IP Extenders on the same subnet
- Check the 5 following factors before installation:

Choose the Right Cable:
Always use Cat 5/6e Ethernet cable or higher installed by a professional between any two devices you are installing. We recommend using ATEN Brand Ethernet cable to ensure the quality. It's best when installing KVM over IP Extenders to use brand new Ethernet cabling for each part of the installation to ensure the reliability of the data being transmitted. This is a key to getting the best uninterrupted video resolution cross the network.

Determine the Distance:
Distance is an important factor when setting up networks, with a shorter distance and fewer hops through routers, data can be transmitted more efficiently. So whenever possible decrease the distance and direct network traffic effectively between subnets that communicate with each other to increase the data throughput.

Ensure the Bandwidth:

Ensuring the bandwidth ahead of time will guarantee performance before installing KVM over IP Extenders on a network. This will eliminate the primary cause of problems related to video quality and transmission of data. If the speed is right at all ends of your network, then the only other causes are derived from device failure or limits caused by a router, switch or device setting.

Number of ports:

Choose a switch that has enough ports to match the number of KVM over IP Extenders you will be installing. Switches typically come in 5, 8, 10, 16, 24, 28, 48, and 52-port configurations. If you are installing 13 KVM over IP transmitters and 13 KVM over IP receivers, you will need to purchase a switch with at least 28 ports.

Stackable verse Standalone:

Stackable switches allow you to easily manage and configure ports spanning across multiple switches that the KVM over IP Extender devices are connected through. This provides a centralized method to configure and troubleshoot the initial setup of KVM over IP Extender devices on a network which makes fine tuning the bandwidth, data throughput and video quality easier. Stackable switches can be configured to direct the KVM over IP Extender transmissions between many units more specifically and effectively. Standalone switches provide the same configuration features as Stackable switches but they must be set individually. Stackable switches provide an easy way to manage multiple switches, as one unit. For example, instead of configuring, managing, and troubleshooting 6 28-port switches individually, you can manage the six as if they are a single unit using Stackable Switches. The six switches (168 ports) function as a single switch and are managed from one web or GUI interface.

Single Switch Networking

When the KVM over IP Extenders are no more than 100 m (330 ft.) from the central distribution point, and number up to 46 devices, a single switch configuration is recommended.
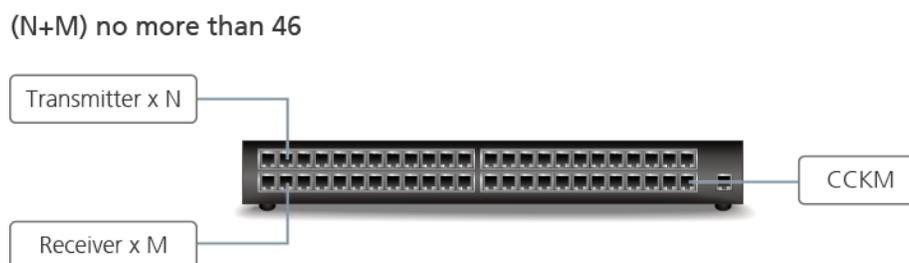
Cascaded Switch Networking

If more than 46 devices are required, it is recommended to cascade switches.

When using 1GB connections between switches, bi-directional data flow must not exceed 1000MB between the core switch and the extended switches, whilst leaving enough headroom for additional traffic.

If the distance between the core switch and the extended switches is more that 100m (330 ft.), fiber optic cabling should be used for the cascade.

In any cascading network setup, it is recommended that the core switch is connected to the KE Matrix Management Software (CCKM).

Simple Cascaded Switch Network

In this setup, the transmitters are centrally deployed.
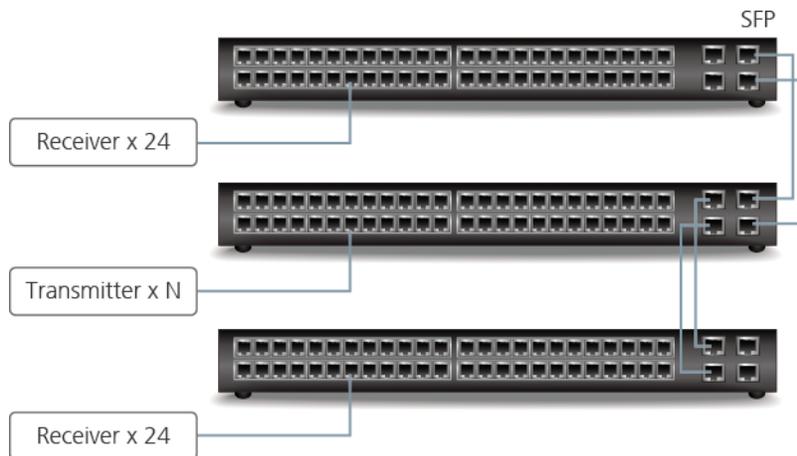
Complex Cascaded Switch Network

If the number of transmitters exceeds 46, or they are not centrally deployed, more complex factors should be considered when cascading. Contact ATEN Tech Support for further information.
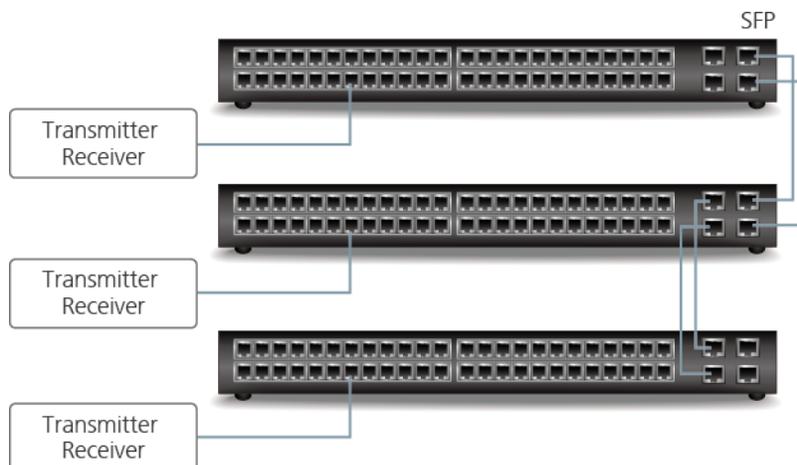
Dedicated or Integrated Network?

It is important to decide as early as possible when implementing the ATEN KVM over IP Matrix System whether the system will be integrated into an existing network or if it will be deployed on a dedicated A/V network. It is highly recommended that the ATEN KVM over IP Matrix System is installed on to a separate dedicated network switch.

4.2 Network Setup Examples

One to One

This is the simplest setup; using a single transmitter to receiver connection that extends a computer's distance from the keyboard, mouse and monitor. One-to-one setups can be directly connected by a Cat 5e/6 cable between two units – up to 100 meters. The KE89xx models can also be connected via optical fiber cables for distances up to 10 kilometers. You can also manage point-to-point connections, set up over a LAN with no distance limitations, by assigning each device an IP address.

Up to 100 meters over a single Cat 5e cable
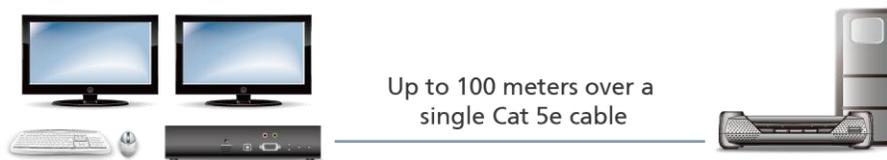
One-to-Many

One-to-Many: With the KVM over IP Extenders you can configure how to share a computer when multiple users access it, with 4 modes: Exclusive (first user has control - others no access); Occupy (first user has control - others view only - when first is inactive - next user to move mouse takes control); Shared (all users have access and control at the same time); or View Only (no control - users can only view the video display).


KE Matrix Manager

Network Switch with IGMP
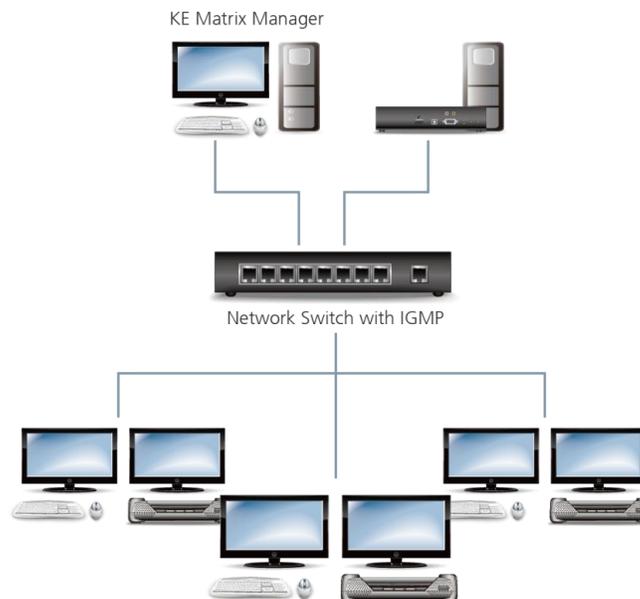
Matrix Mode

Many-to-Many: Delivering the ultimate in flexibility and performance, in this mode the ATEN KVM Over IP Matrix System provides the ability to access, switch, share, and multicast computer resources among multiple KVM consoles across a network. This provides dynamic and flexible extender setups with superior video quality and smooth KVM operations without delays or lags. Utilizing network bandwidth efficiently and intelligently is paramount, particularly with video intensive applications for media post production, live video streams and monitoring control. Multicasting helps optimize network traffic by directing information to the designated receivers without increasing network bandwidth.

* For point-to-multipoint or multipoint-to-multipoint use, the installation requires a network switch with IGMP functionality.
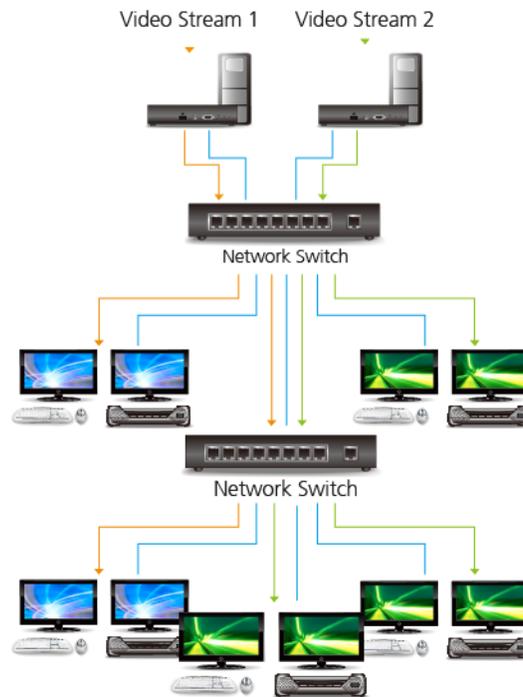
Video Walls

ATEN's CCKM KE Matrix Management Software allows you to create custom video walls. The KVM over IP Matrix System's multicast functionality means it is able to broadcast packets. When the network switch receives the packets, it simultaneously sends them to all of the designated KVM over IP Extenders in the installation for display:
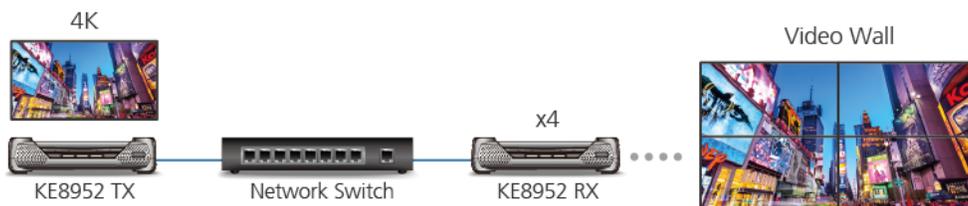
4.3. Choosing a Network Switch

The Basics

In general, the network switches deployed in a KVM over IP Matrix System installation must support the following:

- A dedicated non-blocking switch is preferred in order to prevent congestion, especially when more than 10 KVM over IP Extenders are being deployed
- Gigabit (or faster) Ethernet port
- Multicast forwarding or filtering
- Flow Control Functions
- IGMP Snooping Fast Leave
- IGMP v2 or v3 Snooping (multicast)
- IGMP Querier (on the L3 Switch)
- High bandwidth connection between switches (preferably 10GB fiber)
- Throughput of at least 1GB per port

If the Ethernet switches are to be cascaded, they also need to support the following further functions:

- Dynamic multicast router port
- Forwarding unknown multicast to multicast router only

Types of High Performance Switch

A high performance network switch is the means of a successful KVM over IP Extender setup. When choosing a network switch, first select the type:

Layer 2 or Layer 3 Switches
You will need to determine whether you need a layer 2 or a layer 3 switch for your KVM over IP Extender network. Layer 3 switches cost more than layer 2 switches because they are more complex and handle more network traffic. The best way to calculate which type of switch you need is to first determine if you will have a dedicated network for the KVM over IP Extenders. If the KE devices will be on different subnet with other KVM over IP Extenders, it's best to consider a layer 3 switch if they are on different subnet.

The major differences are:
Layer 3 Switch: A key component of subnets used for multicast distribution is the multicast router. This device plays a vital coordinating role in ensuring that network traffic is delivered to the correct Layer 2 switches and the hosts connected to them. Increasingly, the role of router is being fulfilled by Layer 3 switches, particularly for private networks that do not require links to wider external networks. When selecting a Layer 3 switch for your network, ensure that it can operate as an IGMP Querier and also has sufficient capacity for the size of your subnet.
Layer 2 Switch: Packets are examined and forwarded using only the MAC address. If you have a small central network, a layer 2 switch should do the job. If the network is exclusive and will only transmit the bandwidth of KVM over IP Extenders, layer 2 switches with the correct settings can get the job done effectively.

Further Considerations

Number of ports: Choose a switch that has enough ports to match the number of KVM over IP Extenders you will be installing. Switches typically come in 5, 8, 10, 16, 24, 28, 48, and 52-port configurations. If you are installing 13 KVM over IP transmitters and 13 KVM over IP receivers, you will need to purchase a switch with at least 28 ports.

Stackable verse Standalone

Stackable switches allow you to easily manage and configure ports spanning across multiple switches that the KVM over IP Extenders are connected through. This provides a centralized method to configure and troubleshoot the initial setup of KVM over IP Extenders on a network which makes fine tuning the bandwidth, data throughput and video quality easier. Stackable switches can be configured to direct the KVM over IP Extender transmissions between many units more specifically and effectively. Standalone switches provide the same configuration features as Stackable switches but they must be set individually. Stackable switches provide an easy way to manage multiple switches, as one unit. For example, instead of configuring, managing, and troubleshooting 6 28-port switches individually, you can manage the six as if they are a single unit using Stackable Switches. The six switches (168 ports) function as a single switch and are managed from one web or GUI interface.

What Stackable Switches Can Do:

- Create a link aggregation group with one port in one unit of the stack and another port of that group in another switch in the stack.
- Select a port on one switch in the stack and mirror the traffic to a switch port on another unit of the stack; thus copy the configuration to direct traffic more effectively between KVM over IP Extenders.
- Apply custom ACL security settings to any port on any switch in the stack.
- Stackable switches can be setup in a ring configuration, so that if a port or cable fails, the stack automatically routes around the failure, at microsecond speeds. Stackable Switches also allow you to add and remove stack "members" which are automatically updated and recognized as such.

Switch Specifications

The following specifications are recommended when choosing a layer 2 or layer 3 switch:

- 1000Mbps Gigabit Ethernet switches (1000Mbps or faster Ethernet ports)
- High bandwidth between switches, if possible using Fiber Channel
- Layer 3 switches that efficiently processes IGMP queries
- IGMP Snooping Fast Leave
- IGMP Snooping v2 or v3
- Flow Control Functions
- Throughput of: Full Duplex, 1Gbps up- and down- stream speeds per port
- Performance of their most onerous tasks (e.g. IGMP snooping) with multiple dedicated processors (ASICS)
- It is highly recommended to deploy the same make of switch from the same manufacturer throughout each subnet in the installation to prevent incompatibility issues
- The maximum number of simultaneous 'snoopable groups' the switch can handle meets or exceeds the number of KVM over IP transmitters that will be used to create Channel groups

Note: Please note that implementing IGMP Snooping on a low-level switch may cause serious performance problems, including video lag, due to inefficient handing of data packets

Recommended Capacities

When selecting a suitable switch to work with the ATEN KVM over IP Matrix System, there are important values that need to be considered, such as the switching capacity, forwarding performance, and IGMP functionality. Please note the following basic recommendations.

Switching Capacity – Total bandwidth of the switch * 2.

Forwarding Rate – Total bandwidth of the switch * 1.488.

Switch to Switch Bandwidth – Recommended bandwidth between switches depends on the total count of receivers in the installation.

IGMP Functionality – IGMP is an essential communication protocol for network applications. In multipoint configurations, the IGMP and flow control function of your network switches/hubs must be enabled to avoid the deterioration of data throughput. To ensure full functionality use a layer 3 switch that supports IGMP queries.

4.4. Configuring the Network Switch

IGMP and Other Settings

Configuring the switch correctly will pass data more efficiently, allowing a better stream across the network to each KVM over IP Extender device. The following settings will help optimize your network traffic through a switch:

- Enable IGMP Snooping on L2 switches
- Enable IGMP Querier on the L3 switch
- Enable Flow Control
- Enable IGMP Fast-Leave on all switches where KVM over IP Extender units are directly connected
- Enable Spanning Tree Protocol (STP) on all switches and enable Portfast exclusively on switch ports that have KVM over IP Extender units connected
- Pick an appropriate forwarding mode on all switches. Use Cut-through if available, or Store and Forward

The following table shows the recommended settings for various networking topologies:

Switch Feature	Single Switch Networking	Cascaded Switch Networking	
		Core Switch	**Extended Switch**
Green or energy-saving	Disable	Disable	Disable
Multicast forwarding / filtering	Enable	Enable	Enable
IGMP Snooping	Enable	Enable	Enable
IP Address of IGMP Querier	Must be assigned a valid value		N/A
IGMP Querier	Enable	Enable	Disable
IGMP Snooping fast leave	Enable	Disable	Enable

Note: Please refer to your switch's user guide as different brands and models many have different names for these features

5. Appendix

5.1 Recommended Network Switches

When using a point–to–multipoint or multipoint–to–multipoint (matrix mode) installation it is essential to use a Gigabit network switch with IGMP functionality to experience the best performance. This allows for more efficient throughput of bandwidth resources while supporting this type of setup.

The following table lists network switches that have passed ATEN's stress tests using the KE6900 series extenders. Our tests streamed content over a network with a resolution of 1920 x 1200 @60Hz, 24bit color depth at 60 frames per second.

Cisco	Catalyst 2960X	Catalyst 2960XR	Catalyst 3750
HP	Procurve 2920		
H3C	S5120		
Huawei	S5700		
D-Link	DGS-1510		
Netgear	M4300		
Edgecore	ECS4120		

5.2 Example Switch Models and Capacity Calculations

When you are selecting a network switch suitable to be deployed with the KVM over IP Matrix System, the most important values to check in advance are switching capacity and forwarding rate.

Example Switch Models

Manufacturer	Model	Switching Capacity	Forwarding Rate
Huawei	S5700-28-C-HI	256 Gbps	96 Mpps
	S5700-28-C-HI	256 Gbps	96 Mpps
	S5710-10-BC-PWR-HI	1.024 Gbps	504 Mpps
D-Link	DGS-1510-28	92 Gbps	68.45 Mpps
	DGS-1510-28X	128 Gbps	95.24 Mpps
	DGS-1510-28P	92 Gbps	68.45 Mpps
	DGS-1510-28XMP	128 Gbps	95.24 Mpps
	DGS-1510-52	140 Gbps	104.15 Mpps
	DGS-1510-52X	176 Gbps	130.95 Mpps

Switching Capacity – Total bandwidth of the switch * 2.

Forwarding Rate – Total bandwidth of the switch * 1.488.

Switch to Switch Bandwidth – Recommended bandwidth between switches depends on the total count of receivers in the installation.

5.3 Troubleshooting

Problem: Monitors are flashing and mouse lags when streaming video.
I am using a Cisco Catalyst 2960 in my KVM over IP Matrix System installation (10 KVM over IP Transmitters and 18 KVM over IP Receivers).

Remedy: Ensure that IGMP Querier is enabled. In addition to IGMP snooping for multicast installations, IGMP Querier is also crucial. Use the following commands in Cisco 2960 CLI mode:

```
configure terminal
ip igmp snooping querier
end
show ip igmp snooping vlan 1
copy running-config startup-config
```

5.4. PoE Considerations

Power over Ethernet (PoE) allows an Ethernet switch to provide both data and electrical power to a network device through a single cable. The KE8952 model features PoE functionality, so the transmitter and receiver units can receive power and communications over a single cable.

To avoid overall consumption exceeding the network switch's power capacity, it is recommended that a switch with enough capacity for 15.4W of power to every port is used.