



A Guide to Simple IP Camera Deployment Using ZyXEL Bandwidth Solutions



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Overview:

This article contains guidelines on how to introduce IP cameras into your local network using ZyXEL switches. This article focuses on how to optimize and fine-tune the networks bandwidth requirement. This article assumes that IP camera service is deployed for small to medium businesses and uses unicast instead of multicast. Interaction between the IP camera and server will be strictly through the same layer-2 domain and will not cross any gateways.

Objectives:

- Present configuration examples using Web GUI
- Present scenario on bandwidth optimization
- Troubleshooting VLAN and PoE

Bandwidth Optimization:

This section will now consider the bandwidth of your surveillance traffic. Every link has a maximum transmission rate. 1000Base-T for instance, has a maximum allowable transmission rate of 1Gbps. Each IP camera needs to transmit its video to the server. This can easily create a bottleneck within some of your links. This is especially true on the link leading to your IP camera server. If you fail to properly configure your bandwidth, your surveillance network may suffer from poor video quality or momentary loss of service.

There are four variables to consider in calculating each individual IP camera's bandwidth consumption. *Compression Type, Resolution, Video Quality, and Frame Rate.*

We have provided a table for your bandwidth consumption reference. Note that the *Video Quality* will be fixed in **medium** quality. The output bandwidth of each camera will be in megabits per second (Mbps).

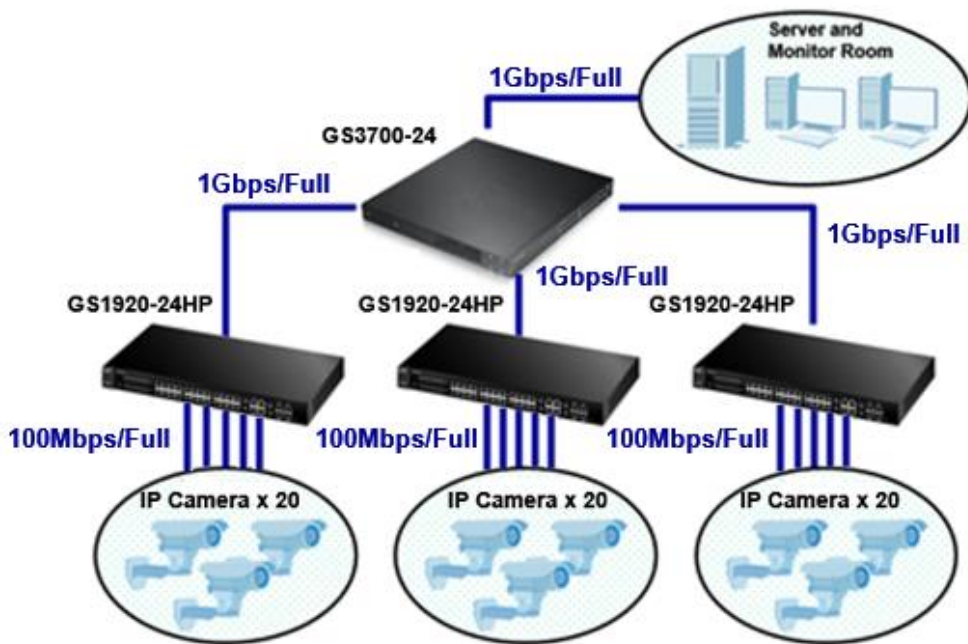


| Video Compression: H.264 | | | | | | |
|---------------------------------|-------|------|-------|-------|-------|-------|
| Resolution \ Frames per second | 5 | 8 | 10 | 15 | 20 | 30 |
| 1 Megapixel | 0.724 | 1.13 | 1.41 | 2.12 | 2.83 | 4.24 |
| 2 Megapixel | 1.04 | 1.67 | 2.09 | 3.13 | 4.18 | 6.27 |
| 5 Megapixel | 2.68 | 4.28 | 5.35 | 8.03 | 10.71 | 16.06 |
| 10 Megapixel | 5.46 | 8.74 | 10.93 | 16.39 | 21.85 | 32.78 |

| Video Compression: MPEG-4 | | | | | | |
|----------------------------------|------|-------|-------|-------|-------|-------|
| Resolution \ Frames per second | 5 | 8 | 10 | 15 | 20 | 30 |
| 1 Megapixel | 1.10 | 1.76 | 2.20 | 3.30 | 4.40 | 6.60 |
| 2 Megapixel | 1.63 | 2.60 | 3.25 | 4.88 | 6.50 | 9.75 |
| 5 Megapixel | 4.16 | 6.66 | 8.33 | 12.49 | 16.66 | 24.98 |
| 10 Megapixel | 8.50 | 13.60 | 16.99 | 25.49 | 33.99 | 50.98 |

| Video Compression: MJPEG | | | | | | |
|---------------------------------|-------|--------|--------|--------|--------|--------|
| Resolution \ Frames per second | 5 | 8 | 10 | 15 | 20 | 30 |
| 1 Megapixel | 9.90 | 15.84 | 19.80 | 29.71 | 39.61 | 59.41 |
| 2 Megapixel | 14.63 | 23.40 | 29.25 | 43.88 | 58.50 | 87.75 |
| 5 Megapixel | 37.48 | 59.96 | 74.95 | 112.43 | 149.91 | 224.86 |
| 10 Megapixel | 76.48 | 122.36 | 152.95 | 229.43 | 305.91 | 458.86 |

Bandwidth Solution Configurations in Web GUI:





Devices:

| Quantity | Device |
|----------|-------------|
| 1 | GS3700-24 |
| 3 | GS1920-24HP |
| 60 | IP Camera |

Objectives:

- Under no circumstances will there be any packet loss between IP cameras and IP camera server.
- For low quality video setting, the physical network topology must not be changed
- Other network services should still function albeit with acceptable packet loss
- IP camera traffic will use priority queue 6

Two scenarios will be implemented. The first scenario will assume that the IP cameras are all configured to produce the same lower quality video and bandwidth requirement. The second scenario will assume that the IP cameras are all configured to produce the same higher quality video and bandwidth requirement. We will assume that the VLAN configurations have already been implemented. Links between the access switch to the IP cameras uses 100Mbps as most PD only supports this transmission speed. We will also assume that this network is not just running a surveillance network but other services as well. The server also has multiple network interfaces allowing link aggregation or LACP as a valid solution.

For the fourth objective, we need to ensure that packets from the IP camera uses priority queue 6. You can do this by going to **Basic Setting -> Port Setup** and set all ports directly connected to your IP cameras with 802.1p Priority: 6

Port Setup

| Port | Active | Name | Type | Speed / Duplex | Flow Control | 802.1p Priority |
|------|-------------------------------------|-----------|--------------|----------------|--------------------------|-----------------|
| * | <input type="checkbox"/> | | - | Auto ▼ | <input type="checkbox"/> | 0 ▼ |
| 1 | <input checked="" type="checkbox"/> | Camera-01 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |
| 2 | <input checked="" type="checkbox"/> | Camera-02 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |
| 3 | <input checked="" type="checkbox"/> | Camera-03 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |
| 4 | <input checked="" type="checkbox"/> | Camera-04 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |
| 5 | <input checked="" type="checkbox"/> | Camera-05 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |
| 6 | <input checked="" type="checkbox"/> | Camera-06 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |
| 7 | <input checked="" type="checkbox"/> | Camera-07 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |
| 8 | <input checked="" type="checkbox"/> | Camera-08 | 10/100/1000M | Auto ▼ | <input type="checkbox"/> | 6 ▼ |



Scenario 1 (Low Quality):

For this scenario, each IP cameras have been configured with the following video format:

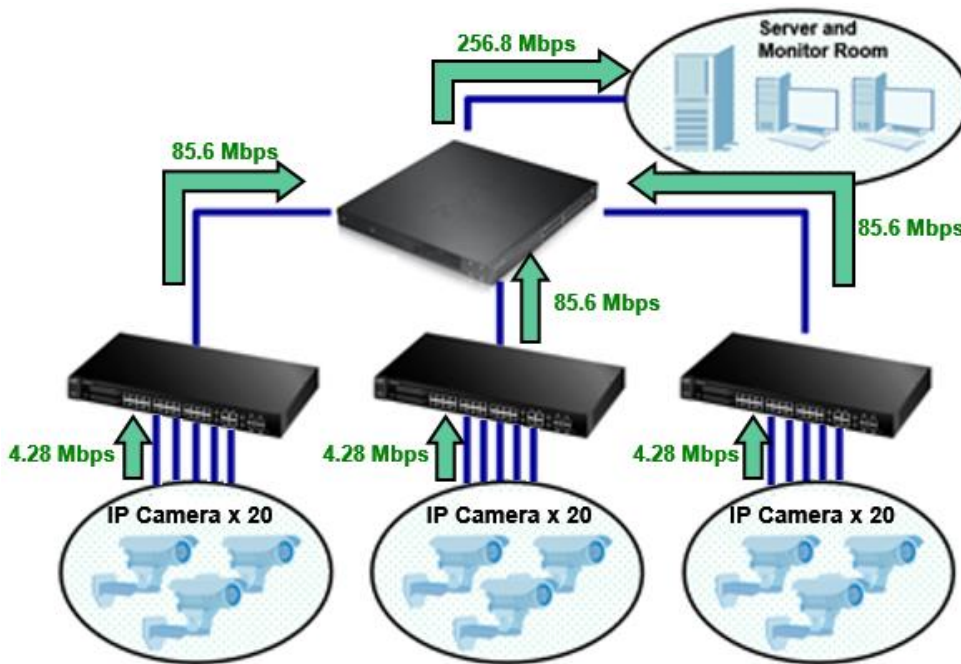
Compression: H.264

Resolution: 5 megapixel

Quality: Medium

Frames per second: 8 fps

Using the table above, we can determine that the bandwidth consumption of each individual IP camera is approximately **4.28 Mbps**.



With 20 IP cameras and each transmitting at 4.28 Mbps, the link between access layers to aggregation layer must have a reserved bandwidth of at least 85.6 Mbps to ensure continued video service during congestion. The link between the core switch and server, on the other hand must reserve 256.8 Mbps.

In order to meet the first and second objectives, we will need to optimize bandwidth using Queueing Method. Weighted Fair Queueing (WFQ) is the queueing method option that allows the switch to reserve bandwidth per queue based on weights during congestion. The reserved bandwidth for each queue can be calculated using this formula:

$$\text{Reserved Bandwidth} = \text{Weight of Queue} * \text{Port Speed} / \text{Total Weight}$$

We know that the bandwidth between the core switch and server must be at least 256.8 Mbps. So let us calculate if the default configuration will reserve Queue 6 with enough bandwidth.



Queuing Method

| Port | Method | Weight | | | | | | | Hybrid-SPQ | |
|------|--|--------|----|----|----|----|----|----|------------|--------------|
| | | Q0 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Lowest-Queue |
| * | WFQ | | | | | | | | | None |
| 1 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | None |
| 2 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | None |
| 3 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | None |
| 4 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | None |
| 5 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | None |

Reserved Bandwidth = $6 * 1000 \text{ Mbps} / 36$

Reserved Bandwidth = **166.67 Mbps**

This is not enough. This means that should congestion happen within your network, the link between the core switch and server will suffer from packet loss. We need to fine-tune the weights for Queue 6.

Queuing Method

| Port | Method | Weight | | | | | | | Hybrid-SPQ | |
|------|--|--------|----|----|----|----|----|----|------------|--------------|
| | | Q0 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Lowest-Queue |
| * | WFQ | 1 | 2 | 3 | 3 | 4 | 5 | 12 | 6 | None |
| 1 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 3 | 4 | 5 | 12 | 6 | None |
| 2 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 3 | 4 | 5 | 12 | 6 | None |
| 3 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 3 | 4 | 5 | 12 | 6 | None |
| 4 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 3 | 4 | 5 | 12 | 6 | None |
| 5 | <input type="radio"/> SPQ <input checked="" type="radio"/> WFQ <input type="radio"/> WRR | 1 | 2 | 3 | 3 | 4 | 5 | 12 | 6 | None |

By taking the weights from the other queues, Queue 6 now has a weight of 12. Let us calculate again to see if this setup meets our requirement.

Reserved Bandwidth = $12 * 1000 \text{ Mbps} / 36$

Reserved Bandwidth = **333.33 Mbps**

Configure the core switch and all access switch with this queuing method setting for consistency.



Scenario 2 (High quality):

This time, we will see what happens when we raise the frames per second of the IP camera to 30 fps. It is expected that the overall bandwidth will increase significantly.

IP Camera Setup

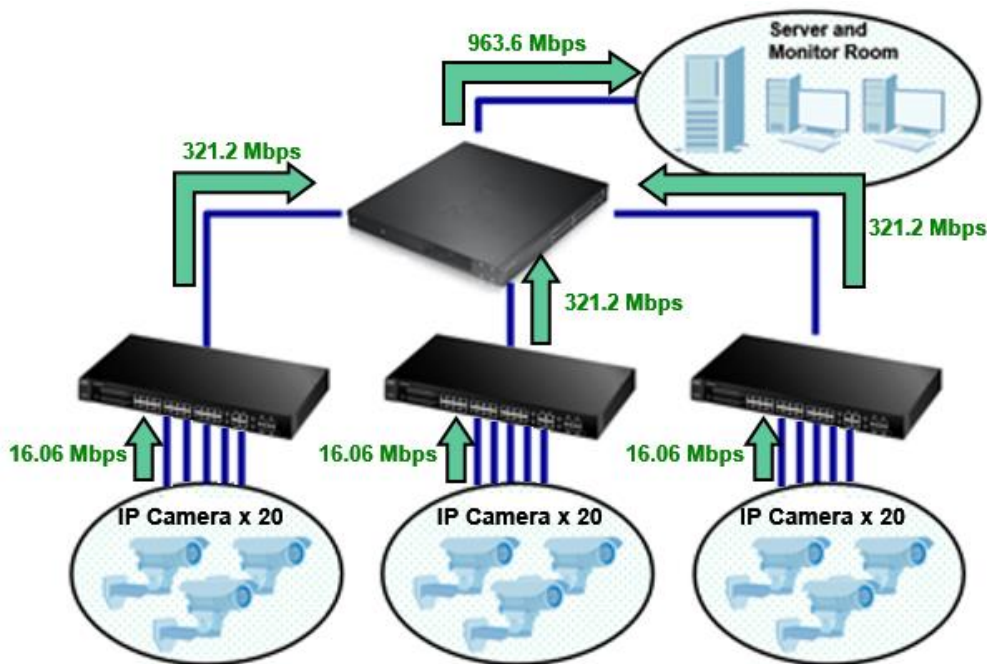
Compression: H.264

Resolution: 5 megapixel

Quality: Medium

Frames per second: 30 fps

Bandwidth of each IP camera: **16.06 Mbps**



The link between access switches and core switch now uses 321.2 Mbps. The link between core switch and server has now risen to 963.6 Mbps. This has now become a problem that queueing method cannot easily solve. 963.3 Mbps is more than 90% of the allowable transmission rate of this link. In this case, we should now use Link Aggregation on the link between core switch and server.

Link Aggregation is the grouping of physical ports into one logical higher-capacity link. This allows your surveillance traffic to be distributed among the aggregated links. Remember, when configuring Link Aggregation, it is important to complete your configurations before physically attaching the extra cables. Failure to configure Link Aggregation before attaching the extra cable will result in a loop.



Go to **Advance Application -> Link Aggregation -> Link Aggregation Setting** of the core switch.

We will use T1 as the trunk interface. Check the **Active** box for T1. Leave criteria as **src-dst-mac**.

Link Aggregation Setting Status [LACP](#)

| Group ID | Active | Criteria |
|----------|-------------------------------------|---------------|
| T1 | <input checked="" type="checkbox"/> | src-dst-mac ▼ |
| T2 | <input type="checkbox"/> | src-dst-mac ▼ |
| T3 | <input type="checkbox"/> | src-dst-mac ▼ |
| T4 | <input type="checkbox"/> | src-dst-mac ▼ |
| T5 | <input type="checkbox"/> | src-dst-mac ▼ |
| T6 | <input type="checkbox"/> | src-dst-mac ▼ |
| T7 | <input type="checkbox"/> | src-dst-mac ▼ |
| T8 | <input type="checkbox"/> | src-dst-mac ▼ |

Below, set the ports you will use to link aggregate as T1. In this case, the core switch is currently physically connected to port 20. A second and third cable will be attached on port 21 and 22 afterwards.

| | |
|----|--------|
| 18 | None ▼ |
| 19 | None ▼ |
| 20 | T1 ▼ |
| 21 | T1 ▼ |
| 22 | T1 ▼ |
| 23 | None ▼ |
| 24 | None ▼ |

In case your server only support LACP, go to **Advance Application -> Link Aggregation -> Link Aggregation Setting -> LACP**.

Check the **Active** box and the T1 **LACP Active** box.

Link Aggregation Control Protocol Link Aggregation Setting

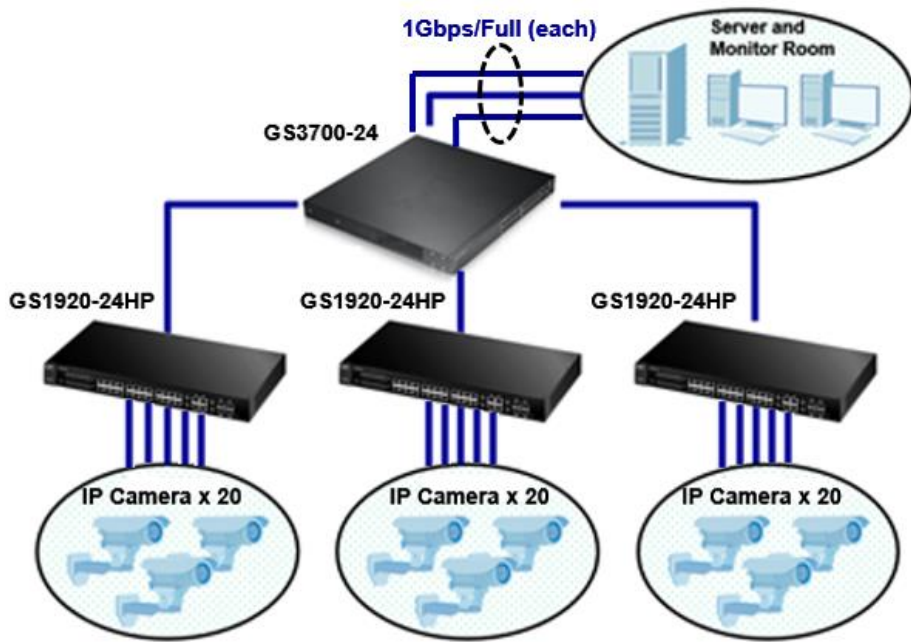
Active

System Priority

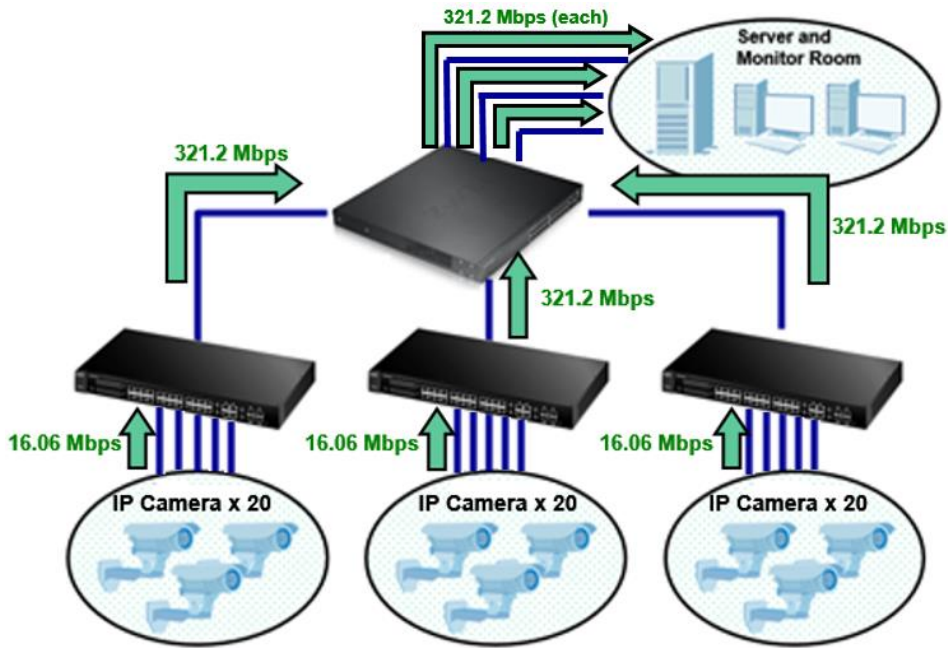
| Group ID | LACP Active |
|----------|-------------------------------------|
| T1 | <input checked="" type="checkbox"/> |
| T2 | <input type="checkbox"/> |
| T3 | <input type="checkbox"/> |
| T4 | <input type="checkbox"/> |
| T5 | <input type="checkbox"/> |
| T6 | <input type="checkbox"/> |
| T7 | <input type="checkbox"/> |
| T8 | <input type="checkbox"/> |



Once configuration is complete, you can proceed to attach the extra cables between the server and core switch.



If you recall the criteria earlier for link aggregation was set to **src-dst-mac**. This means that the traffic is divided among the aggregated links in terms of source mac address to a destination mac address. Each IP camera has its own unique mac address and are supposed to send all their traffic to the server. Therefore, in theory, camera-A is sent out of the first link, camera-B is sent out the second link, camera-C is sent out the third link, and camera-D is sent out the first link again. Each traffic from each camera will be distributed among the aggregated links because of your criteria. Because of this, we can hypothetically assume that each link will transmit 321.2 Mbps of surveillance traffic.



Together with the previous Queuing Method settings, we have already ensured 333.33 Mbps of bandwidth for each link. The network has now been properly configured to optimize the bandwidth of your surveillance traffic.

Troubleshooting VLAN:

1. From the port connected to the IP camera, ping the IP camera server's IP address. A successful ping shows that traffic is flowing both ways. If ping is unsuccessful, verify that packets are processed in the correct VLAN.
 - a. Go to **Management -> MAC Table**.
 - b. Select condition: All.
 - c. Click the "Search" button.

| Index | MAC Address | VID | Port | Type |
|-------|-------------------|-----|------|---------|
| 1 | 00:0c:29:75:2b:5a | 100 | 1 | Dynamic |
| 2 | 00:0c:29:cb:38:d7 | 100 | 2 | Dynamic |
| 3 | 00:0c:29:28:4fae | 100 | 3 | Dynamic |
| 4 | 00:0c:29:11:d4:51 | 100 | 4 | Dynamic |
| 5 | 00:0c:29:2e:98:b9 | 100 | 5 | Dynamic |
| 6 | 4c:9e:ff:6f:90:3f | 1 | 24 | Dynamic |
| 7 | 64:66:b3:50:08:1e | 1 | 24 | Dynamic |
| 8 | 74:d4:35:f4:6b:4e | 1 | 24 | Dynamic |
| 9 | b0:b2:dc:6f:3a:d3 | 1 | 24 | Dynamic |
| 10 | b0:b2:dc:6f:55:db | 1 | 24 | Dynamic |

- d. A list should appear similar to the image above.
- e. Look for the MAC address of the IP camera. If MAC address does not appear, then IP camera most likely has not sent any packets to the switch within the past five



minutes. If MAC address of the IP camera does appear in the MAC table but in an incorrect VLAN, then there is a strong indication of misconfiguration.

2. The ZyXEL VLAN concept follows three rules: the ingress, forwarding, and egress rule. This refers to the PVID, normal/fix/forbidden ports, and Tx-tagging; respectively. Make sure all three rules meet your network policy.
3. If the MAC address of the IP camera does appear in MAC table of your uplink switches and are processed in the correct VLAN, the final thing to consider is if the packets sent to either the IP cameras or server carries any VLAN tag. End-devices by default cannot process packets with VLAN tags. Make sure that ports leading to your IP cameras or servers are set to "untagged".

Troubleshooting PoE:

1. Verify the Ethernet cable condition.
 - a. Make sure that the Ethernet cable length does not exceed 100 meters.
 - b. If PD does not power-on, try swapping the Ethernet cable with a cable that has proven to have no issues powering-on different PD.
 - c. To further determine the condition of the Ethernet cable, go to **Management -> Diagnostic** of the web GUI.
 - d. Select "Cable Diagnostics" and input the port the end-device is connected to.
 - e. Pairs A, B, C, and D should have an "Ok" pair status. If not, please change the cable.
2. Try creating a table to list down which ports were able to power-on PD during your test:

| Device | PD Model X (1) | PD Model X (2) | PD Model Y |
|--------------------|----------------|----------------|------------|
| Switch Model X (1) | | | |
| Switch Model X (2) | | | |
| Switch Model Y | | | |

Testing must be done in an isolated environment. Meaning Switch will only be connected to one PD at a time during testing and no other. Consumption mode is the recommended PoE mode when doing this test.

Switch Model X (1) refers to the reported switch with issue.

Switch Model X (2) refers to a different switch but the same model as the reported switch.

Switch Model Y refers to a different switch but of a different model. Preferably a newer series.



PD Model X (1) refers to the reported PD that has issue.

PD Model X (2) refers to a different PD but same model as the reported PD.

PD Model Y refers to a different PD but of a different model.

Various kinds of conclusions can be made by inspecting the results. Some examples are:

- a. Indicates that PD Model X (1) has hardware issue.

| Device | PD Model X (1) | PD Model X (2) | PD Model Y |
|--------------------|----------------|----------------|------------|
| Switch Model X (1) | None | All | All |
| Switch Model X (2) | None | All | All |
| Switch Model Y | None | All | All |

No ports among all switch could power-on PD Model X (1), while PD Model X (2) shows a different result.

- b. Indicates that your switch has hardware issue.

| Device | PD Model X (1) | PD Model X (2) | PD Model Y |
|--------------------|----------------|----------------|------------|
| Switch Model X (1) | None | None | None |
| Switch Model X (2) | All | All | All |
| Switch Model Y | All | All | All |

Switch Model X (1) could not power-on any PD among any of its ports.

or

| Device | PD Model X (1) | PD Model X (2) | PD Model Y |
|--------------------|----------------|----------------|------------|
| Switch Model X (1) | 1-8 | 1-8 | 1-8 |
| Switch Model X (2) | All | All | All |
| Switch Model Y | All | All | All |

Switch Model X (1) could only power-on PD among some of its ports.

- c. Indicates an interoperability issue.

| Device | PD Model X (1) | PD Model X (2) | PD Model Y |
|--------------------|----------------|----------------|------------|
| Switch Model X (1) | None | None | All |
| Switch Model X (2) | None | None | All |
| Switch Model Y | All | All | All |

Switch of the same model could not power-on PD of the same model among any of its ports.



or

| Device | PD Model X (1) | PD Model X (2) | PD Model Y |
|--------------------|----------------|----------------|------------|
| Switch Model X (1) | 1-16 | 1-16 | All |
| Switch Model X (2) | 1-16 | 1-16 | All |
| Switch Model Y | All | All | All |

Switch of the same model could only power-on PD of the same model among some of its ports.

or

| Device | PD Model X (1) | PD Model X (2) | PD Model Y |
|--------------------|----------------|----------------|------------|
| Switch Model X (1) | 1-16 | 1-16 | All |
| Switch Model X (2) | 16-24 | 16-24 | All |
| Switch Model Y | All | All | All |

Switch of the same model could only power-on PD of the same model among different ports.

3. Verify which PoE mode the switch is using. Classification mode and consumption mode have different behaviors. If one PoE mode does not power-on the PD, try using the other mode.
4. Verify that the total consumed power among all PDs is within expectation. You can verify this in **Basic Setting -> PoE Setup**.
5. Use **Management -> Diagnostic -> System Log** to check for clues:
 - a. PoE Overload Event: means the PD requested more power than the configured max power on the specific port while in consumption mode.
 - b. PoE Power Management Event: means the overall consumed power exceeded the total power budget.
 - c. PoE Short-Circuit Event: means that connected PD may be faulty. It could also mean that the PD is using an older standard and not 802.3af/at. You can try changing the "Power-Up" option to "Legacy" or "Pre-802.3at" in the PoE Setup page.
6. Verify the IP camera model. Some IP camera models will spike in power consumption upon startup. PoE over-budget or port overload can happen if the PoE switch is configured to consumption mode. Visible symptom of this is when multiple IP cameras are able to power-on at the same time, but after the switch reboots, only some of the IP cameras are powered-on.
7. Always remember to upload the latest firmware version of the ZyXEL switch.



8. If you are still having trouble resolving the issue or that you are unsure with your conclusions, kindly contact your local support and provide the following:
 - a. Specific model of the IP camera
 - b. Datasheet of the IP camera models with trouble powering-on
 - c. Firmware of the ZyXEL switch models
 - d. Running configuration of your ZyXEL switches
 - e. Network topology
 - f. Screenshot of the PoE Status page when issue has occurred
 - g. The complete System Log display in web GUI or “show logging” in CLI

For more product information, visit us on the web at www.ZyXEL.com

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