IEEE 802.1p

- *Expedited Traffic Capabilities*
- *Filtering Services that Support the Dynamic Use of Group MAC Addresses*

Expedited Traffic Capabilities (1)

- Allow the transmission of time-critical data to be expedited (to achieve low latency)
  - even when it is in competition for network bandwidth with other non-time-critical data
- Not intended to provide guaranteed quality of service

Expedited Traffic Capabilities (2)

- Three Steps
  - User priority regeneration
  - Mapping of regenerated user priority to traffic classes
  - Mapping of user priority to outbound access priority

User Priority Regeneration (1)

- Not all MAC layer frame formats include priority field in their headers

  - e.g., IEEE802.5 Token Ring defines 8 priority levels
  - e.g., Ethernet, IEEE802.3 do not include a priority field

- For maximum flexibility, user priority for frames received on a given port may be regenerated according to information that is preset by management procedures

User Priority Regeneration (2)

User Priority	Default Regenerated User Priority	Range
0	0	0-7
1	1	0-7
2	2	0-7
3	3	0-7
4	4	0-7
5	5	0-7
6	6	0-7
7	7	0-7

- User priority value for a frame received on a port may be either the value received in the frame itself (the default value) or mapped to some value in the range 0-7 (preset for that port).

User Priority to Traffic Class Mapping

- For a given bridge, there may be more than one traffic specified, and thus one transmission queue for each traffic class

- Frames are assigned to the transmission queues on the basis of their user priority, using the traffic class table that is part of the state information associated with that port.

Recommended
User Priority to Traffic Class Mappings

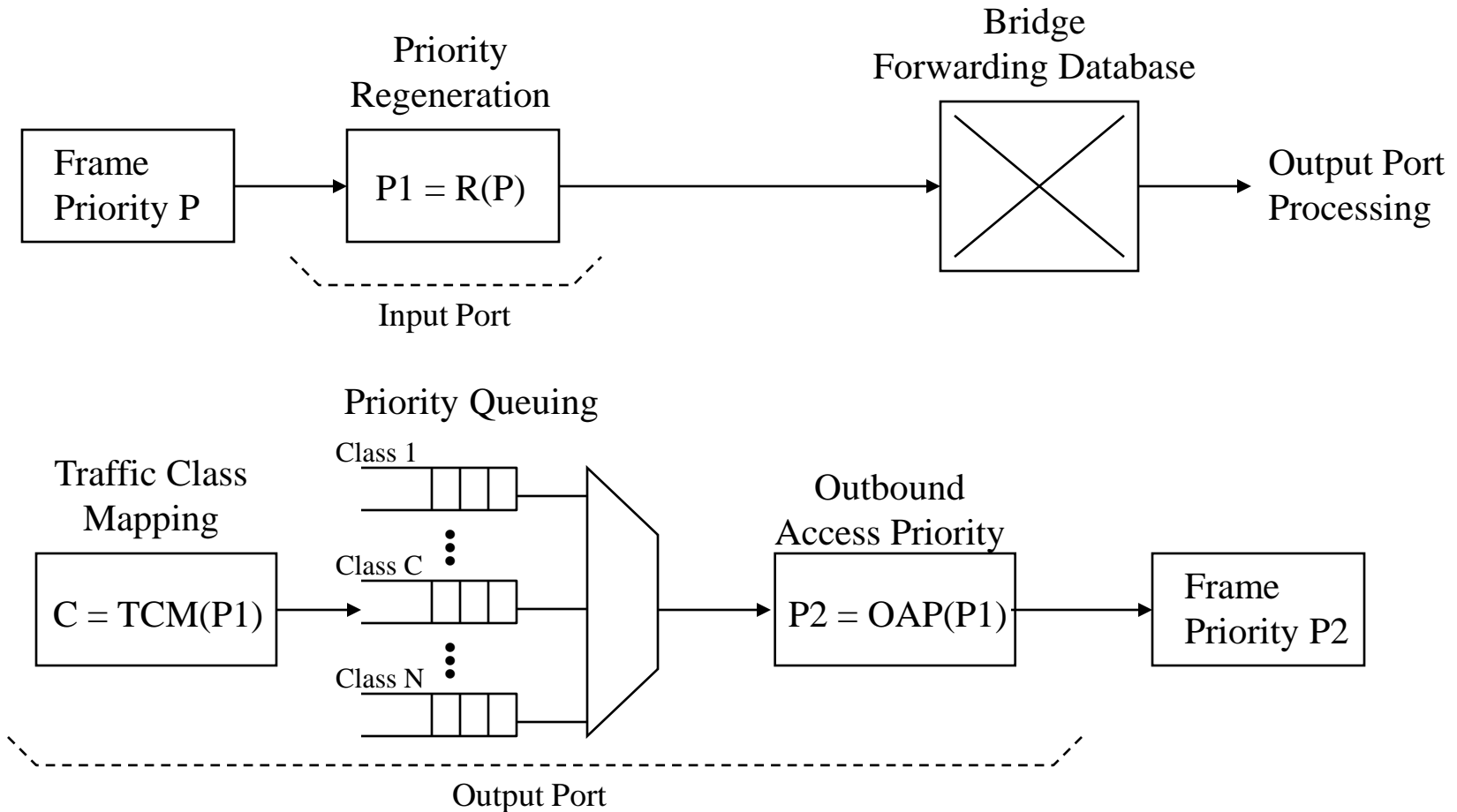|		Number of Available Traffic Classes							
		1	2	3	4	5	6	7	8
User Priority	0 (Default)	0	0	0	1	1	1	1	2
	1	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	1
	3	0	0	0	1	1	2	2	3
	4	0	1	1	2	2	3	3	4
	5	0	1	1	2	3	4	4	5
	6	0	1	2	3	4	5	5	6
	7	0	1	2	3	4	5	6	7

Selection of Frames for Transmission

- According to IEEE802.1p, selection of frames for transmission is based on highest priority first
  - – i.e. , frames are selected from a given transmission queue only if all queues corresponding to numerically higher values of traffic supported by the port are empty at the time of selection
- Other algorithms selectable by management may also be supported as an implementation option

Outbound Access Priorities

User priority	Outbound Access Priority per media access control method							
	8802-3	8802-4	8802-5 (default)	8802-5 (alternate)	8802-6	802.9a	8802-12	FDDI
0	0	0	0	4	0	0	0	2
1	0	1	1	4	1	0	0	0
2	0	2	2	4	2	0	0	1
3	0	3	3	4	3	0	0	3
4	0	4	4	4	4	0	4	4
5	0	5	5	5	5	0	4	5
6	0	6	6	5	6	0	4	6
7	0	7	6	6	7	0	4	6

Summary of the Process

Priority
Regeneration

Bridge
Forwarding Database

| Frame
Priority P | → | $P1 = R(P)$ | | | Output Port
Processing |

Input Port

Priority Queuing

Class 1

Traffic Class
Mapping

Outbound
Access Priority

Class C

$C = TCM(P1)$

$P2 = OAP(P1)$

Frame
Priority P2

Class N

Output Port

Traffic Types
in a Typical LAN Environment (1)

- Network control
  - characterized by a 'must get there' requirement to maintain and support the network infrastructure
- Voice
  - characterized by less than 10 millisecond delay, and hence maximum jitter (one way transmission through the LAN infrastructure of a single campus)
- Video
  - characterized by less than 100 millisecond delay
- Controlled Load
  - Traffic that is subject to *admission control* (i.e., its load is known and limited). Examples: control through traffic engineering, control through reservation mechanisms.
- Excellent Effort -or "CEO's best effort"
  - best effort type services that an information services organization would deliver to its most important customers

Traffic Types
in a Typical LAN Environment (2)

- Best Effort
  - LAN traffic as we know today

- Background
  - bulk transfers and other activities which are permitted on the network but which should not impact the use of the network by other applications

Traffic Type to Traffic Class Mapping

1 Queue

Traffic Type	Maps To
Background	1
Best Effort	1
Excellent Effort	1
Controlled Load	1
Video	1
Voice	1
Network Control	1

2 Queues

Traffic Type	Maps To
Background	1
Best Effort	1
Excellent Effort	1
Controlled Load	2
Video	2
Voice	2
Network Control	2

3 Queues

Traffic Type	Maps To
Background	1
Best Effort	1
Excellent Effort	1
Controlled Load	2
Video	2
Voice	3
Network Control	3

4 Queues

Traffic Type	Maps To
Background	1
Best Effort	2
Excellent Effort	2
Controlled Load	3
Video	3
Voice	4
Network Control	4

5 Queues

Traffic Type	Maps To
Background	1
Best Effort	2
Excellent Effort	2
Controlled Load	3
Video	4
Voice	5
Network Control	5

6 Queues

Traffic Type	Maps To
Background	1
Best Effort	2
Excellent Effort	3
Controlled Load	4
Video	5
Voice	6
Network Control	6

7 Queues

Traffic Type	Maps To
Background	1
Best Effort	2
Excellent Effort	3
Controlled Load	4
Video	5
Voice	6
Network Control	7

The "typical" traffic in each class is in italics.

Traffic Type Acronyms

User_priority	Acronym	Traffic Type
1	BK	Background
2	-	Spare
0 (default)	BE	Best Effort
3	EE	Excellent Effort
4	CL	Controlled Load
5	VI	Video
6	VO	Voice
7	NC	Network Control

Defining Traffic Types

Number of Queues	Defining Traffic Type						
1	BE						
2	BE			VO			
3	BE			CL		VO	
4	BK	BE		CL		VO	
5	BK	BE		CL	VI	VO	
6	BK	BE	EE	CL	VI	VO	
7	BK	BE	EE	CL	VI	VO	NC
8	BK -	BE	EE	CL	VI	VO	NC

Bridge Filtering Services

- Forwarding Process
- Basic Filtering Services
- Extended Filtering Services

Forwarding Process

- When a frame arrives on a bridge port, the frame is submitted to the Forwarding Process

- The Forwarding Process is a six step procedure that determines the outgoing ports on which the frame should be transmitted
    - Enforcing topology restrictions
    - Filtering frames
    - Queuing frames
    - Selecting frames for transmission
    - Mapping priority
    - Recalculating FCS

Step 1: Enforcing Topology Restrictions

- A port is selected as a potential transmission port if and only if:
  - The port on which the frame was received was in the forwarding state
  - The port considered for transmission is in the forwarding state
  - The port considered for transmission is not the same as the port on which the frame was received

Step 2: Filtering Frames

- Filtering decisions are taken by the Forwarding Process on the basis of:
  - The destination MAC address of the received frame
  - The information contained in the Filtering Database for that MAC address and reception port
  - The default Group filtering behavior for the potential transmission port

Steps 3-6

- ## Step 3: Queuing Frames
  - The frame is assigned to a storage queue based on the value of the User Priority as discussed before

- ## Step 4: Selecting Frames for Transmission
  - The default algorithm for selecting frames for transmission is highest priority first

- ## Step 5: Mapping Priority
  - The user priority is mapped to the outbound access priority

- ## Step 6: Recalculating the FCS
  - If a frame is being forwarded between two different MAC types (eg. Ethernet to Token Ring), the Frame Check Sequence may need to be recalculated

The Filtering Database

- The Filtering Database contains information in the form of filtering entries that are either:

  – Static Entries - explicitly configured by management

  – Dynamic Entries - automatically entered into the Filtering Database by the normal operation of the bridge

- Both static and dynamic entries consist of:

  – A MAC address specification

  – A Port Map which specifies the filtering state for the MAC address specification on each outbound Port

Basic Filtering Services

- A bridge must support the basic filtering services
- Basic filtering services allow the specification of the following Filtering Database entries
  - For individual MAC addresses:
    - Static entries which indicate for each outgoing port if frames destined for the specified individual MAC address should be filtered or forwarded
    - Dynamic entries which are created and updated by the learning process
  - For a specific group MAC address:
    - Static entries which indicate for each outgoing port if frames destined for the specified individual MAC address should be filtered or forwarded
    - If no static entry is present for a specific group MAC address, frames destined to the group MAC address are broadcast on all outgoing ports

Extended Filtering Services

- Extended filtering services add the following capabilities to the basic filtering services
  - For individual MAC addresses:
    - Static entries may contain a value which indicates the dynamic filtering information should be used for a specific port rather than always forward or always filter
  - For a specific group MAC address:
    - Static entries may contain a value which indicates the dynamic filtering information should be used for a specific port rather than always forward or always filter
    - Group Registration Entries - dynamic filtering entries which are created and maintained through the use of the GMRP protocol
  - Entries corresponding to All Group Addresses which do not have a specific group MAC address entry
  - Entries corresponding to All Unregistered Group Addresses which do not have a specific group MAC address entry

Default Group Filtering Behavior

- Each port may be assigned a default behavior for forwarding frames with group MAC addresses

- Three default behaviors have been defined
  - Forward All Groups: the frame is forwarded unless an explicit static filtering entry exists
  - Forward All Unregistered Groups: the frame is forwarded unless:
    - An explicit static filtering entry exists
    - An applicable Group Registration entry exists
  - Filter Unregistered Groups: the frame is filtered unless:
    - An explicit static filtering entry exists
    - An applicable Group Registration entry exists