Industrial Ethernet Training 06

Configuring QoS on a Weidmueller switch

Abstract:
QoS is the short form for quality of service. It is used to optimize the performance of multiple applications on a network with resource intensive systems such as Voice over IP (VoIP), video on demand (VOD) or real-time data traffic. It is also used to gain visibility to delay, Jitter and the packet rate of the network. This application note provides a configuration of Quality of Service for the network devices on the Training Kit.

Hardware reference

No.	Component name	Article No.	Hardware / Firmware version
1	IE-Training Kit-01	2881730000	1.1.2 (Build 125086)
2			
3			

IE-Training Kit Content

No.	Component name	Article No.	Hardware / Firmware version
1	IE-SR-4TX	2751270000	1.4.7
2	IE-SW-AL08M-8TX	2682280000	1.08
3	IE-SW-AL05M-5TX	2682250000	1.14
4	IE-CS-MBGW-2TX-1COM	2682600000	3.11

Software reference

No.	Software name	Article No.	Software version
1			
2			
3			

File reference

No.	Name	Description	Version
1			
2			

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Content

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2 Prerequisites for doing

You need to have the following hardware and documentation

- Industrial Ethernet Training Kit
- Application Note Industrial Ethernet Training 01 “Setting up default configuration of IE Training Kit” for applying default IP address configuration

3 Why is Quality of Service (QoS) important?

Let us assume your application, e.g., a production machine, depends on real time data transmitted through your network. In this case, it might be necessary to implement QoS to ensure the real time network traffic is handled with higher priority than other data.

QoS prioritizes data traffic with a higher value which enables detailed management in your network. QoS could for example help to prioritize video and voice data so they don't have to wait in a queue which could result in Jitter or stuttering. If Traffic Prioritization is not enabled the safe communication between two devices cannot be ensured. File Transfer Protocols on the other hand get lower QoS values because they do not rely on low-latency transport.

There are two QoS policies, the weighted fair queuing scheme and the strict priority queuing scheme. The weighted fair queuing scheme will always egress eight frames of the highest priority, four frames of the priority beneath, and so on. This ensures that lower priority frames will not starve. The strict priority scheme will egress only the frames with the highest priority available.

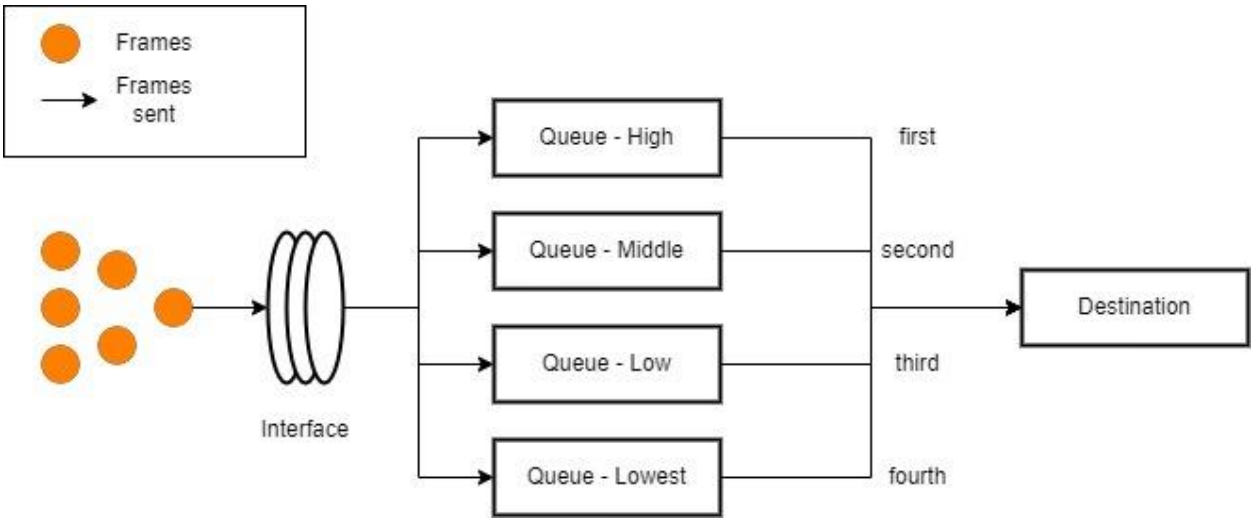

Figure 1: Strict priority queuing scheme

The strict priority queuing scheme will always egress only the packets with the highest frames. This means there will only be high priority packets be sent, as long as there are some in the queue. If the high priority Queue is empty, the middle priority frames will be sent until the queue is empty and so on.

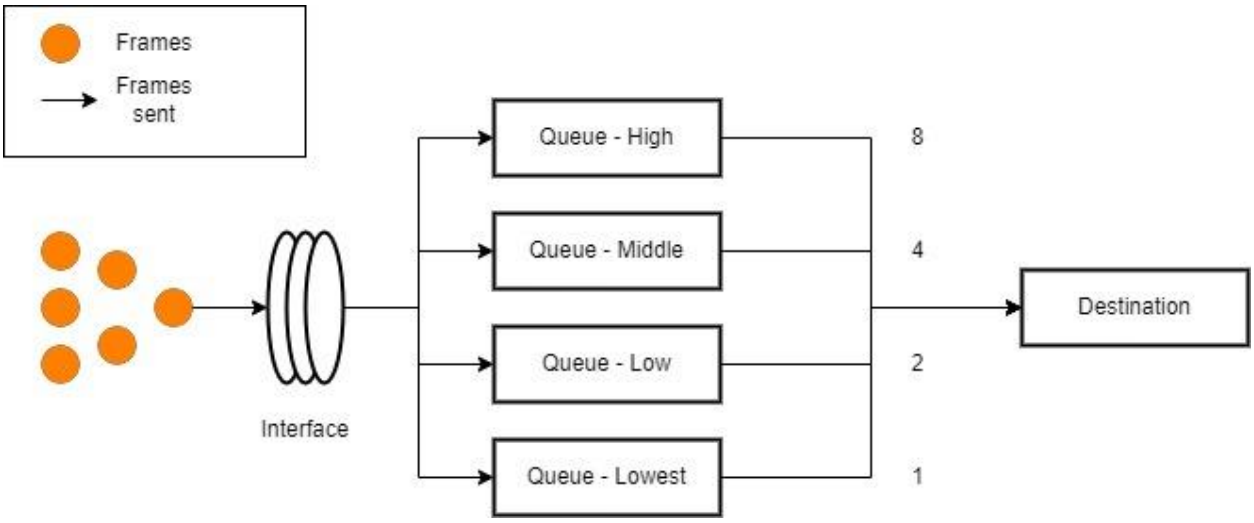

Figure 2: Weighted fair queuing scheme

The weighted fair queuing scheme is a scheme that prioritizes but helps to not let frames starve. It starts with egressing eight frames out of the high priority queue and moves down to the middle queue, where it egresses four frames. Then it will move down to the low priority queue and egress 2 frames. Lastly it will egress one frame out of the lowest priority queue. Now it will start from the beginning and eight frames out of the high priority queue will be egressed.

QoS is NOT available in the Lite Managed models (IE-SW-AL05M-5TX of the IE-Training-KIT-01)

4 How does QoS work?

QoS is a feature usually set in switches or router devices. The 8-port switch of the Industrial Ethernet Training kit allows three different programming modes of QoS: COS (Class of Service), TOS (Type of Service) and Port-based priority.

COS is used at the data link layer (OSI model) and consists of a 3-bit field in the 802.1Q VLAN (Virtual local area network) or 802.1P frame header. When COS is enabled these 3 bits are used to set the priority (0-7) which determines if a frame has a high priority or must wait in the queue in case of congestion. The value of the three bits that indicate the priority according to COS have to be set by the end devices connected to the switch.
Every Weidmüller switch supports a different number of queues, the 8-port switch on the Training Kit has four queues: lowest, low, middle, high (other Weidmüller switches support 8 queues, such as the Gigabit Switch series). The packet's priority is assigned by the default value of the port or the value of the three bits assigned to set the priority according to 802.1P. An example for this would be "*000*" this is the standard priority, "*111*" on the other hand is the priority code for "*immediate*". There are also untagged packets, which do not have a VLAN tag. These untagged packets will get a default value based on the port's value they arrive on.
TOS is used in the network layer (OSI model) and enables IP Precedence. It uses DSCP (Differentiated Services Code Point) which is a 6-bit field inside of a byte in the IP header. This 6-bit field is built as follows:

Meaning	precedence			delay	throughput	reliability	reserved	
Bits	7	6	5	4	3	2	1	0

Table 1: Construction of the DSCP field

Every Bit has a different value when set to 1.

Bits	5	4	3	2	1	0
Value	32	16	8	4	2	1

Table 2: Roots of the 64 DSCP values

In binary format these 6 bits cover a range from 0 to 63, so there are 64 different values in total.

By this, the assignment of the priority is very individual. The File transfer protocol would rely on throughput, this means that the byte would look like this "*010 010*" (x stands for the precedence bits). Where an Email would lay its focus on reliability and the byte would look like this "*xxx 001*". Another good example would be Ethernet/IP with "*101 111*". Looking at the active bits, you can see that a low delay, a high throughput and a high reliability is important. Together with the Precedence, the bits add up to a value of 47, as you can see in Table 1.

Finally, the port-based priority is not based on any standard and does not analyze any information on the received frames. In this mode, the user just defines the priority of each port considering the importance of the devices connected to the different ports.

4.1 Settings for Class of Service

1. To use COS, you first must navigate to “*Traffic prioritization*” on the menu-bar of your IE-SW-AL08M-8TX Switch and select “*Policy*”. Here you can choose if you want to use QoS port-based, COS or TOS and if you want a “*strict priority scheme*” or a “*weighted fair queuing scheme*”. We are going to navigate to “*Policy*” and select “*COS only*” in the drop-down menu and the “*strict priority scheme*”. After completion, please press “*Apply”*.

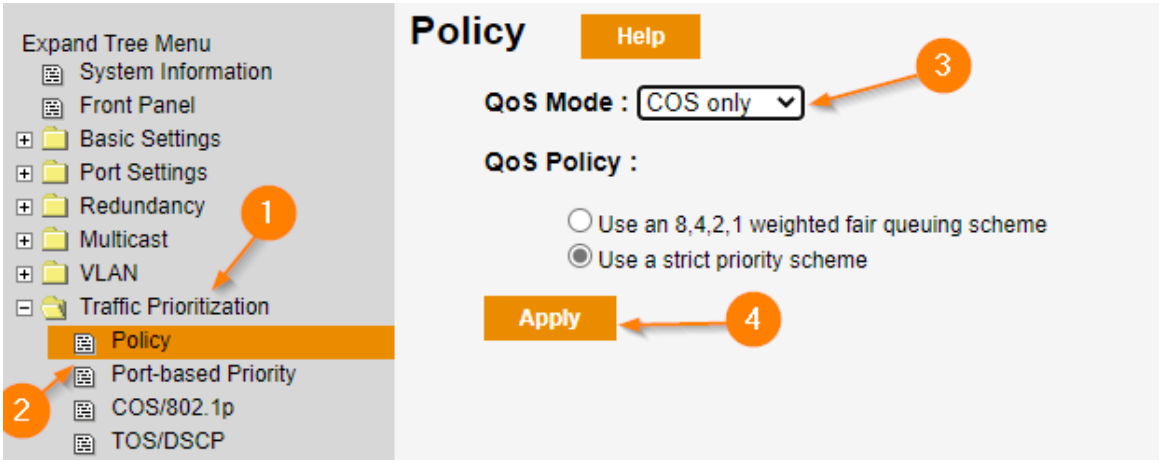

Figure 3: Selecting COS as QoS Mode

2. Now we are going to navigate to *COS/802.1p*. We can assign the four priority values to the eight COS values in the first table and in the table below we can assign default values to ports of the switch. This must be done in a way that packets with no VLAN tag can be treated according to the ports default value. Now you can apply the changes, click on Save Configuration in the menu and COS will work.

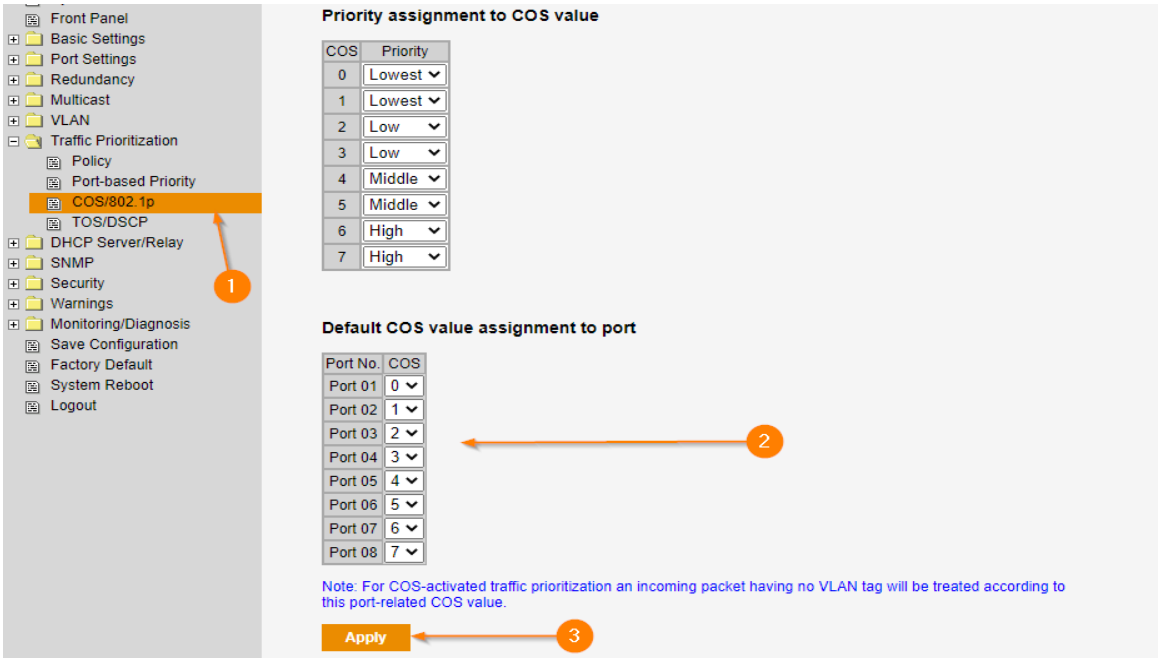

Figure 4: Assigning COS values to ports

4.2 Settings for Type of Service (TOS)

The difference between TOS and COS has been explained in chapter 4: How does QoS work?

1. To use TOS, we first must switch the "*Traffic Prioritization Policy*" to TOS. Therefore, we must navigate to "*Policy*" and switch the QoS Mode to "*TOS only*" and select a QoS Policy. Those are explained in 3 Why is Quality of Service (QoS) important?. Now "*Apply"* the settings.

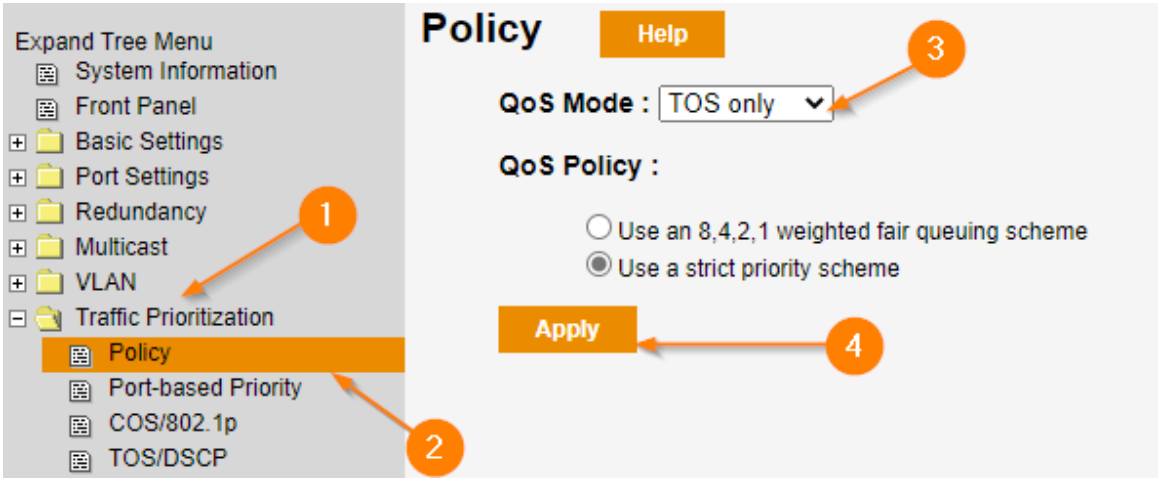

Figure 5: Selecting TOS as QoS mode

2. Now, we can further configure the TOS Settings. Therefore, we must navigate to "*TOS/DSCP*" (differentiated services). With DSCP we have 64 values we can assign to our four priority values (Lowest to High). Now, apply the changes and TOS will be activated. The example "*010 010*" of FTP that is mentioned above, would have a decimal value of 40, which would have a medium priority. Another example are the PTP Event Messages that have a value of 59. Hence 59 should have a high priority and the CIP Priority Low has a DSCP value of 31 which should have a low priority.
   If the network would be beleaguered, the PTP Event Messages would be prioritized, and the CIP Priority Low would have to wait until the network has capacity for it. This could result in starvation of the CIP Priority Low. If this is a problem because the CIP Priority must not starve, then we can change the *QoS Policy* to "*weighted fair queuing scheme*".

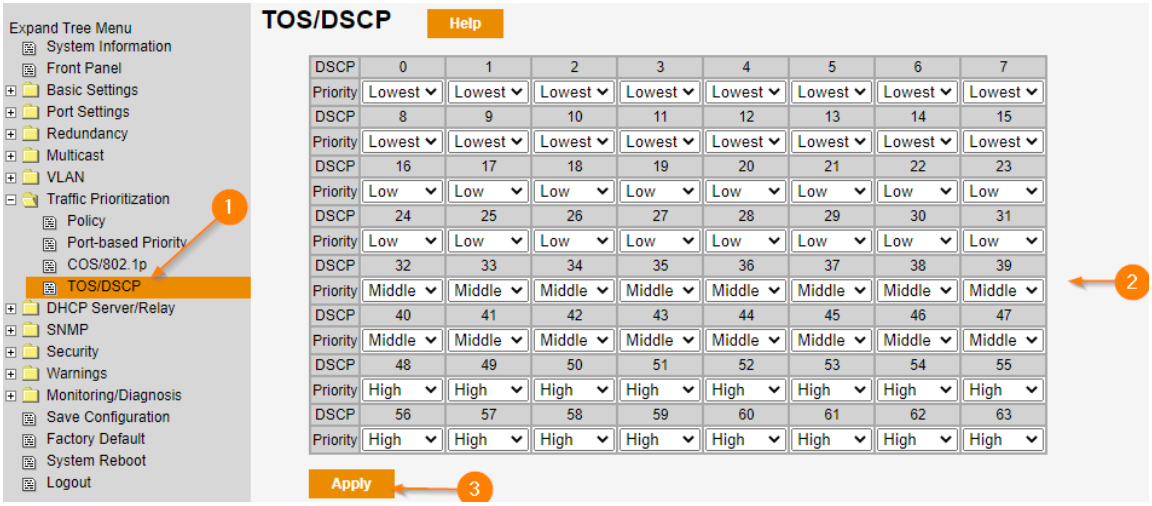

Figure 6: Assigning priority to DSCP values

4.3 Settings for port-based priority

1. Once again, to use Port-based priority, we first must switch the "*Traffic Prioritization Policy*" to "*Port-based*". Therefore, we must navigate to "*Policy*" and switch the QoS Mode to "*Port-based*" and select a QoS Policy (these have been explained in chapter 3: Why is Quality of Service (QoS) important?). Now, click on "*Apply"*.

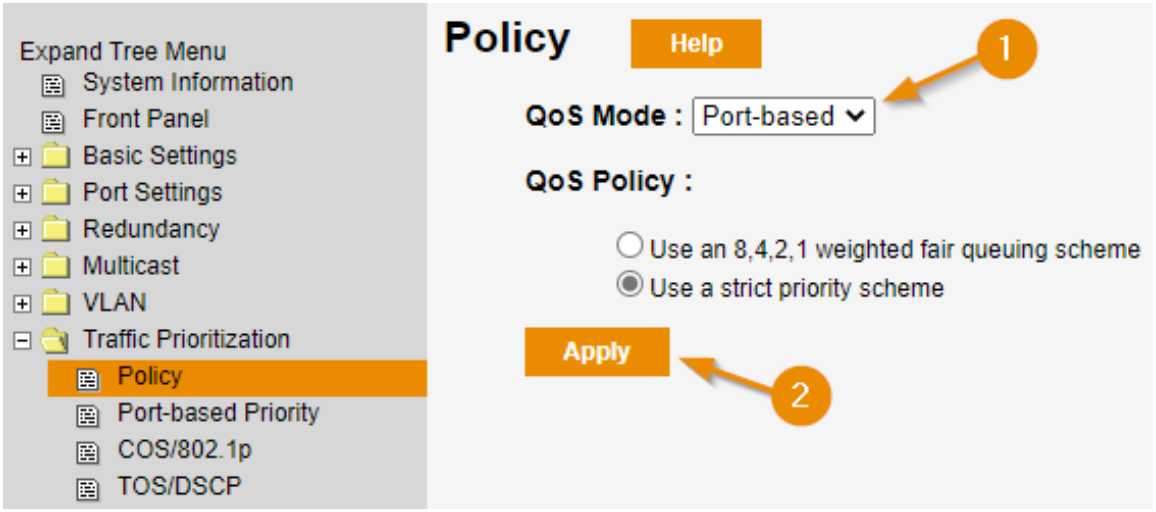

Figure 7: Changing policy to port-based

2. To configure the proper priority, navigate to the menu below *Policy* called "*Port-based Priority*". As an example, we go down in priority from "*High*" to "*Lowest*" in two steps for each port. This means, that a PLC connected to Port 1 of the switch, would have the highest priority for its traffic, whereas any device in Port 8, like a sensor, would have the lowest priority and would have to wait in case of a congested network traffic.

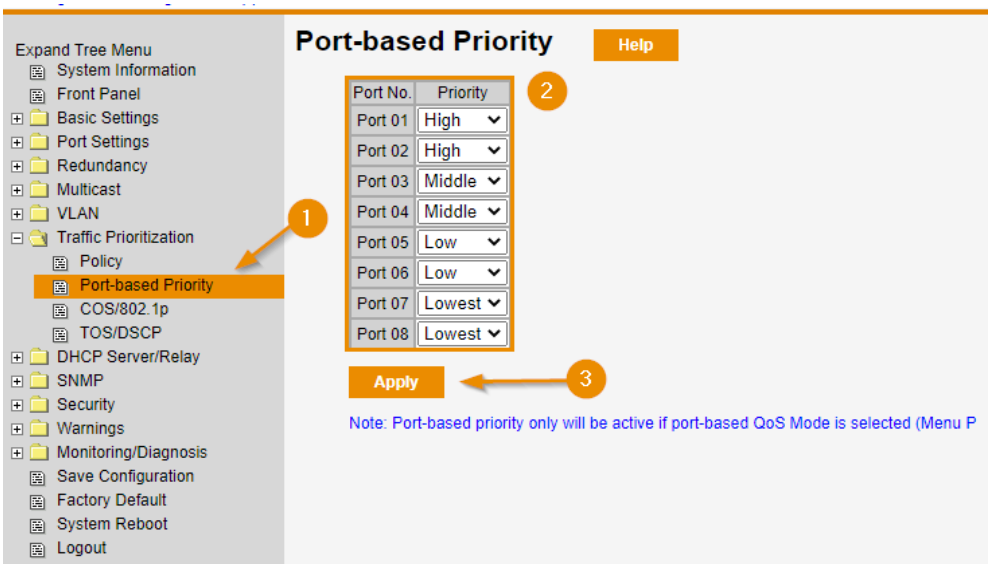

Figure 8: Configuring port-based priority

5 Results

After completing this application note we have now achieved the skills to set up QoS in a Weidmüller switch. This allows us to apply settings to prioritize real time data over other data. This has the consequence that we can prioritize production station traffic over E-mails for example. In other words, this means that even with a beleaguered network we can assure that the production will get the necessary data.

6 List of tables

7 List of figures