

BUFFERS, QUEUES, AND THRESHOLDS ON CATALYST 6500 SERIES ETHERNET MODULES

EXECUTIVE SUMMARY

With the wide variety of Ethernet modules currently available on the Catalyst 6500 series switches, determining the size of the port buffers, the number and type of the receive and transmit queues, and the number of tail-drop or weighted random early detect (WRED) thresholds can be a daunting task.

This document provides a brief discussion of how the port buffers, queues, and thresholds are used in the Catalyst 6500 series switch Ethernet modules, and then describes the buffer sizes, queue structures, and thresholds supported on each of the modules.

This document does *not* discuss the Cisco 7600 Optical Services Module (OSM) interfaces or the new SIP and SPA modules that are also supported in the Catalyst 6500 series switches.

OVERVIEW OF BUFFERS, QUEUES, AND THRESHOLDS

All of the Catalyst 6500 series Ethernet modules implement some form of receive and transmit buffering. These buffers are used to store frames as forwarding decisions are made within the switch, or as packets are enqueued for transmission on a port at a rate greater than the physical medium can support.

In the Catalyst 6500 architecture, access into the switch fabric itself is almost never the bottleneck. Rather, on the transmit side, one or several ports are the likely destination for a majority of the packets entering the switch. As such, the receive-side port buffers on the Ethernet modules are relatively small compared to the transmit-side port buffers.

Without Quality of Service (QoS) features enabled, all packets have equal access to the port buffers, regardless of the type of traffic. For example, Voice over IP (VoIP) packets get placed in the same buffer as HTTP (web) or FTP (file download) data packets. Furthermore, in the event of congestion (that is, a port buffer overflows), all traffic is equally subject to discard. To summarize, packets are serviced in the order in which they were received, and if the buffer is full, all subsequent packets are dropped. This is known as First In, First Out (FIFO) queuing with tail-drop.

When you enable QoS on the switch, the port buffers are carved into one or more individual queues. Each queue has one or more drop thresholds associated with it. The combination of multiple queues within a buffer, and the drop thresholds associated with each queue, allow the switch to make intelligent decisions when faced with congestion. Traffic sensitive to jitter and delay variance, such as VoIP packets, can be moved to the head of the queue for transmission, while other less important or less sensitive traffic can be buffered or dropped.

PORT QUEUE AND DROP THRESHOLD TYPES

When QoS is enabled, the multiple queues and drop thresholds on the Ethernet module switch ports are enabled. There are several different configurations of queue types and thresholds, depending on the model of the Ethernet module.

Ingress and egress scheduling are always based on the COS value associated with the frame. By default, higher COS values are mapped to higher queue numbers. COS 5 traffic, typically associated with VoIP traffic, is mapped to the strict priority queue, if present.

In addition to the different queues, each standard queue has one or more drop thresholds. There are two types of drop thresholds:

- Tail-drop thresholds—On ports with tail-drop thresholds, frames of a given COS value are admitted to the queue until the drop threshold associated with that COS value is exceeded; subsequent frames of that COS value are discarded until the threshold is no longer exceeded.

For example, if COS 1 is assigned to queue 1, threshold 2, and the threshold 2 watermark is 60%, then frames with COS 1 will not be dropped until queue 1 is 60% full. All subsequent COS 1 frames are dropped until the queue is less than 60% full.

- WRED drop thresholds—On ports with WRED drop thresholds, frames of a given COS value are admitted to the queue based on a random probability designed to avoid buffer congestion. The probability of a frame with a given COS being admitted to the queue or discarded depends on the weight and threshold assigned to that COS value.

For example, if COS 2 is assigned to queue 1, threshold 2, and the threshold 2 watermarks are 40% (low) and 80% (high), then frames with COS 2 will not be dropped until queue 1 is at least 40% full. As the queue depth approaches 80%, frames with COS 2 have an increasingly higher probability of being discarded rather than being admitted to the queue. Once the queue is over 80% full, all COS 2 frames are dropped until the queue is less than 80% full. The frames the switch discards when the queue level is between the low and high thresholds are picked out at random, rather than on a per-flow basis or in a FIFO manner. This method works well with protocols, such as TCP, capable of adjusting to periodic packet drops by backing off and adjusting their transmission window size.

When referring to the individual queues and thresholds on a port, a rather terse nomenclature is used. This terminology describes the number of strict priority queues (if present), the number of standard queues, and the number of tail-drop or WRED thresholds within each of the standard queues. The different queue and threshold types on the Catalyst 6500 Ethernet modules are shown in Table 1.

Table 1 Receive and Transmit Port Queue and Drop Threshold Types on Catalyst 6500 Series Ethernet Modules

| Port Queue and Drop Threshold Structure with QoS | Description |
|--|--|
| Receive Queues | |
| 1q2t | One standard queue with two tail-drop thresholds |
| 1q4t | One standard queue with four tail-drop thresholds |
| 1q8t | One standard queue with eight tail-drop thresholds |
| 2q8t* | Two standard queues with eight tail-drop thresholds per queue |
| 1p1q4t | One strict-priority queue, one standard queue with four tail-drop thresholds |
| 1p1q0t | One strict-priority queue, one standard queue with one non-configurable (100%) tail-drop threshold |
| 1p1q8t | One strict-priority queue, one standard queue with eight configurable WRED drop thresholds and one non-configurable (100%) tail-drop threshold |
| Transmit Queues | |
| 2q2t | Two standard queues with two tail-drop thresholds per queue |

Table 1 Receive and Transmit Port Queue and Drop Threshold Types on Catalyst 6500 Series Ethernet Modules

| Port Queue and Drop Threshold Structure with QoS | Description |
|--|---|
| 1p2q2t | One strict-priority queue, two standard queues with two WRED drop thresholds per queue |
| 1p3q1t | One strict-priority queue, three standard queues with one WRED drop threshold and one non-configurable tail-drop threshold per queue |
| 1p2q1t | One strict-priority queue, two standard queues with one WRED drop threshold and one non-configurable (100%) tail-drop threshold per queue |
| 1p3q8t* | One strict-priority queue, three standard queues with eight WRED drop thresholds per queue |
| 1p7q8t* | One strict-priority queue, seven standard queues with eight WRED drop thresholds per queue |

*Queue types that will be standardized on all future linecards

BUFFER SIZE, QUEUES, AND THRESHOLDS BY ETHERNET MODULE

Table 2 provides the following information for each of the Catalyst 6500 series Ethernet modules:

- Total buffer size per port (Total Buffer Size)
- Overall receive buffer size per port (Rx Buffer Size)
- Overall transmit buffer size per port (Tx Buffer Size)
- Port receive queue and drop threshold structure (Rx Port Type)
- Port transmit queue and drop threshold structure (Tx Port Type)
- Default size of receive buffers per queue with QoS enabled (Rx Queue Sizes)
- Default size of transmit buffers per queue with QoS enabled (Tx Queue Sizes)

Table 2 Buffer Size, Queues, and Thresholds by Ethernet Module

| Module Model Name | Module Description | Total Buffer Size | Rx Buffer Size | Tx Buffer Size | Rx Port Type | Tx Port Type | Rx Queue Sizes | Tx Queue Sizes |
|---|---|-------------------|----------------|----------------|--------------|--------------|--------------------|--|
| Supervisor Engine Modules (Gigabit Ethernet and Ten Gigabit Ethernet Uplink Ports) | | | | | | | | |
| WS-SUP720 WS-SUP720-3B WS-SUP720-3BXL | All Supervisor Engine 720 uplink ports | 512KB | 80KB | 432KB | 1p1q4t | 1p2q2t | SP—10KB Q1—70KB | SP—64KB Q2—64KB Q1—304KB |
| WS-SUP32-10GE | Supervisor 32-10GE TenGigabit Ethernet uplink ports | 193MB | 105MB | 88MB | 2q8t | 1p3q8t | Q2—1MB Q1—104MB | SP—14MB Q3—13MB Q2—17MB Q1—44MB |

Table 2 Buffer Size, Queues, and Thresholds by Ethernet Module

| Module Model Name | Module Description | Total Buffer Size | Rx Buffer Size | Tx Buffer Size | Rx Port Type | Tx Port Type | Rx Queue Sizes | Tx Queue Sizes |
|---|---|-------------------|----------------|----------------|--------------|--------------|----------------------|--|
| WS-SUP32-10GE | Supervisor 32-10GE GigabitEthernet Uplink port | 17.7MB | 9.6MB | 8.1MB | 2q8t | 1p3q8t | Q2—1.9MB Q1—7.7MB | SP—1.2MB Q3—1.2MB Q2—1.6MB Q1—4.1MB |
| WS-SUP32-GE | All Supervisor Engine 32 uplink ports | 10MB | 5MB | 5MB | 2q8t | 1p3q8t | Q2—1MB Q1—4MB | SP—715KB Q3—715KB Q2—954KB Q1—2.4MB |
| WS-X6K-S2U-MSFC2 WS-X6K-S2-MSFC2 WS-X6K-S2-PFC2 | All Supervisor Engine 2 uplink ports | 512KB | 80KB | 432KB | 1p1q4t | 1p2q2t | SP—10KB Q1—70KB | SP—64KB Q2—64KB Q1—304KB |
| WS-X6K-S1A-MSFC2 WS-X6K-SUP1A-MSFC WS-X6K-SUP1A-PFC WS-X6K-SUP1A-2GE | All Supervisor Engine 1A uplink ports | 512KB | 80KB | 432KB | 1p1q4t | 1p2q2t | SP—10KB Q1—70KB | SP—64KB Q2—64KB Q1—304KB |
| WS-X6K-SUP1-2GE | Supervisor Engine 1 uplink ports | 512KB | 80KB | 432KB | 1q4t | 2q2t | Q1—80KB | Q2—80KB Q1—352KB |
| Ethernet and Fast Ethernet Modules | | | | | | | | |
| WS-X6524-100FX-MM | 24-port 100BaseFX fabric-enabled with MT-RJ connectors | 1116KB | 28KB | 1088KB | 1p1q0t | 1p3q1t | SP—6KB Q1—22KB | SP—272KB Q3—272KB Q2—272KB Q1—272KB |
| WS-X6548-RJ-21 | 48-port 10/100BaseTX fabric-enabled with RJ-21 connectors | 1116KB | 28KB | 1088KB | 1p1q0t | 1p3q1t | SP—6KB Q1—22KB | SP—272KB Q3—272KB Q2—272KB Q1—272KB |
| WS-X6548-RJ-45 | 48-port 10/100BaseTX fabric-enabled with RJ-45 connectors | 1116KB | 28KB | 1088KB | 1p1q0t | 1p3q1t | SP—6KB Q1—22KB | SP—272KB Q3—272KB Q2—272KB Q1—272KB |
| WS-X6324-100FX-MM | 24-port 100BaseFX with MT-RJ connectors | 128KB | 16KB | 112KB | 1q4t | 2q2t | Q1—16KB | Q2—22KB Q1—90KB |

Table 2 Buffer Size, Queues, and Thresholds by Ethernet Module

| Module Model Name | Module Description | Total Buffer Size | Rx Buffer Size | Tx Buffer Size | Rx Port Type | Tx Port Type | Rx Queue Sizes | Tx Queue Sizes |
|--|--|-------------------|----------------|----------------|--------------|--------------|-------------------|--|
| WS-X6324-100FX-SM | 24-port 100BaseFX with MT-RJ connectors | 128KB | 16KB | 112KB | 1q4t | 2q2t | Q1—16KB | Q2—22KB Q1—90KB |
| WS-X6348-RJ-45 WS-X6348-RJ-45V | 48-port 10/100BaseTX with RJ-45 connectors | 128KB | 16KB | 112KB | 1q4t | 2q2t | Q1—16KB | Q2—22KB Q1—90KB |
| WS-X6348-RJ21V | 48-port 10/100BaseTX with RJ-21 connectors | 128KB | 16KB | 112KB | 1q4t | 2q2t | Q1—16KB | Q2—22KB Q1—90KB |
| WS-X6224-100FX-MT | 24-port 100BaseFX with MT-RJ connectors | 64KB | 8KB | 56KB | 1q4t | 2q2t | Q1—8KB | Q2—16KB Q1—40KB |
| WS-X6248-RJ-45 | 48-port 10/100BaseTX with RJ-45 connectors | 64KB | 8KB | 56KB | 1q4t | 2q2t | Q1—8KB | Q2—16KB Q1—40KB |
| WS-X6248-TEL | 48-port 10/100BaseTX with RJ-21 connectors | 64KB | 8KB | 56KB | 1q4t | 2q2t | Q1—8KB | Q2—16KB Q1—40KB |
| WS-X6248A-TEL | 48-port 10/100BaseTX with RJ-21 connectors | 128KB | 16KB | 112KB | 1q4t | 2q2t | Q1—16KB | Q2—22KB Q1—90KB |
| WS-X6196-RJ-21 WS-X6196-21AF | 96-port 10/100BaseTX with RJ-21 connectors | 1116KB | 28KB | 1088KB | 1p1q0t | 1p3q1t | SP—6KB Q1—22KB | SP—272KB Q3—272KB Q2—272KB Q1—272KB |
| WS-X6148A-RJ45 WS-X6148A-45AF | 48-port 10/100BaseTX with RJ-45 connectors | 5.3MB | 60KB | 5.3MB | 1p1q4t | 1p3a8t | SP—8KB Q1—52KB | SP—810KB Q3—810KB Q2—1.1MB Q1—2.6MB |
| WS-X6148-RJ-45 WS-X6148-RJ-45V WS-X6148-45AF | 48-port 10/100BaseTX with RJ-45 connectors | 128KB | 16KB | 112KB | 1q4t | 2q2t | Q1—16KB | Q2—22KB Q1—90KB |

Table 2 Buffer Size, Queues, and Thresholds by Ethernet Module

| Module Model Name | Module Description | Total Buffer Size | Rx Buffer Size | Tx Buffer Size | Rx Port Type | Tx Port Type | Rx Queue Sizes | Tx Queue Sizes |
|--|--|-------------------|----------------|----------------|------------------|--------------|---------------------------------|--|
| WS-X6148-RJ-21 WS-X6148-RJ-21V WS-X6148-21AF | 48-port 10/100BaseTX with RJ-21 connectors | 128KB | 16KB | 112KB | 1q4t | 2q2t | Q1—16KB | Q2—22KB Q1—90KB |
| WS-X6148X2-RJ-45 WS-X6148X2-45AF | 96-port 10/100BaseTX with RJ-45 connectors | 1116KB | 28KB | 1088KB | 1p1q0t | 1p3q1t | SP—6KB Q1—22KB | SP—272KB Q3—272KB Q2—272KB Q1—272KB |
| WS-X6148-FE-SFP | 48-port 100BaseFX with SFP transceivers | 5.4MB | 60KB | 5.4MB | 1p1q4t | 1p3q8t | SP—8KB Q1—52KB | SP—810KB Q3—810KB Q2—1.1MB Q1—2.7MB |
| WS-X6024-10FL-MT | 24-port 10Base-FL with MT-RJ connectors | 64KB | 8KB | 56KB | 1q4t | 2q2t | Q1—8KB | Q2—16KB Q1—40KB |
| Gigabit Ethernet and 10/100/1000 Modules | | | | | | | | |
| WS-X6816-GBIC | 16-port 1000BaseX dual-fabric with GBIC transceivers | 512KB | 80KB | 432KB | 1p1q4t | 1p2q2t | SP—10KB Q1—70KB | SP—64KB Q2—64KB Q1—304KB |
| WS-X6748-GE-TX | 48-port 10/100/1000T dual-fabric with RJ-45 connectors | 1.3MB | 166KB | 1.2MB | 2q8t (with DFC3) | 1p3q8t | Q2—33KB Q1—133KB (with DFC3) | SP—175KB Q3—175KB Q2—233KB Q1—583KB |
| | | | | | 1q8t (with CFC) | | Q1—166KB (with CFC) | |
| WS-X6748-SFP | 48-port 1000BaseX dual-fabric with SFP transceivers | 1.3MB | 166KB | 1.2MB | 2q8t (with DFC3) | 1p3q8t | Q2—33KB Q1—133KB (with DFC3) | SP—175KB Q3—175KB Q2—233KB Q1—583KB |
| | | | | | 1q8t (with CFC) | | Q1—166KB (with CFC) | |
| WS-X6724-SFP | 24-port 1000BaseX single-fabric with SFP transceivers | 1.3MB | 166KB | 1.2MB | 2q8t (with DFC3) | 1p3q8t | Q2—33KB Q1—133KB (with DFC3) | SP—175KB Q3—175KB Q2—233KB Q1—583KB |
| | | | | | 1q8t (with CFC) | | Q1—166KB (with CFC) | |

Table 2 Buffer Size, Queues, and Thresholds by Ethernet Module

| Module Model Name | Module Description | Total Buffer Size | Rx Buffer Size | Tx Buffer Size | Rx Port Type | Tx Port Type | Rx Queue Sizes | Tx Queue Sizes |
|---|---|------------------------------|------------------------------|------------------------------|-----------------------------|-------------------------------|---------------------|--|
| WS-X6548-GE-TX WS-X6548V-GE-TX WS-X6548-GE-45AF | 48-port 10/100/1000T fabric-enabled with RJ-45 connectors | 1.4MB (shared among 8 ports) | 185KB (shared among 8 ports) | 1.2MB (shared among 8 ports) | 1q2t (shared among 8 ports) | 1p2q2t (shared among 8 ports) | Q1—185KB | SP—182KB Q2—182KB Q1—849KB |
| WS-X6516-GBIC | 16-port 1000BaseX fabric-enabled with GBIC transceivers | 512KB | 73KB | 439KB | 1p1q4t | 1p2q2t | SP—9KB Q1—64KB | SP—64KB Q2—64KB Q1—311KB |
| WS-X6516A-GBIC | 16-port 1000BaseX fabric-enabled with GBIC transceivers | 1MB | 144KB | 880KB | 1p1q4t | 1p2q2t | SP—26KB Q1—118KB | SP—128KB Q2—128KB Q1—624KB |
| WS-X6516-GE-TX | 16-port 10/100/1000T fabric-enabled with RJ-45 connectors | 512KB | 73KB | 439KB | 1p1q4t | 1p2q2t | SP—9KB Q1—64KB | SP—64KB Q2—64KB Q1—311KB |
| WS-X6408-GBIC | 8-port 1000BaseX with GBIC transceivers | 512KB | 80KB | 432KB | 1q4t | 2q2t | Q1—80KB | Q2—80KB Q1—352KB |
| WS-X6408A-GBIC | 8-port 1000BaseX with GBIC transceivers | 512KB | 73KB | 439KB | 1p1q4t | 1p2q2t | SP—9KB Q1—64KB | SP—64KB Q2—64KB Q1—311KB |
| WS-X6416-GBIC | 16-port 1000BaseX with GBIC transceivers | 512KB | 73KB | 439KB | 1p1q4t | 1p2q2t | SP—9KB Q1—64KB | SP—64KB Q2—64KB Q1—311KB |
| WS-X6416-GE-MT | 16-port 1000BaseSX with MT-RJ connectors | 512KB | 73KB | 439KB | 1p1q4t | 1p2q2t | SP—9KB Q1—64KB | SP—64KB Q2—64KB Q1—311KB |
| WS-X6316-GE-TX | 16-port 1000BaseT with RJ-45 connectors | 512KB | 73KB | 439KB | 1p1q4t | 1p2q2t | SP—9KB Q1—64KB | SP—64KB Q2—64KB Q1—311KB |
| WS-X6148A-GE-TX WS-X6148A-GE-45F | 48-port 10/100/1000T with RJ-45 connections | 5.5MB | 120KB | 5.4MB | 1q2t | 1p3q8t | Q1—120KB | SP—810KB Q3—810KB Q2—1.1MB Q1—2.7MB |

Table 2 Buffer Size, Queues, and Thresholds by Ethernet Module

Table 2 Buffer Size, Queues, and Thresholds by Ethernet Module

| Module Model Name | Module Description | Total Buffer Size | Rx Buffer Size | Tx Buffer Size | Rx Port Type | Module Model Name | Module Description | Total Buffer Size | Rx Buffer Size | Tx Buffer Size | Rx Port Type | |
|-------------------------------------|---|------------------------------|------------------------------|------------------------------|-----------------------------|---|---|--|-------------------------------------|----------------|--------------|--|
| WS-X6148-GE-TX | 48-port 10/100/1000T with RJ-45 connectors | 1.4MB (shared among 8 ports) | 185KB (shared among 8 ports) | 1.2MB (shared among 8 ports) | 1q2t (shared among 8 ports) | Optical Services Modules ^a OSM* among 8 ports) | All Optical Services Modules (L2 GbE fabric-enabled ports only) | SP—182KB Q2—182KB Q1—849KB | 73KB | 439KB | 1p1q4t | |
| WS-X6148V-GE-TX | | | | | | | | | | | | |
| WS-X6148-GE-45AF | | | | | | | | | | | | |
| Ten-Gigabit Ethernet Modules | | | | | | | | | | | | |
| WS-X6704-10GE | 4-port 10GbE dual-fabric with XENPAK transceivers | 16MB | 2MB | 14MB | 8q8t (with DFC3) | a. This document only discusses the four “standard” Gigabit Ethernet ports provided by the 4-port GE-WAN OSM or any other OSM-related interfaces. | Q8—40KB Q7—0KB Q6—0KB Q5—0KB Q4—0KB Q3—0KB Q2—0KB Q1—1.6MB | SP—7.2MB Q7—0KB Q6—0KB Q5—0KB Q4—0KB Q3—2.2MB Q2—2.9MB Q1—7.2MB | | | | |
| | | | | | 1q8t (with CFC) | | Q1—2MB | | | | | |
| WS-X6502-10GE | 1-port 10GbE fabric-enabled with OIM connectors | 64.2MB | 256KB | 64MB | 1p1q8t | | 1p2q1t | SP—51KB Q1—205KB | SP—15.3MB Q2—17.9MB Q1—30.7MB | | | |
| WS-X6501-10GEX4 | 1-port 10GbE fabric-enabled with SC connectors | 64.2MB | 256KB | 64MB | 1p1q8t | | 1p2q1t | SP—51KB Q1—205KB | SP—15.3MB Q2—17.9MB Q1—30.7MB | | | |



Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

European Headquarters
Cisco Systems International BV
Haarlerbergpark
Haarlerbergweg 13-19
1101 CH Amsterdam
The Netherlands
www-europe.cisco.com
Tel: 31 0 20 357 1000
Fax: 31 0 20 357 1100

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-7660
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems, Inc.
168 Robinson Road
#28-01 Capital Tower
Singapore 068912
www.cisco.com
Tel: +65 6317 7777
Fax: +65 6317 7799

Cisco Systems has more than 200 offices in the following countries and regions. Addresses, phone numbers, and fax numbers are listed on the Cisco Web site at www.cisco.com/go/offices

Argentina • Australia • Austria • Belgium • Brazil • Bulgaria • Canada • Chile • China PRC • Colombia • Costa Rica • Croatia • Cyprus
Czech Republic • Denmark • Dubai, UAE • Finland • France • Germany • Greece • Hong Kong SAR • Hungary • India • Indonesia • Ireland
Israel • Italy • Japan • Korea • Luxembourg • Malaysia • Mexico • The Netherlands • New Zealand • Norway • Peru • Philippines • Poland
Portugal • Puerto Rico • Romania • Russia • Saudi Arabia • Scotland • Singapore • Slovakia • Slovenia • South Africa • Spain • Sweden
Switzerland • Taiwan • Thailand • Turkey • Ukraine • United Kingdom • United States • Venezuela • Vietnam • Zimbabwe

All contents are Copyright © 1992–2004 Cisco Systems, Inc. All rights reserved. Catalyst, Cisco, Cisco Systems, and the Cisco Systems logo are registered trademarks of Cisco Systems, Inc. and/or its affiliates in the United States and certain other countries.

All other trademarks mentioned in this document or Website are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (0403R) 203254_ETMG_WH_05.04